FIFTH DEANS' COMMITTEE
REPORT

भाकृअनुप
ICAR

AGRICULTURAL EDUCATION DIVISION
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan-II
Pusa, New Delhi-110012

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सत्यमेव जयते

त्रिलोचन महापात्र, पीएच.डी.
एफ एन ए, एफ एन ए एस सी, एफ एन ए ए एस
सचिव एवं महानिदेशक

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Foreword

A comprehensive, vibrant, and quality agricultural education system, in congruence with a dynamic research and technology development setting, is fundamental to the national progress and prosperity. The ICAR-Agricultural University system, through creating trained human resources, and generating and transferring new knowledge, technologies and products, had ushered in the Green, White, Yellow and Blue Revolutions,transforming the country from a food-deficit to a food-surplus nation.

The Rainbow Revolution notwithstanding, India is still home to one-fourth of the world's undernourished and poor people. Further, while the food demand is likely to double by 2050, serious yield and total factor productivity gaps exist in our food and agriculture system. Studies reveal that, with the business as usual, in face of the declining land, water and biodiversity resources and the intensifying volatilities of climate change and markets, by the year 2030, only 59 percent of India's total demand for food and agricultural products will be met. Thus, the challenge is to sustain ably produce more from less for more (MLM).

With the above backdrop, the urgency for strengthening our educational standard, graduates employability, and research and extension outcomes can hardly be over emphasised. The task is doubly challenging as, by and large, the youth is indifferent to agriculture as a profession and to agricultural education and sciences as a career. On the other hand, the sector is facing serious shortage of trained quality human resources. The ICAR has brought and continues to bring necessary reforms for quality assurance in agricultural education in this fast changing world. In this resolve, the Council has been periodically appointing Deans' Committees,which, in consultations and deliberations with all stakeholders, have been making recommendations on updating academic norms and standards towards meeting the challenges and opportunities.

This Fifth Deans' Committee,underpinning the congruence of excellence and relevance, has judiciously updated the curricula, course contents, and degree nomenclature, and recommended reforms in admission and examination, pedagogy, faculty requirement, governance etc. The Report also prescribes minimum standards for establishing a new college. Towards harnessing

India's demographic dividend, the Report explicitly details skill development, entrepreneurship, and enhanced employability of the graduates. Most uniquely, the Report addresses the academic legitimacy of new and emerging issues of food and agriculture systems.

The Council is extremely grateful to Prof. R.B. Singh, Chairman of the Fifth Deans' Committee, for his visionary guidance and steering the Committee to align and contextualise the academic pursuits with contemporary and projected national and global agricultural trends. The Council expresses its gratitude to the Chairman and all the distinguished Committee Members for their deep indulgence and contribution in preparation of this invaluable Report. The ICAR shall strive to effectively implement all the recommendations contained in this Report.

It gives me immense pleasure to congratulate Dr. N.S. Rathore, DDG, Agricultural Education Division, ICAR, for accomplishing this mammoth task under his meticulous guidance. I compliment Dr. G. Venkateshwarlu, ADG (EQR) for his imperative efforts and overall coordination of the meetings. Special thanks are due to Dr. K.L. Khurana, Principal Scientist (EQR) for his significant contribution in compiling, and to DKMA for bringing out this Report.

(Trilochan Mohapatra)
Secretary DARE & DG, ICAR

Preface

Human resource capital is the greatest national treasure, and ever-enriching this treasure must be the foremost national resolve. The thrust on creating trained quality human resources in the Agriculture Sector through the countrywide establishment of State Agricultural Universities (SAUs) in the 1960s onwards, along with the deemed universities, had ushered in the Green Revolution, followed by White, Yellow, and Blue Revolutions. The National Agricultural Research, Education and Extension (NAREE) system, one of the largest in the world, had congruently generated the needed scientists, teachers, researchers, technologists, technologies and technology transfer systems to transform India from Ship-to-Mouth situation to the Right-to-Food status.

Despite the Rainbow Revolution, often due to reasons beyond the national level production, the country is still home to almost one-fourth of the world's hungry and poor. Moreover, the total factor productivity (TFP) growth has slackened and farmer-non-farmer income inequity has widened. On the other hand, the food demand by 2050 is projected to almost double, and is to be realized in an environment-friendly sustainable manner from the shrinking land, water, and biodiversity resources. Further, the challenge is exacerbated due to proverbial uncertainties of the fast changing climate and markets.

The above asymmetries could largely be attributed to the sub-optimal performance of our NAREE. Among other things, the intensity for comprehensiveness is low. Wide disconnects exist among agricultural education, research and extension. The coverage of basic sciences in agricultural curricula has eroded and there is widespread academic inbreeding depression. The ICAR – nation's apex body for managing, guiding, coordinating, and regulating agricultural education and research, addresses these issues through several mechanisms. One of the mechanisms is the constitution of Deans' Committees for setting academic norms and standards and revision of curricula.

This Report is the outcome of the Fifth Deans' Committee. Internalizing the Bhubaneswar Declaration, and adopting a bottom-up approach involving all stakeholders (thus ensuring ownership of the recommendations), the Committee has contextualised academic aspects of the challenges and opportunities. Further, it has articulated the knowledge and skills needed among the graduates and recommended curricula reforms and innovations for enhancing employability, employment potential, entrepreneurship, and science-led transformation of India's food and agriculture system, enabling our graduates to become job-providers rather than job-seekers. Importantly, minimum standards for establishing new agricultural colleges have also been recommended. The supplement volume of the Report contains details of

recommended syllabi of eight major disciplines of agricultural sciences.

In developing the curricula, the Committee has internalized the Government's major initiatives *viz* National Food Security Mission, Rashtriya Krishi Vikas Yojana, Make-in-India, Start-up-India, Skill India, Digital India etc. Student READY, including RAWE and Experiential Learning, has been programmed for one full year. The required basic science courses have been included in the agricultural curricula. The Committee has identified six common courses related to climate smart agriculture, agribusiness, marketing, and ICT to be included across agricultural sciences. Further, four new degree programmes covering biotechnology, nutrition, community science, and sericulture have been designed. In order to meet region-specific needs and opportunities, several topical optional courses have been prescribed. The Committee has recommended, in all, 11 UG degrees in Agricultural Sciences, and further commended these to be declared as professional degrees.

Appreciating that this Report is part of the continued process and effort of the ICAR for dynamic improvement of national agricultural education system, critically addressing the contemporary issues, the Committee kept the major global initiatives and foresight in mind towards developing leadership in agricultural sciences to ensure economic attractiveness, global competitiveness, social equity, and environmental sustainability. It seeks to move Indian agricultural education from "Land Grant" to a "World Grant" system to emphasise that 'local' and 'global' elements are interdependent. Asserting that sciences underpin agriculture, the Committee has commended strengthening of science-based learning experience, and changing STEM (Science, Technology, Engineering, Mathematic) to STEAM, where A stands for Agriculture. Commensurately, frontier sciences, such as biotechnology, nanotechnology, information technology, renewable energy, along with social sciences and agri-business management have been duly internalized in the curricula.

The Committee is beholden to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR, and to his predecessor, Dr. S. Ayyappan, for reposing faith in the Committee and giving opportunity and guidance to examine, revise, and update the curricula to build quality human resources and to fortify academic standards in our vitally important agriculture sector.

The Committee would like to place on record its gratitude to all the Vice-Chancellors, Deans,and other stakeholders for their tremendous support in completing this challenging task. My grateful thanks are due to the Discipline Convener Deans, namely, Drs. J. Kumar (Agriculture), H.B. Lingaiah (Horticulture and Sericulture), A.K. Goel (Agricultural Engineering), D.C. Joshi (Food Science and Technology), S.A. Asokan (Veterinary and Animal Sciences), K.M. Shankar (Fisheries Sciences), P. Durairasu and K. Sudhakara (Forestry), Rita S. Raghuvanshi (Home Science), G.R. Patil and Narasimha Murthy (Dairy Technology), H.S. Vijay Kumar (Agriculture Marketing, Business and Cooperation), and H.S. Dhaliwal (Biotechnology) for their pivotal role in this arduous task. The valuable contributions of Subject Matter Specialists in their capacities as Members, Co-Conveners and Special Invitees of the Dean's Committee are gratefully acknowledged.

The Committee is deeply indebted to Dr. N.S. Rathore, DDG (Edn.), ICAR, and to his predecessor Dr. Arvind Kumar, for their indulgence and guidance. It expresses its gratitude to

Dr G. Venkateshwarlu, Member Secretary, for his commitment and support in numerous ways, to Dr. K.L. Khurana, Principal Scientist, for his timely efforts in compiling the Report, and to Dr Rameshwar Singh, Director DKMA, for bringing out the Report.

This Report drives transformative changes by updating, augmenting, and revising course curricula and academic framework to achieve necessary quality and need-based agricultural education to harness the demographic dividend of the country towards comprehensive sustainable food, nutrition, income, health, and livelihood security – the New Normal and Green Economy. The Report is expected to stimulate policy innovations and institutional reforms towards building vibrant human resource capital, knowledge economy, and world-class agricultural universities. We earnestly hope that this document will duly inform and motivate all stakeholders – educationists to policy makers, to congruently take specific actions to transform agricultural education to reshape India.

R.B. Singh
Chairman

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Executive Summary

The State of Agriculture Education

Quality human resource, the main driver of comprehensive development, is the greatest treasure of a nation. India's national agricultural education and research system - the agricultural universities and ICAR institutes, through creating desired trained humanware, ushered in the Rainbow Revolution, led by the Green Revolution launched in the 1960s.

The agrarian progress during the past few years has, however, slackened and serious asymmetries exist in science-led growth of agriculture, farmers' income and food and nutrition securities. these asymmetries are are exacerbated due to the volatilities in climate change and markets, and the declining land, water and biodiversity resources.

The not so satisfactory state of India's food and agriculture system and agrarian economy could partly be attributed to the decline in quality of agricultural education, *viz* erosion of basic sciences from agricultural curricula, extensive inbreeding, serious skill gaps, and poor employability of agriculture graduates. Thus, bridging these gaps in the availability of quality human resources must be a high national priority.

The Indian Council of Agricultural Research (ICAR), an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India is one of the largest national agricultural research and education system in the world. With **103 ICAR Institutes** and **73 agricultural universities** spread across the country, the ICAR, the apex body for coordinating, guiding and managing research and education in agriculture in the entire country, must address the asymmetries.

The Education Division of the Council, towards addressing the veritable asymmetries, undertakes planning, development, coordination and quality assurance in higher agricultural education in the country and, thus, strives for maintaining and upgrading quality and relevance of higher agricultural education thought partnership and efforts of the components of the ICAR-Agricultural Universities (AUs) System comprising 61 State Agricultural Universities (SAUs), 5 Deemed to be Universities (DUs), 3 Central Agricultural Universities (CAUs) and 4 Central Universities (CUs) with Agriculture Faculty.

Quality assurance in higher agricultural education in the country has been pursued through policy support, accreditation, framing of minimum standards for higher agricultural education, academic regulation, personnel policies, review of course curricula and delivery systems, development support for creating/strengthening infrastructure and facilities, improvement of faculty competence and admission of students thought All India competitions.

As foremost step for quality improvement in education, the ICAR has periodically been appointing Deans' Committees for revision of course curricula. In the series, Fifth Deans Committee was constituted and given terms of reference (TORs) considering contemporary challenges for employability of passing out graduates and to adopt a holistic approach for quality assurance and effective governance in agricultural education.

A comprehensive consultation process adopting a bottom up approach was undertaken for curricula development to ensure nation-wide acceptance of the Committee's Report and its ownership by all stakeholders. Inputs from different stakeholders of agricultural education were obtained at different levels. The Committee first deliberated on the skills which graduates must possess and then worked out backward to design course curricula. The Committee identified Conveners/Co-conveners and gave them the responsibility to have inputs from all the Deans of all the colleges of their disciplines based on the suggestions received from their faculty after holding meetings at University/College level. The suggestions received for all the disciplines were reviewed by the Committee.

The Committee has endeavored to make sure that the Report represents a national consensus in respect of its terms of reference and various issues that were flagged to it. In particular, the course curricula have been restructured to underpin relevant practical skills, entrepreneurial aptitude, self-employment, leadership qualities and confidence among graduates, attracting and retaining youth in agriculture, which among other things, will be helpful in implementing the new initiatives of the government, viz., Make-in-India, Start-up-India, Skill India etc.

During this "Decade of Innovations in India", importance of cost effective, location specific and affordable innovations along the value chain and of new extension systems have been highlighted in the revised curricula. Further, the Committee has also considered the international dimension of agricultural education in context of technological, socio-economic, environmental, and livelihood security, and sought to achieve global level academic excellence and relevance. The updated curricula thus provide academic legitimacy to the new and emerging issues of food and agricultural system, and contextualize the new pursuits.

Salient Issues, Outcomes, and Solutions

The salient issues, outcomes and solutions under the different TORs are summarized below:

Defining UG & PG Degrees for General Market Needs and for Specialist Jobs and Uniformity in UG and PG Degree Nomenclature:

Considering the recommendations of the Committee to Review Essential Qualifications and Degree Nomenclature of various Programmes running in Agricultural Universities, and to provide distinct identity to the four year B.Sc. degree offered by SAUs over the three year degree course being run in some colleges under general universities, the Committee decided to add Honours to the degrees in Agriculture, Horticulture, Sericulture, Forestry, and Home Science. The degrees in Agricultural Engineering, Food Technology, Dairy Technology and Biotechnology have been proposed to be named as B. Tech with name of discipline as suffix. The degree in Fisheries Science is to be named as B.F.Sc.

The Master and Doctoral degrees will be named as M.Sc /M.Tech and Ph. D with name of the department/field of specialization as suffix.

Restructuring of UG Programmes for Increased Practical/Practice Contents

Towards enhancing employability and entrepreneurial ability of the graduates the Committee decided to increase the practical content in the courses wherever necessary. It was decided to restrict the maximum number of credit hours in a semester to 21-22 in order to provide time for library consultation and other activities like assignments, seminars and project preparation etc. The total

number of credit hours in 8 semesters including Student READY programme will range from 170 to 183 for all the programmes.

In order to harness regional specialties and to meet region-specitic needs the Committee has recommended offering certain optional courses. such as coastal agriculture, hill agriculture, tribal agriculture etc. As regards individual course contents. universities/colleges may modify the contents to the extent of 30 percent whenever necessary as per the regional demands and needs.

Many new courses have been recommended to be introduced in emerging fields like GIS, Precision Farming, Conservation Agriculture, Secondary Agriculture, Hi-tech Cultivation, Specialty Agriculture, Renewable Energy, Artificial Intelligence, Mechatronics, Plastics in Agriculture, Dryland Horticulture, Introductory Nanotechnology, Agro-meteorology & Climate Change, Waste Disposal & Pollution Abatement, Food Plant Regulations and Licensing, Food Quality, Safety Standards and Certification, Food Storage Engineering, Food Plant Sanitation and Environmental Control, Emerging Food Processing Technologies etc.

The Committee has recommended also to include courses on Personality and Leadership Development, Yoga Practices and Human Values & Ethics in the list of non-credit courses.

Central Assistance for Strengthening of Higher Agricultural Education

The ICAR provides financial assistance to SAUs, DUs and CUs with Agriculture Faculty for strengthening and development of higher agricultural education system throughout the country.

The Committee has recommended continued augmented support for faculty & student amenities, curriculum delivery, development of facilities for UG practicals, computer labs, updation of professional/technical competence of para-professional staff/administrative staff, students study & educational tours, deans' offices, library and to skill development.

ICAR-funded **'Student Exchange Programme'** between colleges located in different agro-climatic zones is recommended towards promoting skill development in the graduating students for specialized jobs as per market needs and demands. Additional funds have been recommended to support the colleges for strengthening / expansion of existing Experiential Learning Programme (ELP) units and to create additional ELP units to accommodate more numbers of students round the year.

The Committee has further recommended that each college should have a **Demonstration cum Production Centre** for training students, field workers of Government Departments, and NGOs community leaders in income generation skills.

Guidelines for Assessing Training Needs and Performance of Teaching Faculties

Considering the fact that teaching faculty constitutes one of the most important pillars of the university education system besides infrastructure and course curricula, the quality of faculty cannot be underestimated when aiming for quality assurance. The Committee has thus strongly recommended that the need of competent and updated faculty should be taken as most important issue and be addressed on priority. The Committee emphasized that besides Assistant Professors for whom two trainings are a requisite for assessment and promotion to higher grade, at least one such training be made mandatory for other levels also, including Heads and Professors, Deans of Colleges and Directors, Vice-Chancellors and Directors of DUs, every five year.

Various trainings have been organized by ICAR, such as, induction training for scientists at entry level, overseas training for global exposure in key emerging areas; and structured trainings for heads of departments, comptrollers, faculty, and technical and Financial staff, pertaining to their specific needs. While further streamlining these provisions the Committee has recommended for increasing the number of overseas trainings so as to keep pace with the changes, and for strengthening international cooperation and identifying additional areas and programmes for training at winter/summer schools, etc. Further, training programmes have been recommended under CAFT exclusively on the new subjects/ courses included in the Report for the benefit of the faculty in SAUs. A separate training programme for the nodal officers/coordinators of Student READY is recommended for efficient execution of the programme.

Reforms in Governance of SA Us

With an objective to have uniformity in the governance of State Agricultural Universities, ICAR brought out the first Model Act in 1966 and has been revising it from time to time. The last revision was made by the Council in 2009. The Fifth Deans' Committee has recommended judicious adoption of the provisions of the ICAR Model Act by all the SAUs.

Minimum Standards for Establishment of New Colleges

ICAR had constituted committees for preparation of Minimum Standards for Higher Agricultural Education for different disciplines of agricultural sciences, specifically in terms of eligibility, minimum admission strength, divisions/departments/sections required, minimum teaching staff in different categories, administrative staff, and laboratory/field equipment/library facilities. The Deans' Committee considered the reports of the committees and endorsed the suggested norms and standards for establishment of a new college of the given discipline.

Further, assimilating the minimum standards suggested by the disciplinary committees, the Fifth Deans' Committee has prepared a framework for preparing Detailed Project Reports (DPRs) for establishment of new colleges. This move should greatly enhance the standards and harmonize the curricula quality across the country.

New Initiatives:

The world is currently witnessing huge technological, socio-economic and political transformations, necessitating nations to change their priorities, investments, and institutions, and to launch new initiatives accordingly. In this context, the Fifth Deans' Committee has recommended the following new initiatives for aligning Indian agriculture curricula with the current national needs and initiatives and with international trends.

The following new initiatives have been strongly advocated:

Student READY (Rural and Entrepreneurship Awareness Development Yojana)

In compliance with the Student READY programme launched by the Hon'ble Prime Minister of India on 25th July, 2015, the following components are proposed for conducting one year program in all the UG disciplines:

- Experiential Learning (EL)
- Rural Agriculture Work Experience (RAWE)
- In Plant Training/ Industrial Attachment

- Hands-on Training (HOT) / Skill Development Training
- Students Projects

Common Courses

In view of the increasing importance of climate change, market competitiveness, information technology, entrepreneurship, and graduates employability, it was a general consensus that students of all disciplines need to be taught courses on the following concerned topics:

1. Environmental Studies and Disaster Management
2. Communication Skills and Personality Development
3. Information and Communication Technology
4. Entrepreneurship Development and Business Management
5. Agricultural Informatics
6. Economics and Marketing

New Degree Programmes

Keeping in mind the latest scientific developments impacting food and agriculture systems, considering new societal needs and demands, and in line with current national policy thrust, the Fifth Deans' Committee has proposed introduction of the following new courses:

- B. Tech (Biotechnology)
- B.Sc. (Hons) Sericulture
- B.Sc. (Hons) Community Science (Home Science renamed)
- B.Sc. (Hons) Food Nutrition and Dietetics

Holistic Distribution of Courses:

The Committee has attempted to distribute the courses in the following form to inculcate the Basics, Principles and Skills in a systematic way.

I year	–	Basic and fundamental courses (Tradtional)
II Year	–	Principles (Technology)
III Year	–	Production system (For improving Talent)
IV Year	–	Skill and entrepreneurship development (For federating Trading)

Declaring Degrees in Agricultural Sciences as Professional Degrees:

The Committee strongly recommends that all degrees in the disciplines of Agricultural Sciences be declared as professional degrees, which include undergraduates in:

1. Agriculture
2. Agriculture Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries
6. Food Technology
7. Forestry
8. Community Science (Home Science)

9. Food Nutrition and Dietetics
10. Horticulture
11. Sericulture

Increasing Role of Basic Sciences in Agriculture

Over the years, the visibility of basic sciences in agricultural curricula has decreased, On the other hand, globally, greater emphasis is being placed on life sciences - biochemistry, microbiology, genetics, molecular biology, biotechnology, bio - remediation, bioenergy, biosecurity and computational biology. Agriculture graduates and scientists should increasingly seek employment and research opportunities in these frontier areas. Accordingly, agriculture curricula should put Agriculture in the middle of Science, Technology, Engineering and Mathematics ("STEM") to make it "STEAM", where A means Agriculture. While vocational education and RAWE and HOT will remain extremely important in the Indian context, the science-based hands on learning experience should be duly promoted. The revised curricula should increasingly be internalizing the "STEAM" concept.

Global Interdependence and International Agriculture

India, accounting for 17% of world's population and over 30% of world's smallholder farmers, and hardly 2.5% of the world's land and 4% of world's water resources, greatly impacts and gets impacted by the state of global food, agriculture and natural resource system. Thus, the major global initiatives and foresight must be kept in mind while developing leadership in agricultural sciences to ensure global competitiveness, equitable knowledge sharing, and environmental sustainability. Accordingly, the system should move from the Land-Grant to a "World Grant" pattern. The new curricula, courses and contents have been designed to duly inform the students of the new global initiatives, such as Global Green Economy; Knowledge Economy; Global Zero Hunger Challenge; UN International Year themes *viz.* International Years for Pulses, Family Farmers and Smallholder Farmers, Soil and Water; Sustainable Development Goals, 2030; and International Agriculture and Development Challenge, 2050.

Implementation of Recommendations:

The course curricula contained in the report are designed and geared to ensure excellence, relevance, and creation of skilled, talented, and entrepreneurial human resources and knowledge pools to harness demographic dividends, and to achieve high quality of products, farmers profitability, zero environmental footprint, climate resilience, high input and natural resources use efficiency, inclusiveness, and competitiveness.

In order to achieve the above goals, the recommendations of the Fifth Deans' Committee must be implemented judiciously and should be mandatory. The Committee underpinned that an effective process of monitoring, evaluation and accountability as per an agreed result framework is a must for ensuring judicious implementation of the recommendations. Further, it emphasized that only the accredited institutions and programmes should be eligible to seek ICAR development grant.

The Context: Transforming Agricultural Education to Reshape India

Introduction

Transformation of the Indian Agricultural Education in the late 1950s through the 1960s, augmenting science, technology and innovation, was the driver of the Green Revolution, which enabled India to free herself from the Ship-to-Mouth situation to attain the Right-to-Food status. Soon after independence, in 1949, Dr. S. Radhakrishnan, a great educationist, humanist and philosopher, in his Report to the Commission on University Education, had envisioned establishment of autonomous holistic rural universities that would teach not only agricultural sciences and practices but also humanities, mathematics and natural sciences, and usher in the generation and use of new knowledge, skill and technologies needed to develop India. This vision was realized through the implementation of the recommendations of the Indo-American teams, 1955 and 1959, for establishing agricultural universities on the Land Grant University (LGU) pattern, envisaging integrated research, education and extension for agriculture-led development. In 1958, the Indian Agricultural Research Institute (IARI), New Delhi, India's flagship institute, heralded the change by organizing its PG School on the LGU pattern, and was subsequently declared as a Deemed University (DU) by the University Grants Commission.

The first State Agricultural University on the LGU pattern was established in 1960 at Pantnagar, today famous as Govind Ballabh Pant University of Agriculture and Technology (GBPUAT). And, it was not a mere coincidence that the First Convocation Address of the University was delivered in 1963 by the then President of India, none other than the above-mentioned Dr. Radhakrishnan, whose report had triggered the establishment of SAUs. In his Address he had underpinned "We can't blame the farmers, we can't blame the land and we can't blame anything. We, who are the leaders of the country, must not fail the farmers. We must try to bring to them the most up-to-date knowledge. That is what we have to do. If we do that, I have no doubt on the discontinuance of the import of food grains from abroad …… I hope, the graduates of this University will set a different example and will do something substantial for the improvement of Agriculture". These words of the Bharat Ratna must always guide our

agricultural scientists, teachers, academicians, administrators, and students towards a knowledge-led agriculture.

A series of SAUs were established in the 1960s and 1970s, and in the initial decades contributed immensely to build trained human resources and to usher in the Green, Yellow, White, and Blue Revolutions in the country. Between 1960 and now, production of food crops, horticultural crops, livestock, and fisheries has increased four-to-ten-fold. The Rainbow Revolution had halved the incidences of hunger and poverty in the country, whereas the population had more than doubled.

But, despite the Rainbow Revolution and comprehensive National Agricultural Research and Education System (NARES) comprising 73 Agricultural Universities (AUs) consisting of 61 SAUs, 5 DUs, 3 Central Agricultural Universities (CAUs) and 4 Central Universities with Agriculture Faculty, and 101 ICAR institutes, often due to reasons beyond the national level production, the country is still home to almost one-fourth of the world's hungry and poor. Over 40% of world's undernourished children are our own children. It is estimated that the high under-nutrition in the country annually costs about 3% of the national GDP, let alone the entrenched human deprivation. The Second UN International Conference on Nutrition, 2014, had pledged to "improve nutrition by strengthening human and institutional capacities to address all forms of malnutrition through, inter alia, relevant scientific and socio-economic research and development". Moreover, the income inequities, especially between farmers and non-farmers, and other asymmetries, have widened, reflecting the stunted structural changes in the country.

One of the main reasons for the not-so-satisfactory situation is the sub-optimal performance of several of the AUs. Among other things, the intensity for comprehensiveness has declined, investment in agricultural research-education-extension is a low, and academic inbreeding depression is widespread. Consequently, the educational standards, faculty quality, graduates' employability, and research and extension outcomes have declined. These weaknesses are bound to lead to low individual achievements and overall poor performance, and also get reflected in the national indices such as hunger index, human development index, science index etc.

Lately, reports on Ranking of World's Universities have received global attention. Unfortunately, none of the Indian universities find place in the first 100 or 200 ranked universities of the world in the recent years. This situation has been noted by all stakeholders, namely, universities, institutions, scientists, students, industry and farmers. So much so, that the President and the Prime Minister of India have publically expressed their concerns on this unacceptable situation.

Moreover, the indifference of the youth to agricultural sciences and education is greatly hampering the availability of suitably trained human resources across the agricultural value chain, and resulting in inadequate innovations and technologies in the food and agriculture system. This gap must be filled today, as today's students will be the professionals in the 2030s and 2040s, when they will be challenged to provide science-led doubling of agricultural production from the shrinking land, water and biodiversity resources, "more from less for more" (MLM). In doing so, the fast changing trends and new and emerging challenges and opportunities should be duly internalized.

The Bhubaneswar Declaration on Indian Agricultural Education

The National Academy of Agricultural Sciences (NAAS) - the national think tank for agricultural research and education for development, in close collaboration with the Indian Council of Agricultural Research (ICAR) – the nation's apex body for agricultural research and education, organized its XI Agricultural Science Congress on *"Transforming Agricultural Education for Reshaping India's Future"at Bhubaneswar in 2013. It was attended by more than 500 delegates, including several world leaders in agricultural education from India and abroad. The Congress had identified the following gaps and constraints in the Indian agricultural education system.

- Low priority to agricultural education as a career option, consequently the gross enrolment was only 0.03%; poor employability of the graduates
- Declining quality of students, poor quality of education due to obsolete and inadequate equipment, laboratory, farm and library facilities, leading to knowledge deficit all along the value-chain, particularly in new and emerging areas, such as biotechnologies, nanotechnology, informatics and communication, and more so in the private colleges
- Depleting number and quality of faculty members, lack of faculty competence in frontier and emerging areas, limited emphasis on refresher training, faculty improvement and incentives; dwindling faculty in SAUs with majority chunk of the posts remaining vacant
- Disconnect among agricultural education, employment, and industries' requirements; lack of adequate skill, entrepreneurship and experiential learning
- Poor inclusion of basic sciences in agricultural curricula; outdated curriculum delivery mechanisms; increasing irrelevance of Home Science colleges and curricula
- Extensive inbreeding and associated depressions; low access of agricultural education to rural students, especially to the tribals and socially-deprived communities
- Inadequate academic rigour in existing curricula, which are short in informing and sensitizing the students and faculty about the seriousness of the stubbornly high incidences of hunger, under-nutrition, poverty, inequality, fast degrading natural resources - land, water and biodiversity, and high vulnerability to climate change and market instabilities
- Inadequate and declining investment and financial resources in agricultural universities/ colleges; opening of new universities without matching resources; unmindful splitting of agricultural universities, and poor resources planning
- Poor governance, system's inability to take full advantage of modern tools of management for efficient governance (e-governance); widening disconnect amongst education, research and extension; isolation from international exposure and poor internalization of relevant international trends and developments
- Lack of evaluation, monitoring, impact assessment, accountability and incentive systems

Towards resolving the above asymmetries and transforming India's agricultural education system, and sharing the global experiences, the Congress had made the following recommendations comprising new approaches and actions:

- Embrace agricultural education for development (AE4D) as an integral component of the national agricultural policy to ensure adequate, consistent and predictable investments in

agriculture, especially education, research and extension in creating a world-class agricultural university system attuned to face local, national and international challenges and opportunities over short, medium and long terms

- Ensure and institutionalize transparent governance, autonomy, meritocracy, dynamic assessment of human resource requirement, judicious allocation of resources, transparent and effective flow of funds, transparent examination and student enrolment system, effective implementation, monitoring, evaluation, accountability and responsibility based system (measure to manage)
- Minimize inbreeding and splitting of universities, pay focused attention to standards, norms, and accreditation, create centers of excellence and institutes for agricultural education, science, knowledge, research, technology and innovation in an interdisciplinary and multifaculty mode
- Strengthen and streamline Centre-State partnership, identify national and state level public and private sector leaders with differentiated but reiterative responsibilities to work on the design and implementation of reforms and to develop a strong inter-ministerial and inter-departmental cooperation mechanism
- Revamp teaching/learning processes and methodologies to attract best of talents and blooming young minds for nurturing them leading to a nation-wide programme on "Youth for Leadership in Farming"
- Strengthen/initiate/institutionalize skill development, entrepreneurship and experiential learning programmes, and duly promote non-formal education and vocational training
- Support development of an active and continuous long-term relationship-based international cooperation, rejuvenate and dynamically strengthen initial very successful collaborations, such as between Indian SAUs and US Land Grant Universities, and launch need-based South-South and South-North collaborations.

The Bhubaneswar Congress had concluded that human capital should be seen as the greatest national treasure. Creating this treasure is thus the foremost challenge. Attracting talents to agricultural education, faculty competence improvement, addressing faculty shortage, reducing inbreeding and promoting national integration, linkages among institutions, and assurance of quality agricultural education are fundamental to achieving the desired quality human resources. It had emphasised that promoting education in basic and emerging sciences, creation of centers of excellence, modernization of AU farms and laboratories, strengthening education for agricultural extension and rural development, public private partnership for innovations in agricultural education and research, and vocational education will strategically enhance the desired outcomes. Manpower planning, enhanced financial support, IT for networking and communication, e-courses and distance education, and international collaborations were identified as essential components for knowledge-based development.

ICAR's Resolve for Quality Agricultural Education

The ICAR undertakes planning, development, coordination and quality assurance in higher agricultural education in the country. It strives for maintaining and upgrading quality and

relevance of higher agricultural education through partnership and efforts of the components of the ICAR-Agricultural Universities (AUs) system, referred to as the National Agricultural Education System (NAES), comprising 61 State Agricultural Universities (SAUs), 5 Deemed-to-be-Universities (DUs), 3 Central Agricultural Universities (CAUs) and 4 Central Universities (CUs) with Agriculture Faculty.

The quality assurance is undertaken by the Council through policy support, accreditation, framing of minimum standards for higher agricultural education, academic regulation, personnel policies, review of course curricula and delivery systems, development support for creating/strengthening infrastructure and facilities, improvement and incentivization of faculty competence, examination reforms, admission of students through All India competitions, and students counselling and placement. Through various scholarships and fellowships as tools for the HRD, it promotes national integration and reduces inbreeding, strengthens basic research through its National Professor and National Fellow Schemes, and also establishes and helps establish international linkages and collaborations for sharing successful experiences. As the AUs spend 90-95 % of their budget on salaries, ICAR's professional and financial support to the universities for quality assurance is most vital.

Recently, the ICAR has put in place norms and standards for accreditation of AUs and linked them with access to its grants. During the past several years, through its international initiatives, such as the National Agricultural Technology Project (NATP) and National Agricultural Innovation Project (NAIP) supported by the World Bank, the Council has internalized global vision and successful experiences in its agricultural education development programme. Such initiatives will further be explored to link the national system with global knowledge economy, and also to undertake International Experiential Learning. Suitable twinning arrangements with foreign universities could be explored for sharing innovative pilots for agricultural education, research, and technology dissemination. These initiatives will help further strengthen institutional reforms to emphasise learning-centred education, faculty and teaching facilities upgradation, and partnership with private industries.

The Fifth Deans' Committee: Business Unusual to Synergic Relevance with Excellence

The ICAR has periodically been appointing Deans' Committees for improving quality of agricultural education, including updating norms and standards, revising courses curricula and contents in context of the latest developments, setting uniform patterns of credit load and evaluation systems, and providing academic framework for addressing the challenges and opportunities. Based on in-depth analysis and comprehensive national level consultation, the Deans' Committees have been making recommendations for transforming the education system to reshape the country's agriculture-led development. The Fifth Deans' Committee is the latest in the series.

The Fifth Deans' Committee was constituted by the ICAR vide office order F. No. Edn. 5.1.2013-EQR dated: 10 July 2013 under the chairmanship of Prof. R.B. Singh with the following terms of reference (Annexure I).

- Defining UG & PG degrees for general market needs and for specialist jobs and uniformity in

UG and PG degree nomenclature

- Restructuring of UG programmes for increased practical and practice contents
- Central assistance for strengthening of Higher Agricultural Education
- Guidelines for assessing training needs and performance of teaching faculties
- Reforms in governance of SAUs
- Minimum standards for establishment of new colleges

The Committee held its first meeting on 22 Aug 2014 and deliberated on the TORs and reviewed the outcomes of the Fourth Deans' Committee. In particular, it examined the new issues and challenges emerging at the Bhubaneswar Congress and the consequent roadmap prepared by the NAAS for transforming agricultural education to reshape India. Further, it considered contemporary challenges for employability of passing out graduates and adoption of holistic approach for quality assurance in agricultural education.

Reviewing the baseline issues addressed by the Fourth Deans' Committee, the followings emerged as satisfying outcomes of the recommendations of the past Committee:

- Adoption of uniform syllabi across the country in identified eight disciplines of agricultural sciences;
- Streamlining of nomenclature of academic programmes, prescription of essential qualifications for Master and Ph.D programmes and various jobs in State and Central governments;
- Smooth conductance of examination, counselling and admission of students for UG and PG programmes through All India Entrance Examination conducted by ICAR, resulting from the uniformity in academic programmes; and
- Development of suitable human resources, improved skill, and enhanced entrepreneurship in some areas.

However, the Committee noted that several of the recommendations of the Fourth Deans' Committee have not been implemented satisfactorily, such as the degree nomenclature of some of the B.Sc and B.Tech programmes, inconsistent adoption of the norms, standards and regulations, and below-expectation adoption of the Experiential Learning modules. Thus, in true sense, several of the issues have remained unaddressed and are equally valid even today. While sharpening its full TORs, the Fifth Deans' Committee recapitulated the priorities and, as suggested by the ICAR, retained the unattended issues of the past committee(s).

Agriculture in the context of this Report is defined on the same broad lines as by FAO which includes crops, horticulture, livestock, fisheries, and forestry production and associated activities; value chains of food and other produces; natural resources including land, water and biodiversity; mechanization and energy; and the affecting social, economic, trade, market, cultural, ecological, and environmental and climatic factors. Thus, teaching, learning and education in these and related areas fall under the umbrella of Agricultural Education.

Adopting a hub (ICAR) and spoke (AUs) model and undertaking comprehensive consultation and a bottom up approach for curriculum development, inputs from different stakeholders of agricultural education were obtained at different levels. The Committee first deliberated on the skills which the graduates must possess and then did reverse engineering to design course curricula. The Committee identified Conveners/Co-conveners, as annexed, and gave them the

responsibility to have countrywide inputs from all the Deans of all the colleges of their disciplines based on the suggestions thus received from their faculty after holding meetings at University/ College levels. The suggestions received from all the disciplines were reviewed by the Committee.

The draft report was presented in the AU Vice Chancellors Conference on January 16, 2016. The VCs' comments received at the conference were duly internalized in the final draft report, which was shared with all the Vice-Chancellors. The final report has internalized the final comments of the VCs. The Committee has tried to make sure that inputs of all stakeholder groups are duly internalized and the report represents a national consensus in respect of various issues that were flagged during the process.

The Committee reiterated the importance of the development of national human resources capital in the field of agriculture and allied sciences rendering our graduates professionally competent, socially sensitive, and ethically strong. It was felt that highest priority should be given to agriculture for the alleviation of hunger, undernutrition, poverty, and inequity. Accordingly, the course curricula contained in the report are designed and geared to ensure excellence, relevance, and creation of skilled, talented, and entrepreneurial human resources and knowledge pools to harness demographic dividends, and to achieve high quality of products, farmers profitability, zero environmental footprint, climate resilience, high input and natural resources use efficiency, inclusiveness, and competitiveness.

The Committee appreciated that Agriculture is getting increasingly feminized and welcomed the enhanced enrolment of women in various agricultural courses. Gender-sensitive agricultural education and curricula must inform the gender issues, goal and perspectives in agriculture. The Home Science courses were found outdated thus revamped. Human nutrition, human behaviour, and community participation have been given greater attention in the revised curriculum. As family farming is becoming more common and responsibility of women in agriculture has increased, the Committee has sought greater support to women education to enable them to pursue innovative agriculture on their own.

The Committee emphasized that the Private Sector is now a formidable employer of agricultural graduates. Hence, there is a large demand for suitably trained and equipped graduates in agricultural sciences to meet the rapid expanding growth in the modern food and agro industry. This changing scenario of employment pattern requires a change in the curriculum approach to address needs of the industry. Generally, the industry feels that the present curricula inadequately prepare graduates for private sector employment. Accordingly, new academic programmes have been developed and existing curricula revised and upgraded to meet the requirements, including the Student READY and Food Technology programmes.

The Committee thus underpinned that India's agricultural education needs to be stimulated and improved to increasingly enable India's participation in global markets through export of agricultural commodities and technologies, support to domestic and international agribusiness, and development of new bio- and knowledge-based enterprises, including those for rural and agro-industrial services. In doing so, the voices of the farmers, industry, corporate sector, NGOs, Civil Society, scientists, teachers and, of course, students were heard and duly accommodated in the curricula.

The Committee felt the need to broaden the base of agricultural education, while sustaining

the core excellence in the scientific component. In this context, the following considerations were kept in mind: (i) deprivation of rural people, especially poor farmers, has increased and their problems are much more complex, (ii) a holistic approach underpinning multi- and inter-disciplinary aspects is needed, (iii) in the globalized world, effective international collaboration will enhance capacities of universities, (iv) business unusual for financial, administrative and institutional changes are needed towards broadening the base, and (v) the human face of education should be kept in mind to reach the unreached viz. the tribals, and to empower the impoverished to live a dignified life.

Sharing the thoughts of world leaders in agricultural education from several countries and international organizations at the Bhubaneswar Congress and further through bilateral interactions of ICAR and NAAS with selected universities in the USA and elsewhere, the Committee has strived to selectively internalize the emerging global curricular trend. Such trends include Basic and Applied Sciences in Agriculture, and transformation from "STEM" (Science, Technology, Engineering and Mathematics) to "STEAM" where A stands for Agriculture (a recent USDA report). Basic and social sciences have considerably been integrated with state-of-the-art research in agricultural sciences to create synergistic quality education and research and to attract, nurture, and retain talented students and high quality research and academic faculty in food and agriculture system. Further, the move is hoped to integrate and mutually enrich undergraduate, graduate, Ph.D. and post-Ph.D programmes.

The Committee noted the various agriculture-related global trends and declarations such as the Zero Hunger World, the New Normal – Food, Nutrition, Health and Agriculture Nexus; Green Economy and Green Agriculture; Climate Smart Agriculture, Sustainability and Environmental Health; Big Data and Data Science; Entrepreneurship; and International Experiential Learning. It also appreciated the recent UN International Year's thrust on water, family farms, soil, pulses, etc. which must stimulate our educational planners to design and deliver courses with international perspectives. In the globalized world, in view of the fast changes taking place, a question may be asked whether India's agricultural education system could move from the Land Grant to a "World Grant" university system, as the world today is much more integrated and the commonality between local and global agriculture has heightened, as advocated by President Simon of Michigan State University.

Adequate coverage has been provided in respect of new technologies such as biotechnology, information technology, bioinformatics, GIS, remote sensing, precision agriculture, hi-tech cultivation, secondary agriculture, conservation agriculture, organic farming, international agriculture, processing and value addition, agribusiness management, and communication skills. The course curricula have been restructured and reoriented to develop much needed skills and entrepreneurial mind-set among the graduates to take up self-employment, to sustainably enhance rural livelihood security, and to propel agricultural transformation through science informed policy options and actions.

The curriculum on socio-economic fronts has been strengthened to capture the latest trends and their impact in the next 10 to 15 years. For instance, increasing roles of livestock, horticulture and fisheries in meeting the socio-economic goals of accelerated inclusive economic growth and overall nutritional security have been emphasized. Further, while maintaining desired national level uniformity in designing agricultural courses and curricula, adequate flexibility has been

provided to meet the agro-ecologically differentiated challenges and opportunities, *viz* hill agriculture, organic farming, coastal agriculture, dryland agriculture etc.

The committee deliberated on Agriculture Marketing & Cooperation and Agribusiness Management. The committee constituted by ICAR to frame Minimum Standards for Higher Education in Agribusiness Management opined that undergraduate programme in Agribusiness Management is not viable.

The concerned colleges offering undergraduate courses are not ready to agree upon a common nomenclature for the degree, considering expected future complications for the graduates who are being satisfactorily employed in their respective states. The committee thus decided not to include the courses on Agriculture Marketing & Cooperation or Economics & Marketing and Agribusiness Management in the Fifth Deans' Committee report.

Agriculture curricula in the past had little coverage of indigenous knowledge and innovations. In the contemporary agriculture, we need innovations more than ever before. The observance of this decade as the 'Decade of Innovation in India' is a recognition of this reality. Importance of cost effective, location-specific and affordable farm innovations emphasizing value chain management, new extension systems, promotion of agri-business models and entrepreneurship have been highlighted in the revised curricula.

In the past, we have generally been sub-optimal both at national and international levels in adequately communicating our outstanding achievements to the veritable stakeholders – political leaders, policy makers, scientists, development partners, farmers, consumers, and the civil society. The proposed curricula attempt to strengthen communication science and technology capacities to leverage ICT to ensure effective and timely communication of actual and potential impacts of the products and outcomes.

The Committee has made efforts to include relevant practical skills and entrepreneur aptitude, and to impart confidence among graduates. To reorient graduates of Agriculture and allied subjects for higher employability and greater entrepreneurship, the Student READY programme is to be introduced in all the Agricultural Universities as an essential prerequisite for the award of degree to ensure hands-on experience and practical training. Due attention has been given to areas of training and institutions for improving faculty competence for the purpose.

ICAR's 'Farmer FIRST' initiative must motivate our students and other stakeholders to move beyond the production and productivity and to address the complex and diverse realities of majority risk prone farmers through enhancing farmers-scientists-universities contact with multi-stakeholders participation. The concepts and domains that are new or new in emphasis like food and agriculture systems, trade, market chains, value chains, climate smart agriculture, and innovation systems have been reflected in the revised curricula.

Thus, both academic excellence and relevance (employability and entrepreneurial ability) have been emphasized. The required basic science courses have been included in the agricultural courses. The Committee has identified six common courses which need to be included for all programmes of agricultural sciences. Further, four new degree programmes have been designed. The Committee has recommended that all the 11 degrees in Agricultural Sciences be declared as professional degree and has suggested their nomenclature.

In delivering the curricula, the concerned courses may discuss major initiatives of the Government of India, such as the National Food Security Mission, Rashtriya Krishi Vikas Yojana, MGNREGA, Jan Dhan Yojana, Make-in-India, Krishi Sinchai Yojana, Digital India, Skill India, Start-up India, etc. Our students must continuously be reminded that towards shaping India to achieve the future we want, we cannot think of a vibrant, inclusive and happy India without a thriving, multifunctional and comprehensive agriculture. "If agriculture fails, nothing else will succeed". All, from farmers to parliament, particularly the agriculture students, must have faith in Agriculture. The roadmap is: *Unnat Pathykram to Unnat Krishi Shikshha to Unnat Krishi and Kisan to Unnat Bharat – Gramodaya se Bharat Uday.*

Academic Legitimacy and Contextuality of Challenges and Opportunities

India's agriculture now faces additional new challenges, which must be reflected in the national agricultural academic curricula and research priorities. In addition to freeing India of endemic and stubbornly high undernutrition and poverty, India now has to rapidly become competitive in global markets. Indian agriculture has to not only contribute to India's growth but support its shift to a climate smart bio-based more knowledge-intensive green economy. India needs to rapidly innovate in its agriculture. India's agriculture has resiliently to improve its productivity by more than 4 per cent annually from the shrinking available arable land and water resources to meet its burgeoning food and nutritional needs and to maintain food sovereignty to impact upon poverty, especially in rural areas. Thus, agriculture has to be economically viable, globally competitive, socially equitable and environmentally sustainable, and these facts must be duly internalized in the curricula.

Agricultural education is thus increasingly challenged to engage in a new global social contract to serve the needs of society, improve the quality of life and environment, build leadership, increase collaboration and develop new approaches to new challenges and uncommon opportunities. Agricultural education thus needs to evolve in tune with the fast changing national and international scenarios. The present situation demands a renewed thrust for enhanced quality and relevance of higher agricultural education so as to facilitate and undertake human capacity building for developing self-motivated professionals and entrepreneurs in view of the changing scenario of globalization of education, emergence of new areas of specialization such as biosensors, genomics, alternative sources of energy, nanotechnology, etc.

The graduates are required to possess professional capabilities to deal with the concerns of sustainable development (productive, profitable and stable) of agriculture in all its aspects. Further, there is need for agricultural graduates to possess knowledge, skills, including "soft skills" e.g. written and verbal communication ability, and also entrepreneurship to provide a class of village-based services such as advisories on new innovations, markets and avenues of development assistance for corporate and contract farming. Industry and universities partnership is essential if industry is to obtain well-trained agricultural professionals in cutting edge technologies for international competitiveness. Thus, it may be desirable to declare agriculture degree as a professional degree, and implications thereof should be critically examined.

Agriculture students must be aware that by 2035, India will be the most populous country in the world. Towards the year 2050, its population will reach about 1.9 billion, and nearly 70% of the

people will be in middle income group. The high population and income growths are continuously pushing up the demand for food, particularly high value quality foods, such as livestock and horticultural products. The food demand is likely to almost double by 2050. On the other hand, serious yield and productivity gaps exist in our food and agriculture systems. India's total factor productivity growth rate has been sluggish. With the business as usual, by the year 2030, only 59 percent of India's total demand for food and agricultural products will be met.

Today's graduates should be the torch bearers of the United Nations Zero Hunger Challenge Program. The challenge is to produce more from less for more (MLM) under the limited and declining land, water, and biodiversity resources and more difficult and complex environmental settings, climate change, carbon and GHG imbalances, intensifying biotic and abiotic stresses, and worsening socio-economic inequities and inequalities (average income of a farmer is 1/5th of that of a non-farmer). A business unusual is thus called for achieving: (i) sustainable intensification and diversification of production and zero waste to meet demand for nutrition and food quantity and quality, (ii) 100 percent increase in smallholder productivity and income; ensuring desired profitability, social justice, and attractiveness to agriculture as a profession, and (iii) ecosystem services that improve water quality and quantity, soil health, carbon capture, and biodiversity.

India's agriculture graduates should be fully aware of the developments in international agriculture both for locally adopting the success stories from across the world as well as for having worldwide employment opportunity and ability to enrich human resources, global science and technological progress. India has to reduce the distressing pressure on natural resources and on population dependant on agricultural production with complementary non-farm engagements. The NARES thus must shift from viewing agriculture as only a production and productivity challenge that can be solved by a set of generic technology packages to one where agriculture is a key contributor to sustainable and resilient growth, development and improvement of quality of life and the environment. Our graduates should be able to act in context of the stubbornly high incidence of food insecurity, stunted structural transformation, enhanced volatility both in agricultural production and market, accelerated environmental and ecological degradation, and widening inequalities.

While firming up the academic legitimacy and contextuality of the challenges and opportunities, the Committee suggested the following check-list to be used by planners and managers to assess outcomes and impacts of various programmes:

- Whether our agricultural education system is prepared to produce such leaders who would navigate us through the changing water and render our universities world-class?
- Do the staff and students have real-world experience as part of learning and could our graduates essentially become job creators rather than job seekers, and realise demographic dividend?
- Are we ready to change the Land Grants System to the "World Grant System"? How relevant are the existing teaching and skill development programmes and institutions?
- Is our agriculture backed by basic sciences and best of practices to convert "STEM" into "STEAM"?

- Are we prepared to adopt business unusual and disruptive innovations to effect the much needed changes in our agricultural education system, including centre-state congruence, the hub-spoke model?
- Do we have the necessary quality financial and other resources, commitment and political will to lead India to be a major knowledge hub in the world geared towards an all time Zero Hunger and prosperous India?

Disruptive Innovations to Promote Excellence in Agricultural Education

Higher education is emerging as an international service, and there is a growing concern the world over about quality, standards and recognition. Prioritizing the quality of higher education services by implementing or strengthening quality assurance measures is a strategy for increasing global stature. Quality assurance, which may include accreditation processes, is one of the universal tactics to enhance global competitiveness. A number of strategic funding programmes have been implemented to promote excellence by different countries and regions, such as China's 985 Project, Japan's Centres of Excellence and World Premier International Research Centres etc. India can emerge as a knowledge power only if an appropriate architecture for higher education is put in place. The Indian Government has decided to recast the country as "knowledge economy", purportedly by making higher education a top national agenda item and creating world-class universities. Some of the uncommon efforts are elucidated below.

Ranking of Agricultural Universities: The universities ranking exercises in recent years have revealed as to how the leading universities are reshaping the nations and the world, and have underpinned that the level of knowledge domains, meritocracy, governance, transparency, and international partnership underpin the quality of science, innovations, technologies, human resources, and competitiveness. Since quality education is the lifeline of progress, national developments can be viewed through the lens of education, research, technology and innovation.

In the era of globalization and increased internationalization of education, the ranking of the universities has become imperative as university ranking and indicators of excellence widen the basis of information for a well-informed university choice. In a country like India, where livelihood security of over 600 million real people directly depends on agriculture, the leading role of quality agricultural universities in the nation's progress can hardly be overemphasized. It is, therefore, desirable to work out "robust, transparent and sophisticated" criteria for ranking of agricultural universities in the country so as to give students informed choice as well as to build their reputation in the international arena, and to develop effective technologies and innovations.

The national agricultural education system may benefit from successful "robust" models for universities ranking available nationally and internationally. In this context, it is gratifying that the Ministry of Human Resources Development, Government of India, has recently developed a National Institutional Ranking Framework (NIRF) for engineering, management and a few other disciplines. The NIRF has identified 22 parameters in five major heads: (1) Outreach and Inclusivity, (2) Teaching, Learning and Resources, (iii) Research, Professional Practice and Collaborative Performance, (4) Perception, and (5) Graduation Outcomes. Some of the India-centric parameters include regional and international diversity, outreach, gender equity, and inclusion of disadvantaged sections of society.

Towards improving quality of agricultural education, the ICAR has adopted several measures viz. Accreditation and Quality Assurance, Curricula Development, Model University Act etc. In this resolve, involving the NARES, the NAAS has prepared a set of indicators/parameters for ranking of Indian Agricultural Universities, keeping in mind Indian context, particularly the educational aspirations, needs, employability, and livelihood security. As the ICAR institutionalizes the outcome/impact assessment and accountability pathway process, ranking of universities should be the foremost activity to be pilot-tested and hopefully all the agricultural universities and colleges will ultimately be part of the ranking process. Further, the efficacy of the "hub and spoke" model should dynamically be assessed.

Massive Open Online Courses (MOOC): Towards building a more knowledge intensive agriculture and associated food chains as also safeguarding the environment through sustainable use of natural resources, a new strategy for education and learning is required. In addition to formal on-campus education, open, informal, distance, off-campus, continuing learning for all should be promoted. Online learning should be used for linking learners, learning materials and mentors/teachers deploying technology mediation.

The Massive Open Online Courses (MOOC) are the recent disruptive innovations that can enable a small group of teachers/mentors to offer learning services to many people in the duration of a single course. MOOC can be meaningfully and effectively harnessed for training of public on a massive scale. Considering the need to explore the opportunities and challenges for capacity building in Indian agriculture using MOOC, the NAAS in partnership with the Commonwealth of Learning (COL), Vancouver, Canada convened a brainstorming session in 2014, and prepared a roadmap for adopting MOOC in NARS. Individual universities, as per the roadmap, should develop custom-designed MOOCs to meet the skill requirements of their students, as desired under the Skill India initiative.

Mentoring: Mentoring comprising "role modelling , giving counsel, providing acceptance and confirmation, and offering friendship", if properly administered, would benefit our institutions to: build bridges across the hierarchy levels, empower change management, enhance work ownership and sharing of responsibility, retention of team members, expansion of learning ecosystem and good practices etc. This would result in enhanced transfer of skills, knowledge, products, technologies, and services, leading to elevated performance and contribution. The NAAS, through a brainstorming session has prepared a roadmap for mentoring, emphasizing the need for matching the experience and wisdom of mentor with the learning needs of mentee. The potential mentors could be given orientation training to enable them undertake mentoring in a systematic way so that the mentoring so achieved could be properly evaluated.

Attracting and Retaining Youth in Agriculture: The need for attracting and retaining intellect, especially the youth, in agriculture must be a high priority as the complexities of challenges and opportunities are intensifying. Mentoring all stakeholders, from the ground to the top level, by experienced and successful mentors should become a part of the teaching-learning process in the NARES, as being practiced in the Ministry of Human Resources Development (MHRD), and common in western countries. The Department of Science and Technology (DST) is already mentoring students through its Innovation in Science Pursuit for Inspired Research (INSPIRE) program and MHRD is funding such incentives under the program called Global Initiatives of

Academic Network (GIAN). The Handbook of Mentoring and Performance Audit prepared by the DST and MHRD could be used as a starting template for the agricultural system. The Department of Agricultural Research and Education (DARE), ICAR and NAAS may institutionalize implementation of the roadmap prepared by the Academy. Willing NAAS Fellows may participate in the initiative to encourage younger colleagues for excellence in agricultural sciences.

India is joining the Big Data Management. In a country of India's size and magnitude with varying agro-climatic situations, we need a centralized agriculture data base on a variety of issues that are of interest to scientists, students, farmers and industry. Through such an arrangement, in line with the Big Data movement, the data can be easily accessed by one and all. It is extremely important to use modern information and communication systems for marketing, sales and pricing activities to move with the time. This is a bright option for the graduating youths as well as for the e-market platform recently launched by the Prime Minister. These developments have been seeded in the curricula, and should figure more prominently as the necessary facilities and faculties are in place.

With the current thrust on Make-in-India, Start-up-India, Skill India, Digital India etc. we need to evolve agricultural education system that is harmonized with job markets and entrepreneurship and also meets the changing needs of agriculture and rural sectors. Special capacities are thus required to be built in education system for nurturing the students. These include creativity and innovation, use of high technology, and entrepreneurial and moral leadership. India is already a knowledge power and must become the leader in the knowledge revolution. And, this will also help the universities to occupy respectable places in the world ranking.

Several of the ICAR initiatives, such as the Rural Entrepreneurship and Awareness Development Yojana (READY), encompassing Experiential Learning Programme (ELP) and Rural Agricultural Work Experience (RAWE) and in-plant/industrial attachment are highly relevant. The Council has stepped up efforts to attract talented students and young faculty, such as the Agricultural Science Pursuit for Inspired Research Excellence (ASPIRE) programme. Along with READY, Attracting and Retaining Youth in Agriculture (ARYA) programme, is most timely, and could mutually reinforce the Farmer First campaign of ICAR. These various initiatives should be congrued and regularly monitored for their implementation and impact assessment.

A few projects, such as the Bill and Melinda Gates Foundation (BMGF) initiatives, are innovating in the areas of social engineering and humanity towards enhancing and stabilizing livelihood security of resource-poor and vulnerable farmers. BMGF being a telecommunication giant, the Foundation may establish model Innovation Centres at selected SAU campuses to link farmers, agriculture, agribusiness and digital communication in a real-world situation to trigger new exciting opportunities, particularly for the young innovators in harnessing best of the science and technology in serving farmers to save and transform farming.

Incubation centres should be created in research university campuses. Such settings become incubators for new ideas and stimulate and trigger young minds to innovate. Several of such innovations find practical applications and synergise the university-industry linkage including joint appointments, and enrich the research and academic stream. With such a setup, a good number of students shall be working as interns with the companies, thus gaining invaluable

hands-on experience that will jump start their careers. The incubators for start-up companies will help convert innovations into commercial businesses thus boosting the Startup India initiative.

Education for Agriculture in the 21st Century and the Third Generation Universities should have the goal that every agricultural graduate becomes an entrepreneur. Thus, as suggested by the Committee, business management should be mainstreamed in major applied courses, e.g. Seed Technology, Dairy Technology, Fish Technology, Food Processing etc., besides establishing new Faculties or Departments of Agricultural Business Management. Private companies and cooperatives, manufacturing and distributing agricultural inputs and related products should, other things being equal, give preference to such agricultural graduates for employment and granting licenses and dealerships.

The proposed curricula and quality measures should render agriculture as an intellectually more stimulating discipline and an economically rewarding profession to attract talent and investment. An academic legitimacy has been provided to contemporary challenges and opportunities for greater understanding in the classrooms as well as by our policy makers. The efforts should revitalize the youth to find agriculture, agribusiness, agriculture related service sector, and the pursuit of agricultural science and technology generation as an attractive vocation, career and profession. In this context, new trans-disciplinary areas and entrepreneurship have been proposed as new subjects of formal study and informal learning to harness demographic dividends.

Given the comprehensive leadership of the ICAR and the commitment of the NARES, judicious implementation of the recommendations of this committee will go a longway in transforming Indian Agricultural Education to reshape India is the fast changing demographics, socio-economic, ecological and environmental regimes of the world.

New Initiatives Proposed by Fifth Deans' Committee

I. Student READY (Rural and Entrepreneurship Awareness Development Yojana)

To reorient graduates of agriculture and allied subjects for ensuring and assuring employability and to develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the program in all the agricultural universities as an essential prerequisite for the award of degree to ensure hands on experience and practical training. Considering the variation in different streams of agricultural education and feasibility, the Committee proposes to include the following five components, which are interactive and are conceptualized for building skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, quality control, marketing and resolving conflicts, etc. with end to end approach in Student READY program.

i. Experiential Learning/Hands on Training

ii. Skill Development Training

iii. Rural Agriculture Work Experience

iv. In Plant Training/ Industrial attachment

v. Students Projects

The students will be required to have any three of the five components listed above depending on the requirement of their graduate education but it should be implemented for the complete year, so that their education upto level of III year may get right information in IV year and finally they should attend right stage of entrepreneurship.

II. Introduction of common courses in all agriculture disciplines

The Fifth Deans' Committee is of the opinion that some of the courses like Environmental Studies & Disaster Management, Communication Skills & Personality Development, Information & Communication Technology, Entrepreneurship Development & Business Management,

Agri-Informatics and Economics and Marketing need to be taught in all the undergraduate programmes of agricultural sciences, as these are ,must for overall enhanced professional capacity as well as for personality development and to deal with the unforeseen circumstances.

III. Introduction of new degree programs

Since Biotechnology has become an important subject in the field of agricultural sciences, the Committee has recommended introduction of B. Tech (Biotechnology) course in SAUs. Similarly, Sericulture being an important traditional subject, the Committee endorses its inclusion as one of the disciplines in agricultural sciences.

It has been observed that the degree in Home Sciences has been losing its importance in the recent past, particularly in terms of limited employability. The Committee has recommended to rechristen the discipline of Home Science to Community Science and introduce one more new course in Food Nutrition & Dietetics under the umbrella of Community Science.

IV. Development of DPRs for establishment of new colleges

The Deans Committees have been listing some minimum standards/requirements for the colleges. Fifth Deans Committee has developed a comprehensive Detailed Project Report (DPR) for establishing a college for each discipline.

V. Holistic distribution of courses

The Committee has distributed the courses in a systematic way so as to teach basic courses first followed by principles and finally skill development. It is planned to keep courses related to basic and fundamentals in first year, theory/practicals and principles with present State of Art of Technology in second year, modern and frontier area of education in third year and Student READY program of one year in final year.

VI. Declaring degrees in Agricultural Sciences as professional

The Indian Council of Agricultural Research constituted a committee to review Essential Qualifications and Degree Nomenclature of various programmes running in Agricultural Universities under the chairmanship of Dr R B Lal. This Committee has recommended to consider degree in agriculture as a professional degree. The Fifth Deans Committee endorses this view and recommends to declare all degrees in agricultural sciences as professional, like Veterinary and Animal Science, which include undergraduates in:

1. Agriculture
2. Agriculture Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries
6. Food Technology
7. Forestry
8. Community Science (Home Science)

9. Food Nutrition and Dietetics
10. Horticulture
11. Sericulture

VII. Making implementation of recommendations of Deans Committee mandatory

A lot of efforts are made to improve the quality of agricultural education to make it internationally competitive. Implementations of the recommendations of the Fifth Deans' Committee to be made mandatory for accreditation of academic programmes and academic institutions by the National Agricultural Education Accreditation Board (NAEAB).

Student READY Programme

Student READY programme was launched by the Hon'ble Prime Minister of India on 25th July, 2015

Introduction

The term **READY** refers to "Rural Entrepreneurship Awareness Development Yojana".

To reorient graduates of agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the program in all the Agricultural Universities as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

Component of the programme : It is proposed to include the following components in Student READY programme.

i. Experiential Learning/Hands on Training
ii. Skill Development Training
iii. Rural Agriculture Work Experience
iv. In Plant Training/ Industrial Attachment
v. Students Projects

In some disciplines where some components, say, Experiential Learning, is not possible at graduate level, the students will be given Hands on Training and/or Skill Development Training, but it should be (out of these 5 components) implemented for the complete year.

All the above mentioned components are interactive and are conceptualized for building skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, quality control, marketing and resolving conflicts, etc. with end to end approach. Salient features of each component are summarised below.

- Experiential Learning helps the student to develop competence, capability, capacity building, acquiring skills, expertise, and confidence

to start their own enterprise and turn job creators instead of job seekers. This embraces the earning while learning concept. Experiential Learning is a major step forward for high quality professional competence, practical work experience in real life situation to graduates, production oriented courses, production to consumption project working, facilitates producing job providers rather than job seekers and inculcates entrepreneurial orientation.

- Rural Agriculture Work Experience also enables the students to gain rural experience giving them confidence and enhancing on-farm problem solving abilities in real life situations especially in contact with farmers, growers, other stakeholders.
- In-plant Training for a short period of time in relevant industry helps gain the knowledge and experience of the work culture. In-plant Training by reputed organizations either MNCs or organised sectors provide an industrial exposure to the students as well as helps develop their career in high tech industrial requirements.
- Skill Development component includes use of Agriculture Systems & devices for enhancing functional skill. It is expected that basic infrastructure and Experiential Learning Unit available in universities may help in boosting livelihood-ensuring opportunities.
- Student Project is essential for students interested in higher education. Through this component, they will know how to identify research problem, create experimental set up and to write report etc.

For the discipline of Dairy Technology, Food Science & Technology and Agricultural Engineering there will 20 weeks in-plant training in place of RAWE. The students of Veterinary Science discipline will undergo six months training at hospitals.

All the components as per suitability of course i.e. Experiential Learning, Skill Development Training, Rural Agriculture Work Experience (RAWE), Internship/In-Plant Training and Student Projects are included in the final year of study for 2 semesters, to provide entrepreneurial skills, confidence and hands on experience. There are 20 credits for Experiential Learning/Skill Development Training (24 weeks), 10 credits for RAWE (10 weeks programme) and 10 Credits for Industry Attachment/Student Project (10 weeks attachment to industry). For the students of Veterinary Science, Experiential Learning is moduled as per VCI pattern.

Some of the important components of Student READY programme are given as follows:

I. Experiential Learning (EL)

a) Concept

The word 'experiential' essentially means that learning and development are achieved through personally determined experience and involvement, rather than on received teaching or training, typically in group, by observation, study of theory or hypothesis, and bring in innovation or some other transfer of skills or knowledge. Experiential learning is a business curriculum-related endeavour which is interactive.

EL is for building (or reinforcing) skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, marketing

and resolving conflicts, etc. The programme has end to end approach. Carefully calibrated activities move participants to explore and discover their own potential. Both activities and facilitation play a critical role in enhancing team performance.

b) Objectives

EL provides the students an excellent opportunity to develop analytical and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and execute project work.

The main objectives of EL are:

- To promote professional skills and knowledge through meaningful hands on experience.
- To build confidence and to work in project mode.
- To acquire enterprise management capabilities

c) Duration

The experiential learning programme will be offered for 180 days (one semester) period in the final year. As the programme is enterprise oriented, students and faculty are expected to attend the activities of the enterprise even on institutional holidays with total commitment, and without any time limit or restriction of working hours for ELP. The Experiential Learning Programme shall be run for full year by making two groups and rotating activities of the final year in two groups.

d) Attendance

The minimum attendance required for this programme is 85%. The attendance of a student will be maintained at the EL unit. The attendance particulars shall be communicated to the Chief Executive Officer (Associate Dean) by the Manager of the EL unit every week. The students will be eligible for the final evaluation of EL only when the attendance requirement is met with. Any student in the event of recording shortage of attendance has to re-register the EL when offered next by paying the assigned fee.

e) Students' Eligibility

To get the eligibility for registering for the EL programme, the students should have completed all the courses successfully. No student should be allowed to take up the EL programme with backlog/repeat courses. The assignment/allotment of the EL programme shall be based on merit of the student at the end of 5th semester. A separate certificate should be issued to the students after successful completion of EL course. Allotment of EL programmes amongst students to different modules should be done strictly on the basis of merit at the end of fifth semester.

II. Rural Agricultural Work Experience

The Rural Agricultural Work Experience (RAWE) helps the students primarily to understand the rural situations, status of agricultural technologies adopted by the farmers to prioritize the farmers' problems and to develop skills & attitude of working with farm families for overall development in rural area. The timings for RAWE can be flexible for specific regions to coincide with the main cropping season.

2. Objectives

1. To provide an opportunity to the students to understand the rural setting in relation to agriculture and allied activities.
2. To make the students familiar with socio-economic conditions of the farmers and their problems.
3. To impart diagnostic and remedial knowledge to the students relevant to real field situations through practical training.
4. To develop communication skills in students using extension teaching methods in transfer of technology.
5. To develop confidence and competence to solve agricultural problems.
6. To acquaint students with on-going extension and rural development programmes.

III. In Plant Training (IPT)

Technology and globalization are ushering an era of unprecedented change. The need and pressure for change and innovation is immense. To enrich the practical knowledge of the students, In-plant Training shall be mandatory in the last semester for a period of up to 10 weeks. In this training, students will have to study a problem in industrial perspective and submit the reports to the university. Such In-plant Trainings will provide an industrial exposure to the students as well as to develop their career in the high tech industrial requirements. In-plant Training is meant to correlate theory and actual practices in the industries. It is expected that sense of running an industry may be articulated in right way through this type of industrial attachment mode.

Objectives

- To expose the students to industrial environment, which cannot be simulated in the university.
- To familiarize the students with various materials, machines, processes, products and their applications along with relevant aspects of shop management.
- To make the students understand the psychology of the workers, and approach to problems along with the practices followed at factory
- To make the students understand the scope, functions and job responsibility-ties in various departments of an organization.
- Exposure to various aspects of entrepreneurship during the programme period.

The students will be required to submit report on various aspects and will be issued certificates upon successful completion of the student READY components. It is planned that **ICAR will provide Rs. 3000/pm per student for the duration of RAWE/ In- plant Training/ Hands-on Training (HOT) / Skill Development Training subject to a maximum of 6 months.**

Fifth Deans' Committee, after deliberations with the Conveners/Co-conveners and Subject Matter Specialists, recommends the discipline-wise Student READY programmes as follows:

AGRICULTURE

Semester VII

Rural Agricultural Work Experience (RAWE) and Agro-Industrial Attachment (AIA) This program will be undertaken by the students during the seventh semester for a total duration of 20 weeks with a weightage of 0+20 credit hours in two parts, namely, RAWE and AIA. It will consist of general orientation and on-campus training by different faculties followed by village attachment/unit attachment in university/ college/ KVK or a research station. The students would be attached with the agro-industries to get an experience of the industrial environment and working. Due weightage in terms of credit hours will be given depending upon the duration of stay of students in villages/agro-industries. At the end of RAWE/AIA, the students will be given one week for project report preparation, presentation and evaluation.

The students would be required to record their observations in field and agro-industries on daily basis and will prepare their project report based on these observations.

Semester VIII

Experiential Learning Programme (ELP)/ Hands On Training (HOT)

This program will be undertaken by the students preferably during the eighth semester for a total duration of 24 weeks with a weightage of **0+20** credit hours. The students will register for any of two modules, listed below, of **0+10** credit hours each.

- Production Technology Bio-agents and Bio-fertilizer
- Seed Production and Technology
- Mushroom Cultivation Technology
- Soil, Plant, Water and Seed Testing
- Poultry Production Technology
- Hybrid Seed Production Technologies
- Floriculture and Landscaping
- Food Processing
- Commercial Horticulture
- Agriculture Waste Management
- Organic Production Technology
- Commercial Sericulture

In addition to these ELP modules other important modules may be given to the students by SAUs.

Indian Council of Agricultural Research has already provided financial help for establishment of two or more Experiential Learning units in different State Agricultural Universities, hence, each university is expected to plan EL program accordingly.

AGRICULTURE ENGINEERING

Student READY program of the Agricultural Engineering is proposed to have the following components:

1. Summer break after IV semester -Student READY Skill Development Training -I for five weeks in the summer break after IV semester with a credit load of 0+5 credit hours.
2. Summer break after VI semester- Student READY Skill Development Training -II for five weeks in the summer break after VI semester with a credit load of 0+5 credit hours.
3. Semester VII - Industrial attachment of 10 weeks with a credit load of 0+10 credit hours.
4. Semester VII - On campus Experiential Learning Program of 12 weeks with a credit load of 0+10 credit hours.
5. Semester VIII - Project Planning and Report Writing of 12 weeks with a weightage of 0+10 credit hours.

BIOTECHNOLOGY

The Student READY program of Biotechnology will comprise of the following three parts:

Semester VII

1. Any one of the following four modules for in-house skill development with a duration of 20 weeks carrying a weightage of 0+20 credit hours to be taken up during VII semester.
   a. Plant Biotechnology
   b. Animal Biotechnology
   c. Microbial and Environmental Biotechnology
   d. Bioinformatics

Semester VIII

1. Project Formulation, Execution and Presentation of 12 weeks duration to be taken up during VIII semester with a weightage of 0+10 credit hours.
2. Entrepreneurial Development in Biotechnology (On-campus/Off-campus) of 12 weeks duration to be taken up during VIII semester in Micro-Propagation; DNA Fingerprinting; Genetic Purity for Maintenance Breeding; Marker Assisted Selection; Haploid Production; Database Management Skills; Molecular Diagnostics; Recombinant Protein Production; Animal Cell Culture and Maintenance; Fermentation, Biopharma Production; Bioprocess Enrichment; Bioremediation; Bio-fules, etc. with a weightage of 0+10 credit hours.

DAIRY TECHNOLOGY

Summer Breaks after II, IV and VI semesters (0+10 Credit hours)

Student READY Rural Dairy Work Experience Program-I (Summer Break after II semester) of 5 weeks with credit load of 0+5 credit hours to provide exposure to the students to the areas on Milk Production & Procurement to be taken up in State Dairy Federations/Dairy Development Departments/Private Dairies/Animal Husbandry Department/Cattle farm/Progressive dairy farmers.

Student READY Rural Dairy Work Experience Program-II (Summer Break after IV semester) of 5 weeks with credit load of 0+5 credit hours for exposure on Preliminary Dairy Operations to be taken up in Experimental Dairy/Referral lab/Dairy Plants / Exposure to product manufacturing operations in Dairy & Food Industry.

Semester-VII

Student READY In-Plant Training in Seventh Semester of 24 weeks with credit load of 0+20 credit hours. Plant visits and involvement in processing and manufacturing of value added products in each Dairy Technology course to have Industrial exposure in specialized products like Market Milk, Ice Cream, Milk Powders, Cheese, By-products etc. should be made compulsory.

Semester-VIII

Student READY Experiential Learning Module of 10 weeks with a credit load of 0+10 credit hours. The module will run concurrently in the final semester along with the regular courses. This shall include development of Detailed Project Report on setting up of enterprise in the selected areas of product manufacture and Evaluation of the Module.

FISHERIES

Student READY Program will be taken up during VII and VIII semesters and will have the following components:

VII Semester

Student READY–In-plant Attachment for 12 weeks (0+10 credit hours).

Student READY–Rural Fisheries Work Experience Program for 8 weeks (0+8 credit hours).

Student READY–Study Tour (in and outside State) for 4 weeks (0+2 credit hours).

VIII Semester

Student READY Experiential Module

This will include capacity building and skill development of the students in planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency with a total credit load of 0+20 credit hours as detailed below:

- Skill Development will have 0+5 credit hours and include Aquarium Fabrication, Analysis of Soil and Water Quality Parameters, Preparation of Fish Products or in any appropriate applied aspect of fisheries.
- For Experiential Learning Program will have 0+12 credit hours, a minimum of two out of the following areas should be decided by each university:
  - Ornamental Fish Culture
  - Seed Production
  - Trade and Export Management
  - Aqua-clinic
  - Post-Harvest Technology
  - Aqua Farming.

- Project work: Student will select relevant or interested area of specialization such as Fish pathology, Fish diagnostic, Fish pharmacology, Fish toxicology, Fish nutrition, Fish immunology, Fish genetics and breeding, Ornamental fish production, Genomics in Aquaculture, Fish stock assessment, Aquatic pollution, Fish value addition, Fish in nutrition, Fish processing waste management, Quality control and quality assurance, Fish products and by-products etc.. He/she will prepare a research project plan and it will be presented in-front of committee appointed by the Dean of the respective college. Also, for each student, one advisor will be provided, who will guide the student in completion of proposed research plan. A total of 3 credit hours will be allotted for preparation of the project and its presentation as a seminar. This exercise will prepare students interested in higher education. They will be exposed with identifications of problems in experimental setup and project preparation.

FOOD TECHNOLOGY

Student READY Program will be taken up during VII and VIII semesters and will have the following components:

Semester –VII

1. Student READY - Experiential Learning with a credit load of 0+14 credit hours through relevant pilot plants for processing of various commodities, preferably on campus. This shall include development of Detailed Project Report on setting up of an enterprise in the selected areas of product manufacture and evaluation of the module. The Experiential Learning is intended to build practical skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self-employment.
2. Student READY –Project with a credit load of 0+3 credit hours to undertake investigation of selected problems of special interests in Food Processing Technology to individual student. The work includes library work, field or laboratory research, recording data, analyzing data and writing of report, etc.
3. Student READY – Seminar including preparation of synopsis, presentation and discussion by each student on current topics / interests in Food Processing Technology with weightage of 0+1credit hours.

Semester –VIII

1. Student READY –Educationl Tour of two- three weeks to various industries within and outside the state of the university and submission of report on Industrial Tour carrying a weightage of 0+2 credit hours.
2. Student READY – In-plant Training of one semester duration with a credit load of 0+20 credit hours at relevant food processing industry, machinery manufacturer, marketing or other agencies. The In-plant Training is intended to expose the students to an environment in which they are expected to be associated in their future career. The students will be required to have hands-on-experience in one or more commercial establishments.

FORESTRY

Semester -V

Student READY Experiential Learning Module – I (5 weeks) (0+5 credit hours). Any one of the modules to be taken up during V semester:

1. Production and Marketing of High Value Forest Produce (FPU)
2. Raising Quality Planting Materials for Forest Regeneration (SAF/FBT)
3. Apiculture/Sericulture (FBU/NRM/WLS)
4. Ecotourism (BSS/WLS)
5. Wild Animal Health Management– WLS

Semester-VI

Student READY Experiential Learning Module – II (5 weeks) (0+5 credit hours). Any one of the modules to be taken up during VI semester:

- Production and Marketing of High Value Forest Produce (FPU)
- Raising Quality Planting Materials for Forest Regeneration (SAF/FBT)
- Apiculture/Sericulture (FBT/NRM/WLS)
- Ecotourism (BSS/WLS)
- Wild Animal Health Management – WLS

Semester -VII

Student READY Forestry Work Experience (FOWE) 24 weeks will be taken up in semester VII with a credit load of 0+20 credit hours. The program will have the following components:

- Orientation
- Forest Range Training Program
- Industrial Placement
- Weapon Training and First-Aid Training
- Socio-economic Surveys and Village Attachment
- Socio-economic Surveys and Village Attachment
- Report Writing and Presentations

Semester -VIII

Student READY Project Work & Dissertation 10 weeks (0+10 credit hours) to be taken up during the VIII semester.

COMMUNITY SCIENCE (HOME SCIENCE)

A) B.Sc (Hons) Community Science

The Student READY program will be taken up during VII and VIII semester. The program will be divided into two parts:

Semester VII

Student READY Experiential Learning Program: the students will take up any one of the following ELP modules for a period of 24 weeks with credit load of 0+20 credit hours during the VII semester.

Module 1- Product Development and Entrepreneurship

This module aims to grant practical knowledge to students regarding product development and entrepreneurship, covering all aspects related to income generation through production and sale of clothing and textile and interior decoration products and also the management of their entrepreneurial ventures. The students will take up the work out of the topics like :

1. Apparel Designing Technique-Flat Pattern and Draping
2. Principles of Textile Designing
3. Fashion Illustrations
4. Computer Aided Designing-Pattern Designing
5. Retailing and Merchandising- Textiles and Apparel
6. Instructional Video Production
7. Public Relations and Social Marketing
8. Event Management
9. Interior Design and Decoration
10. Computer Aided Interior Designing
11. Tourism and Hospitality Management
12. Web Designing and Multimedia Production

Module 2 - Community Nutrition and Welfare

This module aims to impart practical knowledge to students regarding community welfare encompassing all the aspects *viz*. diet counseling, food preservation, food service and hospitality management, nutraceuticals and health foods, early childhood care, education and counseling for parents and community and multimedia and video production. Students would be ready to conduct and manage community welfare programs independently. The students will take up the work out of the topics like

1. Print and Electronic Journalism
2. Web Designing and Multimedia Production Marketing
3. Instructional Video Production
4. Diet and Nutrition Counseling
5. Food Preservation and Storage
6. Food Service and Hospitality Management
7. Nutraceuticals and Health Foods
8. Methods and Materials for Teaching Young Children
9. Education and Counseling for Parents and Community
10. Early Childhood Care, Education and Management
11. Sanitation & Hygiene
12. Developmental Assessment of Young Children

Semester -VIII

Student READY In-plant training / Internship / RAWE will be taken up during VIII semester for a period of 20 weeks with a credit load of 0+20 credit hours.

B) B.Sc.(Hons) Food Nutrition and Dietetics

The Student READY program will be taken up during VII and VIII semester. The program will be divided into two parts:

Semester -VII

Student READY - In-plant Training: the students will be deputed to nearby hospitals, testing labs and processing units/foods industries for a period of 20 weeks during the VII semester with a credit load of 20 credit hours. The students will be provided a platform to study at least two topics in depth depending upon place of their training . At the end of the training they will make a presentation before faculty and other students.

Semester -VIII

Student READY Hands–on-training: The students will take up Hands –on –Training program for a period of 24 weeks with credit load of 20 credit hours during the VIII semester. The following aspects will be taken up during the training to develop competence, capability, capacity building, acquiring skill, expertise and confidence to start their own enterprise and turn job creators instead of job seekers.

1. Fruits and Vegetables: Preparation and Utilization – II
2. Nutritional Status Assessment Methods
3. Food Service Management – II
4. Diet and Nutrition Counseling
5. Special Project depending upon the regional requirement
6. Entrepreneurship Development and Business Management

HORTICULTURE

Student READY Program will be taken up during VII and VIII semesters and will have the following components:

Semester - VII

Student READY- Rural Horticulture Work Experience (RHWE) & Placement in Industries. This program will be taken up during the VII semester for a duration of 24 weeks and will be allotted 0+20 credit hours. The program will include orientation, village stay, all India study tour, industrial placement program, report writing and final examination.

Semester –VIII

Student READY Experiential Learning (Professional Package) will be for the duration of 20 weeks and will carry a weightage of 0+20 credit hours. Students can select any two modules from the following under STUDENT READY- Experiential Learning program depending on the facilities available at the college:

- Commercial Horticulture
- Protected Cultivation of High Value Horticulture Crops

- Processing of fruits and vegetables for value addition
- Floriculture and landscape architecture
- Bio-inputs: Bio-fertilizers and Bio-pesticides
- Mass multiplication of plant and molecules through tissue culture
- Mushroom culture
- Bee keeping

SERICULTURE

The Student READY program will be implemented during VII and VIII semester with the following components:

Semester - VII

STUDENT READY- Experiential Learning Program (ELP)/ Hands on Training(HOT) modules – the program will be taken up in VII semester for a period of 20 weeks carrying a weightage of 0+20 credit hours. The students can take up one of the following modules:

- Host Plant Production
- Cocoon Crop Production
- Silk Product Science
- Natural Resource Management

Semester –VIII

STUDENT READY-Rural Work Experience Program (Sericulture) will be taken up during VIII semester for a period of 24 weeks and a credit load of 20 credit hours. The students will have exposure to Placement in Grainage Technology, Seri Clinic, Placement in Silk Product Technology, Placement in Value Addition to Sericulture By-Products and Practical Extension Work in Villages

EVALUATION OF STUDENT READY PROGRAM

- Students shall be evaluated component-wise under village attachment/ agro-industrial attachment/ hands on training/skill development training/experiential learning/student projects.
- Each college of the University will designate a Student READY Program Coordinator and componentwise evaluation committees. These committees will evolve a method of evaluation depending upon the component undertaken giving due weightage to the observations made by the Scientists/Agro-industrial Officer and the Program Coordinator with whom they are attached.
- Since the credit hours allotted to the Student READY program are gradial, the minimum condition of attendance and grading system will apply for the program as will be applicable to other courses.
- It is expected that at the end of Student READY program, the students should gain competency for entrepreneurship, which should be innovative and creative in nature. The evaluation committee must ensure percentage increase in this competency at the end & successful organization of all Student READY programs.

Common Courses

It was a general consensus that students of all disciplines need to be taught the following courses:

I. Environmental Studies and Disaster Management (as per UGC guidelines-core module for under graduate courses of all branches of higher education)

Theory

Unit 1 : Multidisciplinary nature of environmental studies: definition, scope and importance

Unit 2: Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual and communities in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.

Unit 3: Ecosystems • Concept of an ecosystem. • Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow

in the ecosystem. • Ecological succession. • Food chains, food webs and ecological pyramids. • Introduction, types, characteristic features, structure and function of the following ecosystems :-

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4: Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India.

Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels, India as a mega-diversity nation.

Hot-spots of biodiversity

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India.

Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Characterization, evaluation and utilization of agrobiodiversity.

Unit 5 : Environmental Pollution: definition, cause, effects and control measures of :-

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards.

Solid Waste Management: causes, effects and control measures of urban and industrial wastes.

Role of an individual and communities in prevention of pollution.

Pollution case studies.

Unit 6: Social Issues and the Environment:

From Unsustainable to Sustainable Development

Urban problems related to energy

Water conservation, rain water harvesting, watershed management

Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dyes.

Wasteland reclamation.

Consumerism, wastage and waste products.

Environment Protection Act.

Air (Prevention and Control of Pollution) Act.

Water (Prevention and control of Pollution) Act

Wildlife Protection Act

Forest Conservation Act

Issues involved in enforcement of environmental legislation.

Public awareness.

Unit 7: Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Demographic patterns and impact on Agriculture

Environment and Human Health: Human Rights, Value Education, HIV/AIDS.

Women and Child Welfare.

Role of Information Technology in Environment and Human Health.

Case Studies.

Unit 8: Field work: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Disaster Management

Theory

UNIT-1 :-Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

UNIT-2 :-Man made disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, field fires-burning of straw, stables and residues oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT-3:-Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

II. Communication Skills and Personality Development

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

III. Information and Communication Technology

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practicals

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

IV. Entrepreneurship Development and Business Management

Theory

Concept of Entrepreneur, Entrepreneurship Development, Assessment of entrepreneurship skills, SWOT Analysis & achievement motivation, Entrepreneurial behavior, Government policy and plan for entrepreneurship development, Developing Leadership Skills, Encoding and decoding communication skills; Communication skills for entrepreneurship development, Developing Speaking Skills, Developing Listening Skills, Developing organizational skill, Developing Managerial skills, Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation.

V. Agri-Informatics

Theory

Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in

Agriculture, World Wide Web (www): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations.

e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advisory, e-banking markets market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix/ Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning. Forecasting and early warning.

VI. Economics and Marketing

Theory

Economics – Terms and definitions - Consumption, Demand and Supply. Factors of production. Gross Domestic Product – Role of Poultry Sector in National GDP – Marketing-definition – Marketing Process – Need for marketing – Role of marketing –– Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets. Functioning of E-markets

The contents given above are suggestive. It was decided by the Committee these contents be adjusted in courses and credit hours as per their relevance to the concerned.

Examination and Evaluation System

Fifth Deans' Committee deliberated on the examination and evaluation system being followed by different universities. The Committee recommends Uniform Grading system to be followed with uniform OGPA requirements for award of degrees at all levels and uniform conversion formulae to be followed for declaration of I, II and III divisions, distinctions etc. Declaration of division in the degree certificate to be made compulsory. by all universities:

1. Examination

- External theory (50%)
- Internal Theory + Practical (50%)
  - Courses with Theory and Practical

    Mid-term Exam (30%) + Assignment (5%) in practical oriented courses + Practical (15%)
  - Courses with only Theory

    Mid-term Exam (40%) + Assignment (10%)
  - Courses with only Practical:

    (100%) Internal
- Paper to be set by external: HOD shall ensure the coverage of syllabus. If needed moderation can be done.
- Evaluation to be done internally by the faculty other than the Course Instructor. Syllabus of the concerned course shall be sent to the external examiner, who shall prepare the question papers. For practical, it is recommended that examination shall be conducted by course instructor(s) and one teacher nominated by HOD.

2. Evaluation

Degree	Percentage of Marks Obtained	Conversion into Points
All	100	10 Points
	90 to <100	9 to <10
	80 to <90	8 to <9
	70 to <80	7 to <8
	60 to <70	6 to <7
	50 to <60	5 to <6
	<50 (Fail)	<5
	Eg. 80.76	8.076
	43.60	4.360
	72.50 (but shortage in attendance)	Fail (1 point)

OGPA	Division
5.000 – 5.999	Pass
6.000 – 6.999	II division
7.000 – 7.999	I division
8.000 and above	I division with distinction

GPA = Total points scored / Total credits (for 1 semester)

CGPA = ∑ Total points scored / Course credits

OGPA = ∑ Total points scored (after excluding failure points)/ Course credits

% of Marks = OGPA x 100/10

Central Assistance for Strengthening of Higher Agricultural Education

The SAUs are autonomous bodies established by the Act of respective State Legislature and wholly funded by the State Government concerned. The ICAR supplements the State funding by releasing fund that is actually Grant-in-Aid.

The Agricultural Education Division under the aegis of Indian Council of Agricultural Research undertakes planning, development, coordination and quality assurance in higher agricultural education in India and, thus, strives for strengthening and development of higher agricultural education system through partnership and efforts of the components of the ICAR-Agricultural Universities System comprising State Agricultural Universities (SAUs), Deemed to be Universities (DUs), Central Agricultural Universities (CAUs) and Central Universities (CUs) with agriculture faculty. The Agricultural Education Division is providing financial assistance to Agricultural Universities under the XII Plan Scheme "Strengthening and Development of Higher Agricultural Education in India"

This grant is provided for infrastructure development, gender main streaming including girls' hostels, other new civil works related to student amenities, including boys and international hostels, educational museums, examination halls and auditoriums, repair/ refurbishing/ renovation and modernization of educational structures etc. This also includes personality development, faculty development, strengthening of sports and games facilities, placement cells and other student amenities, building-on the agricultural education legacy by providing support to old historical universities/ colleges; equipments/ computers/ implements for higher education; strengthening of library, e-resources including existing e-courses, e-granth, ICT facilities etc. Support also includes preparation of quality instructional material, writing university level textbooks, manuals, etc. for effective teaching and learning process. The following are eligible to receive grant from the Council:

- All State Agricultural Universities (including Animal Science, Fishery, and Horticulture) established by an act passed in State Legislature, and its constituent colleges from which at least one batch of students have

passed out. Necessary documents related to establishment of the university and achievements must have been submitted to the Council.

- All Deemed to be Universities of ICAR, Central Agricultural Universities, Central Universities with agricultural faculty involved in teaching and research in agricultural sciences and have been established by an act of either the State Legislature or the Parliament and recognized by the UGC.
- Deemed to be Universities duly recognized by Government of India and admit students as per guidelines of ICAR through AIEEA.

During the early phase of SAUs' establishment, funding from Centre and State was fairly adequate for development of infrastructure including laboratory facilities, equipment, libraries and research farms. Upto VI Plan, almost 33 percent of the ICAR budget was devoted to strengthening of agricultural education in the country and this is the major reason that most of the universities established during that period have excellent infrastructure, which is largely contributed by the ICAR. The share of agricultural education in ICAR budget was 8.9% in VIII Plan, which increased to 14 % in X Plan and further to 21.5% in XI Plan. In absolute figures, it has increased from Rs. 224.69 crores in the IX Plan to Rs. 2900.00 crores in the XII Plan. However, with time, the number of universities and their constituent colleges and departments have increased but the budgetary provisions could not be increased commensurately. Sectoral splitting of SAUs into different subject areas has also contributed to their rising number and falling financial share. Consequently, the financial health of SAUs, in general, is precarious. It is imperative to enhance budgetary support both at the Centre and the State level, to attain and sustain enhanced capacity for technology development and quality of research and education.

In this backdrop, it seems imperative to enhance central/state assistance to agricultural universities for strengthening of Higher Agricultural Education in the country. In this context, following key components are being proposed for providing central assistance to agricultural universities and their constituent colleges for imparting quality and relevant skill-based education.

Civil Work: Support should be provided for repair, renovation, modernization and furnishing of academic infrastructure, student hostels, electrification and road network. Following specific support for new construction is recommended:

(i) Student Hostels: For construction of girls, boys and international hostels, the Council has a provision to provide grant of maximum of Rs. 250.00 lakh for NEH region/difficult terrains, and Rs. 200.00 lakh for other areas. Priority is given for the construction of girls hostel as per actual need of the university.

In the last couple of decades in most of the universities, there has been welcome change in respect of student enrollment. Moreover, most of the state governments now have provided for reservation of the girl students in Agricultural Sciences. One of the major difficulties for students in pursuing higher studies in agricultural sciences is the lack of availability of residential accommodation.

With the increasing number of students coming to agricultural sciences, it is necessary that adequate infrastructure is built for residential accommodation. The Committee is of the view that, additional Boys Hostel and Girls Hostel required, if any, as per the number of students enrolled may be funded by the ICAR/State Govts. making an adequate provision as per the estimated expenditure.

(ii) **Class Rooms and Examination Halls:** Support for development of Examination Hall subject to a maximum of Rs. 100 lakh per examination hall is being provided by the Council. There is also a provision to provide a special grant upto a maximum of Rs. 20.0 lakh per university per year for the establishment of Smart Class Rooms consisting interactive board, touch screen, bio-matrix, visualized, e-kiosks and Artificial Intelligence (AI) based course modules, etc.

It is observed that in many universities the number of seats at undergraduate and postgraduate levels has increased over time. Although, new buildings particularly, class rooms and examination halls have been constructed but still they are inadequate to cater to the present day requirements. It is, therefore, necessary that requisite infrastructure is constructed to run academic programmes effectively. In view of this, adequate financial support from ICAR/State Govt. as per the estimated expenditure is proposed.

(iii) **International Hostel:** The ICAR provides support for International Hostels subject to the condition that no support under this head has been provided to the university earlier and international students are regularly enrolled in sufficient number. The committee proposes to continue such support keeping in view, the number of students seeking admission in SAUs.

(iv) **Faculty & Student Amenities:** Council provides a support of Rs. 200/- per student for managing campus interviews and other related welfare activities in the colleges and hostels including games, sports & cultural activities and health-care facilities with a maximum limit of Rs. 5.00 lakh per university. Support of Rs. 50.00 lakhs or actual expenditure, whichever is less, is also provided for each event like Agri Unifest/ Agri Sports/ Education Olympiad per year to organize the event. Funds are also provided, based on merit of the case, for faculty related activities such as games, cultural, literary activities and special lectures of common interest with a maximum limit of Rs. 5.0 lakh per university. Need based support for strengthening of existing sports facilities is also provided subject to a maximum of Rs. 50.00 lakh per university.

The Committee proposes to continue such need based supports.

(v) **Electrification and Road Network:** It is observed that all SAUs although have access to electricity but suffer from serious deficiency in electricity supply on account of poor electric infrastructure. Similarly, many universities are having a poor road network infrastructure. It is, therefore, necessary that existing electric and road infrastructure should be improved and new infrastructure in this regard be taken up on priority basis. The Committee is of the view that the concerned state governments should provide funds for creation and maintenance of such facilities.

(vi) **Repairs and Renovation:** The SAUs have created facilities of boys and girls hostels, laboratory and other buildings with ICAR support. Some of them are quite old and need to be modernized. Limited need based support subject to maximum ceiling of Rs. 500.00 lakh per university is being provided by the Council for refurbishing, renovation, repair, and maintenance of existing structures *viz.* Hostels and Academic Blocks, International Hostel, Museum, Sports Complex, Examination Hall and other structures related to teaching and learning activities. Such support is recommended to be continued.

(vii) **Old/Historical College:** The ICAR provides a maximum amount of Rs. 500.00 lakh each for more than 100 years old; Rs. 250.00 lakh each for 50 to 99 years old and Rs. 100.00 lakh each for 25 to 49 years old colleges in order to maintain/protect the old and historical colleges, as per the availability of funds. The support is recommended to be continued.

(viii) **Up-gradation/Replacement of Facilities, including Equipments:** Need based support is being provided by the Council for replacement/ up-gradation of facilities/ equipment for teaching and practicals, which are either outdated or have lived their life and are required to be urgently replaced to impart quality education. Support is recommended to be continued.

(ix) **Annual Maintenance Contracts (AMCs), Replacement of Old and Obsolete Equipments and Parts thereof:** For further strengthening research and teaching need based support not exceeding Rs. 25.00 lakh per AU per year is being provided for AMCs and replacement purpose. Support is recommended to be continued.

Academic Augmentation.

(x) **Curriculum Development and Delivery:** The ICAR is providing a support of Rs. 50,000/- per college for preparation of textbooks, practical manuals and computer-led instructional material. Support is also being provided to meet day-to-day needs for conduct of practicals including consumable, glassware and experimental material etc., at the rate of Rs. 3000/- per UG student and of Rs. 5000/- per PG student. Such grants are recommended to be continued and amount be revised from time to time as upgradation of these facilities is must to keep pace with the current scenario.

(xi) **Strengthening of UG & PG Teaching:** Participation of faculty in scientific meetings enables them to keep abreast of latest developments in science and educational reforms and helps in building confidence while making presentations and designing teaching materials for classroom discussions and practical sessions. A support to the tune of maximum Rs. 50 lakh per university is being provided by the Council for this purpose. University can utilize a maximum of 25% of grants allocated under this head, for deputing faculty at National Symposium/ Workshop/ Seminar/ meetings and Specific National level trainings in emerging areas respectively. Such type of activities are must and need to be funded continuously.

(xii) **Development of Facilities for UG Practicals, Computer Labs:** Strengthening of the laboratories including computers to keep the labs equipped with the latest equipments for smooth conduct of practicals is must. The grant to a maximum ceiling of Rs. 20.0 lakh per AU per year is being provided by the Council.

(xiii) **Strengthening of international collaboration in Agricultural Education:** In the spirit of the "World Grant Universities" system increasing interdependence of local and global and, the enhancing internationalisation of agriculture, India's international collaboration in agricultural education research and innovation must be augmented also at the level of students, curricula development and delivery. The specific activities may includes: student and faculty exchanges, sandwich degree programs and internships, co-advisorship, research-led curriculum enhancement, co-teaching, development of courses on International Agriculture and Experiential Learning. Necessary funds should be provided for these activities.

(xiv) **Updation of professional/technical competence of para-professional -staff/administrative staff:** ICAR, provides a grant to a maximum ceiling of Rs. 10.0 lakh per university per year for updating professional/technical competence of para-professional staff/administrative staff. This support is being provided for the purpose of training 10% of the staff every year in skills related to his/ her job performance, preferably in the form of group trainings. The support is recommended to be continued.

(xv) Students Study & Educational Tours: Student study and educational tours, to well-known institutions and organizations and interactions with their faculty, help students broaden their knowledge and skills. There is a provision for a support of Rs. 5000/- to each student once in degree course for educational tours subject to a maximum support of Rs. 15.0 lakh per university. The Committee is of the view that support should continue to be provided based on actual number of students.

(xvi) Support to Dean: Committee members were of the view that the grant-in aid released by the Council goes to the Vice-Chancellor and all Deans may not get the due share, hence suggested that grant be released to the Deans of colleges. Education Division officials informed that looking into the large number of constituent colleges, it will not be practically possible. However, a provision to a maximum ceiling of Rs. 5.0 lakh per college in university has been kept to carry out following activities:

- Support in order to introduce innovative teaching techniques and carrying out creative activities in the college for overall welfare of staff and students.
- Support to meet part of the expenditure for conducting examinations and strengthening of examination cell.
- Support for assisting faculty with special grant to strengthen learning, particularly in conduct of practicals or research by the students.
- Support for existing e-resources including **NISAGENET** and **e-Courses.**

(xvii) Library Strengthening: The libraries of the agricultural universities and its constituent colleges have to be strengthened to enhance their learning resources including writing of text books and preparation of quality instructional material, e-learning resources and infrastructure. Financial support needs to be considered for strengthening and modernization of libraries including networking for online access to literature for ensuring equity and availability of quality learning resources both in the main campuses and off-campus colleges for the benefit of students and teachers, e-learning tools, modules and networking and overall library strengthening along with promotion of ICT connectivity, video conferencing and Technology Enhanced learning (TEL). The aim is to develop a unique virtual digital library of NARS accessible globally.

The ICAR provides a sum of maximum Rs. 25.00 lakh per college and Rs. 30.00 lakh for university library for strengthening of existing library. The proposals for existing programme *viz.,* e-Granth, to be considered separately with a maximum ceiling of Rs. 30.00 lakh per year in the XII Plan. The funds are allocated under the following heads under the sub-components "Library Strengthening".

(a) Essentially to convert existing library into digital library for books issue, deposition, maintaining text, reference, and book bank etc.

(b) Procurement of books from international publishers and e-resources related to subject matter.

(c) Repair and renovations of old library and equipping them with new shelves, air conditioners, de-humidifier, illumination shields, comfort seating zone and e-Kiosks for assessing facilities.

(d) Digitization of already available books/references/CD ROMS, etc.

(e) Strengthening of digital library and ICT tools, annual maintenance of equipments installed

in library, strengthen/installation of security system, purchase of fire extinguishers, establishment of Wi-Fi zone in the library.

(xviii) Skill development

a) **Experiential Learning:** In the revised syllabus, more emphasis on experiential learning has been laid. This is a major structural change undertaken, for bringing professionalism and practical work experience in real life situations to graduates. These programmes will build confidence, facilitate skill development through experiential learning and facilitate in producing job providers rather than job seekers. Modification in course curriculum necessitates change in methodology in teaching and learning and development of facilities like model farms, dairy plants, food processing facilities, workshops, procurement of state of the art equipments for practical training, ICT facilities, etc. The proposed budgetary outlay of Rs. 175.00 crores has been kept in XII Plan for setting up of EL modules across the universities.

b) **RAWE/ In-plant Training:** For this important activity, students need to be provided stipend as they have to mostly live outside and have to incur expenditure. It is proposed, that a provision of Rs. 3000 per student/month be made during RAWE/In-plant Training or Internship of Veterinary graduates. Of the ICAR share of Rs. 3000, Rs. 2500 would go as stipend to the student and Rs. 500 towards operationalizing of the programme *(meeting faculty expenses, contingency expenses POL, medicines during clinic etc)*

(xix) Human Resources Development

a) **Centres of Advanced Faculty Training (CAFT):** Centers of Advanced Faculty Training were created for undertaking discipline oriented advanced training for teaching, research and extensions in emerging areas and also training and retraining of faculties/scientist of other ICAR Institutes/AUs in enhancing their capabilities in use of educational innovations, modern teaching and research methodologies along with serving as repository of ideas and information in concerned discipline/department. In the XI Plan, 31 such centers were functioning and until now all the CAFTs were actively organizing atleast one training programme of 21 days duration annually and about 3400 faculty and scientists participated in these programme, which resulted in acquisition of desired skills and knowledge in emerging areas. It is proposed to further strengthen these centers in view of their major outcome and also creation of new CAFTs, in areas like, Bioinformatics and Statistics, Genetic Resource Management and Nanotechnology, Biotechnology (Animal/Plant), Computational Biology, Climate Change, Food Processing, Organic Farming, Agriculture Trade and Management, Veterinary Pathology and ICT and thus taking their number to 40. The mandate of CAFTs is recommended to also include long-term customized training and benefit of CAFTs trainings may also be extended beyond ICAR institutes/AUs on payment basis. Education Division, ICAR has kept a provision of budgetary support of Rs. 25.0 crore with a minimum of Rs. 15.0 lakh for each CAFT per year during XII Plan.

b) **Faculty Exchange/Guest & Adjunct Faculty:** In order to address faculty shortage especially in cutting edge areas, outstanding performing scientists/academicians from public and private R & D institutions with academic and research credentials are proposed to be made eligible for appointment as adjunct faculty in a university department. Professionals and specialists from public sector units and business corporations, and innovative farmers will also be eligible for these positions. A budgetary provision of Rs. 20.0 crore has been made for this programme in XII Plan.

c) **ICAR International Fellowships:** With the objective to develop competent human resource and showcasing the strength of Indian ICAR-AUs system, ICAR International Fellowships were introduced in 2009-10, for pursuing Ph.D. programme at Indian agricultural universities (AUs) and the overseas universities, for both overseas and Indian candidates. The objective is to develop competent human resource that are trained in best laboratories in the world (for Indian candidates) and expose overseas candidates to top rated Indian AUs for facilitating future cooperation with these countries. To continue the scheme a budget outlay of Rs. 30.00 crore has been kept in XII Plan. Additional allocations should be made on a continuing basis to initiate and continue selected international bilateral and multilateral joint R&E programs in frontier areas.

d) **ICAR Emeritus Scientist:** This on-going activity facilitates outstanding scientists to complete the nationally important research already being undertaken at the time of their superannuation. The programme has helped to make use of the experience of retired professionals for remedying manpower imbalances in some of the crucial areas of research. It is proposed that this initiative may be used not only to primarily complete the on-going research projects but also initiating a new programme in nationally important priority areas for a period of three years. This would ensure a structured outcome from the outstanding superannuated faculty/ scientists. The existing slots of 50 (in XI Plan) has been increased to 100 (in XII Plan).

e) **ICAR Emeritus Professor:** Quality of education in most of the universities is adversely affected due to shortage of faculty, little opportunities for faculty development and aging/ superannuating faculty. Only 65% of the sanctioned faculty strength remains filled, and over 50% universities have over 30% vacant faculty positions. The ICAR Emeritus Professor program started in XII Plan will be a new initiative of tapping Brain and Skill Bank of the outstanding superannuated professionals of NARS by utilizing their talent in teaching courses and other related activities, student research guidance and developing instructional material/ Text Books including e-learning resources for use in national agricultural education programme and distance education in the field of agriculture, veterinary science & animal husbandry, fisheries, home science, dairy technology and allied sciences. The Scheme is open to the scientists/teachers of the level of Principal Scientist/Professor and above from National Agricultural Research System that includes AUs and ICAR institutes engaged in Agricultural Research, Education, Human Resource Development and Extension.

(xx) **National Talent Scholarship for UG and PG Students:** The NTS awards, @ Rs. 2000 per month, are presently given to students on the basis of qualifying the ICAR's All India Entrance Examination or Veterinary Council of India Examination for Under Graduate degree programme in Agricultural / Veterinary science subjects and subsequent admission in Agricultural University/ Institute outside the State of Domicile of the candidate. This has changed the cultural life on campuses, brought healthy competition, promoted national integration, leading to improvement in instruction. The NTS awards have, in XII Plan, been extended to Post Graduate programme as well to students selected on the basis of qualifying the ICAR's All India Entrance Examination for Post-graduate degree programme in agriculture and allied science subjects and subsequent admission in Agricultural University/ Institute outside the State of Domicile of the candidate. PG students are given NTS @ of Rs. 3000 per month.

The committee appreciates the efforts of ICAR towards improvement of Higher Agricultural Education and recommends to continue further and to undertake additional initiatives.

Guidelines for Assessing Training Needs and Performance of Teaching Faculties

A massive exercise has been done by the Fourth Deans' Committee to develop guidelines for assessing training needs and performance of teaching facilities. The quality of agricultural education is governed interactively by faculty, infrastructure and curricula. Today we are in jet age and with rapid developments in science and technology especially cutting edge technologies, the technology gap is widening, hence to maintain quality of faculty its continuous updation is must. At present most of the universities have extensive inbreeding which is one of the important factors contributing to poor quality of graduates. Although, the State Agricultural universities were established on land grant pattern requiring integration of teaching, research and extension education, but the integration is almost negligible. The faculty strength in most of the SAUs is dwindled in the recent past. The state governments are required to make provision for adequate funds for knowledge updation of faculty in structured manner, so as to assure quality of education in SAUs.

Indian Council of Agricultural Research for the last many years have been insisting for making provision for training of each faculty once in five years nationally facilitating these trainings through increased number of summer schools, winter schools and training programmes conducted by the Centers of Advance Studies (CAS) and Niche Area of Excellence (NAE). The quality of trainings provided at NAE and CAS have been of first rate in many of the new and emerging areas because ICAR provided enough funds initially for purchase of state of the art equipments and necessary budget for training. Assistant Professors were the most benefitted because of the requirement of two training programmes for assessment and promotion to higher grade. The committee was of the view that such requirements be made essential for higher level of scientists and managers as well, so that the aim of updation in competence of senior faculty is also achieved.

Faculty is required to be abreast with current developments, and have adequate knowledge and expertise in cutting edge technologies, it is, therefore, in the interest of the concerned organizations, to have a structured mechanism for career development of faculty through need assessed regular training at different levels for improving quality of education. This will facilitate providing knowledge and expertise to our

graduates in real life situations. The Committee, therefore, recommends that realizing the ICAR goal, at least one training every five year be made mandatory with the following duration of courses at different levels.

- Associate Professor: 10-14 day programme
- Heads and Professors: 7 day programme
- Deans of Colleges and Directors: 3-5 day programme on management
- Vice-Chancellors and Directors of DUs: Retreat for two days

a. Induction training:

ICAR has been organizing induction training for scientists at initial entry level and this has been appreciated by all. Similar induction trainings need to be built-in the SAUs for a period of 3-4 months with a focus on pedagogy, computer literacy, knowledge about national and international agriculture, curriculum development, financial and administrative rules and procedures, etc.

b. Training overseas:

In key emerging areas such as biotechnology, processing and value addition, GIS, remote sensing, IPM, INM, agribusiness management, diagnostics, IPR, specialty foods, packaging, international quality standards, exports, entrepreneurship development, etc., faculty needs to be trained at best of the institutions globally. It is recommended that as an institutional goal ten per cent of the faculty be sent for training overseas every year for a period ranging from three months to one year depending upon the area and the time required for necessary skill acquisition. The trainings also need to be provided to ICAR scientists since the Committee has recommended linkage of SAUs with at least one ICAR institute and vice-versa. Since knowledge and qualification of teachers holds the key for quality of education, building and rebuilding of faculty competence assumes importance. The focus needs to be on basic and applied sciences relevant to different branches of agriculture sciences. Building faculty competence will ensure skill and entrepreneurship development among graduates for taking up enterprise and be job providers. ICAR needs to develop HRD policy to make mandatory training and retraining of the faculty. For this purpose the Committee recommends providing support for national and international trainings to the extent of Rs. 150 crore. Out of this, Rs. 25 crore be earmarked for providing facilities to the faculty members on return for maximizing the impact and benefit from training overseas.

c. Structured trainings:

- In-service training on global developments and issues pertaining to management of education
- Training for Comptrollers and Registrars on educational administration and financial management
- Training for Heads of the Departments on educational administration, evaluation systems and management
- Refresher programme for teachers on applied and basic courses
- Training for technical, administrative and financial staff

d. Focused effort of human resource development on following areas:

- Educational technologies and their applications
- Technology-based teaching learning (ICT and multimedia)
- Experiential learning and group learning
- Personality development
- Communication and presentation skills
- Developing winning research proposals
- Quality assurance in education
- Content development for distant education
- Evaluation of students' learning
- Andragogy for self-employment and entrepreneurial skills
- Curriculum design and development

The requirement of training needs to be made at college level and training designs be decided as per the needs. The training needs should be based on the analysis of strengths and weaknesses of the department and the requirement may be an individual or a group training. The objectives of these trainings should aim at:

- Acquiring skills in the newly emerging areas and cutting edge technologies.
- Updation of knowledge in frontier areas.

The Committee recommends the following:

- **Induction training:** ICAR has been organizing induction training for scientists at initial entry level and this has been appreciated by all. SAUs are also required to build up facilities for similar induction trainings for a period of atleast 4 months focussing on computer literacy, knowledge about national and international agriculture, curriculum development, financial and administrative rules and procedures, etc.
- **Training overseas:** In key emerging areas where facilities are not available in India, faculty need to be trained in best of the institutions globally. It is recommended the faculty be sent for training overseas at regular intervals for a period ranging from three months to one year depending upon the area and the time required for necessary skill acquisition.
- State Agricultural Universities lack one centralized training centre for training faculty on the lines of NAARM for ARS Scientists, Academy in Dehradun for Civil Services and Forest Services, Academic Staff College under University Grants Commission (UGC).National Academy of Agricultural Research Management, Hyderabad has already initiated giving training to newly recruited faculty of SAUs and to senior faculty through its regular and executive / management development programme but it is insufficient for the SAUs. Looking at the training needs of the new and old faculty of SAUs, the V Deans' Committee felt that one regional training centre for faculty and learning in each zone (East, West, North and south zones of India) may be established with full assistance from ICAR/ DARE.

- An understanding may be made between ICAR and concerned institutions (IIMs, NAARM etc.,) for imparting training to senior executives of the SAUs on human resource development and management, inspiration and motivation of the faculty till the establishment of regional training centres for training and learning are established by ICAR.
- Funding by ICAR to set-up training centres / centres of excellence is expected to be widened further. Each university should identify the potential centres of the region and create the Centre of Excellence to cater the needs of stakeholders.
- Ongoing Winter/Summer Schools, training by CAFT centers are not able to attract desired number of participants. The participants in these trainings do not represent a national scenario. Therefore, the quality of these trainings needs to be revamped in order to attract participants from across the country. It was also felt that the trainings should focus more on practical and practice oriented contents.
- *Performance based incentives / awards / rewards / recognition:* Some annual incentives/ awards in form of advance annual increment should be started to the outstanding performers based on the annual assessment report. The timely, transparent system across the SAUs may be put in place.
- *Students evaluating teachers:* The proforma needs revision. The IARI model for identification of best teacher may be adopted across the universities which includes the inputs from the students of second year M.Sc., and second and third year Ph.Ds. Based on inputs of the students given, 2-3 teachers are identified from each discipline to invite their biodata in a prescribed proforma. These are evaluated and recommended by an external committee based on the criteria given in the proforma such as number of classes taken, participation in credit seminar, students guided, publications from students' thesis, awards won by the students, placement of students guided by the faculty etc.,
- Respective Deans should monitor their teachers' performance. Though the performance indicators are already in place in many SAUs but the following points may be considered for evaluation of faculty by the Deans:
  - Punctuality in adhering to schedule of classes, examinations, submission of students' progress/ thesis etc.
  - Technologies/ varieties/ patents /products developed and approved by the SAUs/ authorities.
  - Research publications in peer reviewed journals (preferably with more than 6 rating but not less than 5)
  - Invited participation in Seminar/Symposia/National Level Committees
  - M.Sc. /Ph.D. students guided and publications arising from the students' thesis
  - Awards and recognitions from the recognized state /central organizations
  - Externally funded projects as PI and Co-PI

Not many faculty training opportunities have been created till now for FST resulting human resource as the major constraint at almost all the SAUs. Refresher training program should be developed for the discipline of Food Processing and organized periodically. Adequate industrial training and international exposure must be there for all teaching faculty.

Teaching faculties should also be trained on industrial operations, plant inspections, assessment, licensing, certification and auditing activities, etc. for the benefit of knowledge transfer to the students.

Evaluation should go beyond 'outputs'. Outcomes and impact should be measured. Critical Impact Pathway Analysis should be institutionalised. The universities should participate in the Big Data Initiative, and in collaboration with ICAR, SAUs should be able to create their own score card. The exercise should be linked closely with the university ranking.

Reforms in Governance of SAUs

With an objective to have uniformity in the governance of State Agricultural Universities, ICAR brought out first Model Act in 1966 and has been revising it from time to time. The last revision was made by the Council in 2009. The Act has not been adopted by most of the SAUs. The Committee was of the view that there needs to be a body with statutory powers to regulate agricultural education for quality assurance as this will go a long way in ensuring relevance and quality of education in addition to soundness and vibrancy of the national agricultural education system.

The Committee recommends the adoption of the following provisions of the Model Act by all the SAUs:

AUTHORITIES OF THE UNIVERSITY

The following shall be the authorities of the University, namely:-

(1) Board of Management
(2) Academic Council
(3) Research Council
(4) Extension Council/Extension Education Council
(5) Faculties and their Board of Studies
(6) Such other bodies of University as may be declared by the Statute to be authorities of University

Board of Management and its Constitution

(1) The Chancellor shall, soon after the first Vice-Chancellor is appointed, constitute the Board of Management.
(2) The Board of Management shall constitute of the following:-
   (i) The Vice-Chancellor –Chairperson
   (ii) Principal Secretary/ Secretary, Department of Agriculture, State Government or his nominee not below the rank of Joint Secretary.
   (iii) Principal Secretary/ Secretary, Finance Department of the State Government or his nominee not below the rank of Joint Secretary.
   (iv) Principal Secretary/ Secretary from the Department of Animal Husbandry/ Fisheries/ Forestry or his nominee not below the

rank of Joint Secretary, may be nominated by the State Government keeping in view the teaching and research programmes at the university.

(v) One eminent educationist (not below the rank of Professor) from the field of Agriculture and Allied Sciences to be nominated by the Chancellor.

(vi) One representative of State Legislative bodies such as Assembly/Council or any other autonomous/ para-statal/ Zila Parishad body, with substantial contribution towards rural upliftment and empowerment, to be nominated by the Chancellor.

(vii) One outstanding woman social worker having background of rural advancement to be nominated by the Chancellor.

(viii) One progressive farmer from the jurisdiction of the university to be nominated by the Government.

(ix) One distinguished agro-industrialist to be nominated by the Government.

(x) One eminent educationist from outside the university from the field of Agriculture and allied science to be nominated by the Vice-Chancellor.

(xi) One representative from the Indian Council of Agricultural Research (ICAR) to be nominated by the Director General, ICAR.

(xii) One Director to be nominated by the Vice-Chancellor.

(xiii) One Dean to be nominated by the Vice-Chancellor.

(xiv) Registrar – Secretary

(3) The term of the office of the Members of the Board other than the ex-officio members shall be two years.

(4) When a vacancy occurs in the office of any member by the reason of death, resignation or any cause other than the expiry of term, the vacancy shall be filled in accordance with the provisions of this section and the person who fills such vacancy shall hold office for the residue of the term for which the person whose place he/she fills would have been a member.

(5) No action or proceedings of the Board shall be invalid merely on the ground of the existence of any vacancy or defect in the constitution of the Board.

(6) One third of the members of the Board shall form quorum at a meeting of the Board. Provided that if a meeting of the Board is adjourned for want of quorum, no quorum shall be necessary at the next meeting called for transacting the same business.

(7) No other officer or employee of the University shall be eligible to be a member of the Board under clause (v) to (x) of sub-section (2) of this section.

(8) The Board for the purpose of consultation may invite any person having experience or special knowledge on any subject under consideration to attend its meeting. Such person may speak or otherwise take part in the proceedings of such meeting but shall not be entitled to vote. Any person so invited shall be entitled to such allowances for attending the meeting as may be prescribed.

(9) Normally the Board shall on dates to be fixed by the Vice- Chancellor meet at least twice a year. However, Vice-Chancellor may whenever, he thinks fit and shall, upon the requisition in writing signed by not less than five members of the Board, convene a special meeting of the Board.

Powers and Functions of the Board

(1) Subject to the provisions of this Act and the Statute, the Board shall be the Chief Executive Body of the University and shall manage and supervise the properties and activities of the University and shall be responsible for the conduct of all administrative affairs of the University not otherwise provided for in this Act.

(2) Without prejudice to the generality of the foregoing powers, the Board shall exercise and perform the following powers and functions:-

(i) To consider and approve the financial requirements, estimates and the budget of the University.

(ii) To hold and control the property and the funds of the University and issue any general directive on behalf of the University.

(iii) To accept or transfer any property on behalf of the University.

(iv) To administer funds placed at the disposal of the University for the purpose intended.

(v) To arrange for the investment and withdrawal of the funds of the University.

(vi) To borrow money for capital investments with prior approval of the State Government and make suitable arrangements for its repayment.

(vii) To accept on behalf of the University trusts, bequests and donations.

(viii) To consider and approve the recommendations of the Academic, Research and Extension Councils where required.

(ix) To direct the form and use of the common seal of the University.

(x) To appoint such committees and bodies as it may deem necessary and set down the terms of reference thereof in accordance with the provisions of this Act and the Statutes.

(xi) To consider and approve establishment, amalgamation and abolition of Colleges, Department, Centre or Research Station/sub-station on the recommendation of Academic Council, Research Council or Extension Council. New college / faculty shall be established only after approval from the Government.

(xii) To create teaching, research and extension education posts with the approval of the State Government.

(xiii) To approve the recommendations of Selection Committee in the prescribed manner for appointment of officers, teachers and employees of the rank of Assistant Professor and above.

Academic Council

(1) Academic Council shall consist of the following members-

(i) The Vice-Chancellor - Chairperson

(ii) Directors of Research and Extension

(iii) All Deans

(iv) Two Heads of the Department from each faculty nominated by the Vice-Chancellor on rotational basis.

(v) One teacher of the Professor rank from each faculty to be nominated by the Vice Chancellor on rotational basis.

(vi) One eminent agriculture educationist from outside the University to be nominated by the Vice-Chancellor.

(vii) Registrar

(viii) Director of Education – Member Secretary

Comptroller and University Librarian shall be the non-member invitees.

(2) Academic Council may co-opt as members not more than two persons for such period and in such manner as may be prescribed so as to secure adequate representation of different sectors of agriculture and allied fields.

(3) All members of the Academic Council other than the ex-officio members and members referred in sub-section (2) shall hold office for a term of two years.

(4) One third of the members of the Academic Council shall form quorum at a meeting of the Council.

Provided that if a meeting of the Council is adjourned for want of quorum, no quorum shall be necessary at the next meeting for the transaction of the same business.

(5) Normally the Academic Council shall meet once in each semester on such dates as may be fixed by the Vice-Chancellor. However, special meetings of the Academic Council can be called by the Vice-Chancellor.

Powers and Functions of the Academic Council

(1) The Academic Council shall, subject to provisions of this Act and the Statute, have the power by regulations of prescribing all courses of study and determining curricula, and shall have control on teaching and other educational programmes within University, and shall be responsible for the maintenance of standards thereof.

(2) It shall have power to make regulations consistent with this Act and the Statute relating to all academic matters subject to its control and to amend or repeal such regulations.

(3) In particular, and without prejudice to the generality of the foregoing power, the Academic Council shall have power:-

(i) To advise the Board and Vice-Chancellor on all academic matters.

(ii) To make recommendations for the institution of Professorships, Associate Professorships, Assistant Professorships and other teaching posts including posts in research and extension education and in regard to the duties thereof.

(iii) To make recommendations for adjunct professorship.

(iv) To make recommendations for the establishment/amalgamation/abolition of Faculty, College, Department of teaching, research and extension education.

(v) To make regulations regarding the admission of students to the university, and determine the number of students to be admitted.

(vi) To make regulations relating to the courses of study leading to degrees, diplomas and certificates.

(vii) To make regulations relating to the conduct of examinations and to maintain and improve standards of education.

(viii) To make recommendations to the Board regarding conferment of honorary degree.

(ix) To make recommendations regarding the qualifications to be prescribed for teachers in the University.

(x) To exercise such other powers and perform such other functions as may be conferred or imposed on it under the provisions of this Act, by the Board or Vice-Chancellor.

Research Council

(1) There shall be a Research Council consisting of the following members-

(i) The Vice-Chancellor - Chairperson

(ii) The Directors of Agriculture/Horticulture/Animal Husbandry/Fisheries and Chief Conservator of Forests (depending upon research mandate and programmes of the University) of the Government

(iii) Directors of Education and Extension

(iv) All Deans

(v) All Heads of Departments/ Associate Directors

(vi) Research Council may co-opt as members not more than four persons including one progressive farmer for such period and in such manner as may be prescribed so as to secure adequate representation of different sectors of agriculture and allied fields;

(vii) Director of Research - Member Secretary.

Registrar and Comptroller shall be the non-member invitees.

Functions of Research Council

(1) The Research Council shall consider and make recommendations in respect of-

(i) Research programmes and projects undertaken, or to be undertaken by the various university scientists in the field of agriculture and allied sciences and their prioritization, monitoring and evaluation.

(ii) Physical, fiscal and administrative facilities required for implementing research projects.

(iii) Orienting research to meet farmers and other stake holders needs.

(iv) Public-Private Partnership in research.

(v) Any other matter pertaining to research programmes which may be referred to by the Vice-Chancellor or the Board or any other authority of the University.

Extension Council/ Extension Education Council

(1) There shall be an Extension Council consisting of the following members-

(i) Vice-Chancellor – Chairperson.

(ii) Directors of Agriculture/Horticulture/Animal Husbandry/Fisheries and Chief Conservator of Forests (depending upon mandate and programmes of the University) of the Government.

(iii) Director of Education, Research and all Associate Directors/Joint Directors.

(iv) All Deans.

(v) All Heads of the Departments/Regional Research Station/ Centers.

(vi) Two eminent persons in the field of Extension Education from outside nominated by the Vice-Chancellor.

(vii) Two progressive farmers to be nominated by the Vice-Chancellor.

(viii) Vice Chancellor may co-opt up to two members from related organizations.

(ix) Director of Extension - Member Secretary.

Registrar and Comptroller shall be the non-member invitees.

Functions of the Extension Council/ Extension Education Council

(1) Extension Council shall consider and make recommendations in respect of-

(i) The Extension Education Programmes and Projects of the University.

(ii) Coordination of Extension Education Activities.

(iii) Development of farmers' education, training and advisory services.

(iv) Monitoring and evaluation of the Extension Education Programmes and Projects of the University.

(v) Any other matter referred to it by the Vice-Chancellor, Board or any other authority of the university.

Faculties and Board of Studies

1. The University shall have the faculties.
2. Each faculty shall have Board of Studies consisting of the following members:
   (i) Dean of Faculty – Chairperson.
   (ii) Deans of the constituent colleges of the faculty.
   (iii) All Heads of the Departments of the concerned faculty.
   (iv) One elder faculty member from each Department nominated by the Dean of Faculty.
   (v) A senior Head of the Department – Member Secretary.
3. The functions of each faculty shall be as follows:
   (i) To review teaching programme and suggest improvements thereof.
   (ii) To consider the recommendations of the Committee of Courses and Curricula or similar body of department/faculty and submit to the Academic Council for approval.
   (iii) To perform such other functions as may be assigned to it by the Academic Council or Vice-chancellor.

Constitution of Committees

Every authority shall have the power to appoint Committees which may unless otherwise provided in this Act or Statute consist of the members of the authority and such other persons as it may deem fit.

Provisions in relation to Membership of Authorities

(1) Save as otherwise provided in this Act, if any member other than ex-officio member of any authority or body of the University, is unable by reason of his death, resignation, removal or otherwise to complete his full term of office, the vacancy so caused shall as soon as convenient, be filled by the appointment, nomination or co-option, as the case may be and the person so appointed, nominated or co-opted shall fill such vacancy for the un-expired portion of the term for which the member in whose place such person is appointed, nominated or co-opted would otherwise have continued in office.

(2) The Board may remove any person from membership of any authority or body of the University on the ground that such person has been convicted of any offence involving moral turpitude or conduct not befitting the office held by the concerned member with the approval of the Chancellor, except that prior approval of the Chancellor shall not be necessary where such a person has been convicted by a competent Court of law.

Provided that no such order shall be made against any person without giving reasonable opportunity of being heard.

(3) A person who is a Member of any authority or body of the University as a representative of another body whether of the University or not, shall cease to be a member of such authority or body if before the expiry of the term of his membership he ceases to be a member of that other body by which he was appointed or nominated.

(4) Whenever any person becomes a Member of any authority or body of the University by virtue of the office held by him, he shall forthwith cease to be a member of such authority or body if he/she ceases to hold such office before the expiry of the term of his membership.

Provided that he shall not be deemed to have ceased to hold his office merely by reason of his proceeding on leave for a period not exceeding four months.

(5) Any member, other than an ex-officio member of any authority or body of the University may resign his office by letter addressed to the Vice-Chancellor and such resignation, upon acceptance, shall take effect from the date on which the same is submitted.

Validity and Protection of Acts

(1) The university shall adhere to the acts and laws of the union and the state.

(2) No act or proceeding of any authority or body of the University shall be invalid by reason of the existence of any vacancy among its members or by reason of some person having taken part in the proceedings who is subsequently found to have been not entitled to do so.

(3) Save as otherwise provided in this Act, all the acts done or orders made in good faith by the University or any of its authorities shall be final and no suit shall be instituted against or damages claimed from the University or its authority for anything done or purported to have been done in pursuance of this Act or the Statute or the Regulations.

(4) No suit or other legal proceeding shall lie against any officer or other employee of the University in respect of anything which is in good faith done or intended to be done in pursuance of this Act or any Statutes made there under.

Officers of the University

Officers

The following shall be the officers of the University namely-

(i) The Chancellor
(ii) The Vice-Chancellor
(iii) The Directors
(iv) The Deans
(v) The Registrar

(vi) The Comptroller

(vii) The University Librarian

(viii) Such other persons in the service of the University as may be declared by the Statute to be the Officers of the University.

The Chancellor

(1) The Governor of the respective State shall by virtue of his office be the Chancellor of the University.

(2) The Chancellor shall be the Head of the University and shall when present, preside at the Convocation of the university.

(3) Every proposal to confer an honorary degree shall be subject to the confirmation of the Chancellor.

(4) The Chancellor may by an order in writing annul any order or proceeding of the officer or authority of the University which is not in conformity with this Act and Statutes;

Provided that before making any such order he shall call upon the officer or authority concerned to show cause why such an order should not be made and if any cause is shown within the time specified in this behalf, he shall consider the same.

(5) The Chancellor shall exercise such powers and perform such other duties as are conferred on him by this Act or the Statute.

The Vice-Chancellor

(1) The Vice-Chancellor shall be a whole time officer of the University and he shall be appointed by the Chancellor from the panel of eminent educationists in Agricultural Sciences drawn by the Search Committee. The Search Committee shall consist of the following Members:-

(i) Director General, ICAR

(ii) One nominee of the Government

(iii) One nominee of the Chancellor

Provided that one of these Members shall be nominated by the Chancellor to act as Convener.

Nominee of the Government and the Chancellor shall be in the rank of Vice Chancellor or equivalent.

(2) A person who has attained academic excellence and demonstrated leadership qualities in research, education and extension shall be eligible for candidature to the post of Vice Chancellor.

(3) Notice of Search Committee shall be widely publicized and go to all agricultural universities/ institutes. The Search Committee will select and suggest a panel of the three names.

(4) The Vice-Chancellor shall hold office for a term of five years or until he attains the age of 70 years, whichever is earlier. The emoluments and other conditions of the service of the Vice-Chancellor shall be such as may be prescribed by UGC/ICAR.

(5) The Vice-Chancellor may relinquish his office by resignation in writing under his hand addressed to the Chancellor which shall be delivered to the Chancellor normally 60 days prior to the date on which the Vice-Chancellor wishes to be relieved from his office, but the Chancellor may relieve him earlier.

(6) In the event of a temporary vacancy of the post of Vice-Chancellor or his absence on leave or for any other reason, senior most Director/Dean of Faculty/Registrar of the University, with the approval of the Chancellor, may perform the duties of the Vice-Chancellor but his period shall not exceed six months.

(7) The Vice-Chancellor shall not be removed from his office except by order of the Chancellor passed on the ground of mis-behaviour or incapacity or if it appears to the Chancellor that the continuance of the Vice-Chancellor in office is detrimental to the interests of the University, after due inquiry by such person who is or has been a Judge of High Court to be nominated by the Chancellor in which the Vice-Chancellor, shall have an opportunity of making his representation.

Powers and Duties of the Vice-Chancellor

(1) The Vice-Chancellor shall be the Principal Executive Officer of the University and ex-officio Chairman of the Board, Academic Council and other authorities and shall in the absence of the Chancellor, preside at the Convocation of the University and confer degrees on persons entitled to receive them.

(2) The Vice-Chancellor shall exercise overall control over the affairs of the University and shall be responsible for due maintenance of discipline in the university.

(3) The Vice-Chancellor shall convene meetings of the Board of Management, Academic Council, Research Council and Extension Council.

(4) The Vice-Chancellor shall ensure faithful observance of the provisions of this Act and Statutes and Regulations.

(5) The Vice-Chancellor shall be responsible for the presentation of the annual financial estimates and the annual accounts to the Board of Management.

(6) The Vice-Chancellor may take any action in any emergency which in his opinion calls for immediate action. He shall in such case and as soon as may be thereafter report his action to the authorities who would ordinarily have dealt with the matter. If the authority disagrees with the action of the Vice-Chancellor the matter shall be referred to the Chancellor whose decision shall be final.

(7) Where any action taken by the Vice-Chancellor under sub- sections (6) affects any person in the service of the University to his disadvantage, such person may prefer an appeal to the Board within thirty days from the date on which such person has been served a notice of the action taken.

(8) If the Vice-Chancellor is satisfied that a decision of the Board is not in the best interest of the University, he shall refer it to the Chancellor whose decision thereon shall be final.

(9) Subject to the provisions of the preceding sub-sections, the Vice Chancellor shall give effect to the decisions of the Board regarding the appointments, promotions and dismissal of officers, teachers and other employees of the University.

(10) The Vice-Chancellor shall be responsible for the proper administration of the affairs of the University and for a close co-ordination and integration of teaching, research and extension.

(11) The Vice-Chancellor shall exercise such other powers and perform such other duties as are conferred or imposed upon him under the provisions of this Act and the Statutes.

Other Officers of the University

General Terms & Conditions: The officers of the University referred to in clause (iii) to (viii) of section 22 shall be appointed by the Vice-Chancellor with the approval of the concerned authority of the University on such terms and conditions as may be prescribed.

Provided that the Vice-Chancellor may make appointments of such officers as a temporary measure for a period of six months under intimation to the concerned authority of the University.

Directors, Deans, Registrar, Comptroller etc.

(1) Director of Education:

(a) Shall be responsible for planning and academic coordination for teaching, quality of education, policy matters and system regarding resident instruction, overseeing the examination and evaluation, development and enforcement of curricula, development of educational technology and teachers' training programme(s), HRD of faculty, etc.

(b) Shall function as Member Secretary of the Academic Council.

(2) Director of Research:

(a) Shall be responsible for the direction and co-ordination of research programmes in the University as laid down in section 29 and efficient working of research stations.

(3) Director of Extension/ Extension Education:

(a) Shall be responsible for the Agriculture Extension Education programmes as laid down in Section 30.

(4) Dean:

(a) Shall be Head of the College and be responsible for teaching, research and extension activities in the College.

(5) Dean of Faculty

(a) Shall be the Chairman of Board of Studies of the concerned faculty and shall be responsible to the Vice Chancellor for the organization and implementation of the teaching programme of the faculty.

(6) Dean of Students Welfare:

(a) Shall plan and direct the programme of students' advisement and counseling and to enlist the co-operation of prospective employers and employment agencies to assist in the placement of graduates of the University and to promote discipline amongst the students of the University.

(b) Shall plan and organize students' extra-curricular activities such as sports, cultural and other recreational activities, National Cadet Corps, NSS and communication skill improvement and other allied activities.

(c) Shall make arrangements and supervise management of students' hostel, cafeteria and mess.

(d) Shall supervise and control medical and health services and other welfare measures in the University.

(7) Registrar:

(a) Shall be Ex-officio Secretary of the Board of Management and permanent invitee of all councils.

(b) Shall be responsible for the due custody of records and common seal of the university.

(c) Shall be responsible for establishment matters and general administration in the university as prescribed.

(d) Shall be responsible for admissions of UG and PG and conduct and management of examinations at UG and PG, maintenance of permanent records of the students at the university including the courses taken, credits obtained, degrees, prizes or other distinctions and other items pertaining to academic performance and discipline of the students.

(8) Comptroller:

(a) Shall be responsible for preparation of the budget, the statement of accounts, management of the funds and investments of the University.

(b) Shall be responsible for ensuring that expenditure is made as authorized.

(c) Shall arrange periodical internal inspection of the accounts maintained in various units of University.

(d) Shall be responsible for the maintenance of the accounts of the University in the form and manner as approved by the Board and keep constant watch on the state of cash and bank balance and on the state of investment.

(e) Shall see that the asset registers are maintained up-to date and that the regular stock checking is conducted.

(9) University Librarian:

He shall be responsible for the maintenance and management of the University Library Information System and to guide and co-ordinate library activities of all the constituent units of the University.

Subject to the provisions of this Act, the Officers of the University referred to in clauses (iii) to (viii) of section 22 shall perform such other duties as may be prescribed or as may be assigned to them from time to time, by the Vice-Chancellor.

EDUCATION, RESEARCH AND EXTENSION

Education

(1) Subject to provisions of this Act, Education in the University shall include Bachelor's, Master's and Doctoral degree programmes and short-term diploma / certificate courses in the disciplines of Agriculture and allied sciences as prescribed.

(2) The Educational programmes would maintain congruence with the State and National policies.

(3) The University shall put in place initiatives for e-learning, distributed / distance education, ICT-enabled knowledge sharing etc.

(4) Programmes of Agricultural Education should aim at producing competent and skilled graduates and post-graduates, possessing leadership qualities.

Research

(1) Subject to the provisions of this Act and the Statutes, the University shall carry on strategic, basic and applied research in agriculture.

(2) The University through its research organization shall be the principal agency of control over research activities in Agriculture, Animal Husbandry and other allied branches in its jurisdiction.

(3) The University with the concurrence of Government may establish Regional/Zonal Research Stations and Sub-Stations in different agro-climatic zones in its territorial jurisdiction for the conduct of research including operational research.

Extension

(1) Extension Education programmes shall be established in the University and shall, subject to the provisions of this Act and the Statutes, ensure technology assessment and refinement and facilitate adoption of technology based on research findings to farmers and others for accelerated agricultural growth. It shall conduct demonstrations and training programmes for the benefit of various stakeholders. Extension Education programmes shall be coordinated with various units of the University and other appropriate agencies of the Centre and the State.

(2) The University shall be responsible for developing models of Agricultural Extension in the State.

Integration of teaching, research and extension

(1) In consultation with the appropriate officers of the University, the Vice-Chancellor shall be responsible for taking such steps as may be necessary for the full integration of teaching, research and extension activities of the University.

(2) Every faculty member borne on teaching cadre shall devote some time (not exceeding 30% and as decided by the Vice Chancellor in consultation with the appropriate officers of the University) in an academic year for undertaking research and/or extension besides teaching. Likewise a faculty member borne on research or extension shall spend some time in teaching.

(3) All teaching, research and extension staff located in the college shall be under the administrative control of Dean of the College and overall technical control of Director (Research) and Director (Extension) as the case may be.

(4) The University shall develop its programme of research and extension keeping in view the regional needs of the State and provide the appropriate technological backstopping, to the Government and other stakeholders.

(5) The NARS of the state shall develop informed policies for promotion of agricultural research, education and extension for development (AREE4D) in the state and shall work closely with State Government to have the policies institutionalised and implemented.

FUNDS AND ACCOUNTS

The University Funds

(1) The University shall have a General Fund to which shall be credited:-

(i) Its income from fees, endowments and grants and income from properties of the University including hostel, experimental stations and farms.

(ii) Contribution and grants made by the Government on such conditions as are consistent with the provision of this Act.

(iii) Other contributions, grants, donations, beneficiations and loans and other receipts.

(2) The University shall form a fund called the Foundation Fund from contributions and grants made by the Central Government or the State Government or approved agency for being credited to that fund and such other sums as may be specified by the Board, shall be credited to this fund. The Board may as and when necessary retransfer such amount as may be specified, from the Foundation Fund to the General Fund, in manner prescribed.

(3) The University shall furnish statements of accounts, reports and other particulars to the Government relating to any grant made by the Government and shall take such action and furnish such statements, accounts, reports and other particulars relating to the utilization of any grant within such time and manner as the Government may direct.

(4) It shall be competent for the University in furtherance of its objectives to accept the grants from the Government or any other State Government or the Central Government or Statutory Bodies or endowments or donations under such conditions as may be agreed upon between the University and the granter or donor.

Management of Funds

The General Fund, Foundation Fund and other funds of the University shall be managed according to the provisions laid down by the Statute.

Accounts and Audit

The Annual Statement of accounts (based on the double entry system of accounting) of the University shall be prepared by the Comptroller and certified by an authority to be nominated or authorized by the Board. The Statement shall include all the money accruing to or received by the University from whatever source and all amount disbursed and paid by the University. Such statement shall be submitted to the Government by the Board normally within six months after close of the financial year to which these pertain.

Provident Fund, Pension and Insurance

(1) The University shall constitute for the benefit of its officers, teachers, ministerial staff and other employees, in such manner and subject to such conditions as may be prescribed, such pension, gratuity, insurance, provident fund, contributory pension fund as it may deem fit.

(2) For such pension, gratuity, insurance and provident fund so constituted by the University, the Government should declare that the provisions of the Provident Funds Act shall apply to such funds as it were Government provident Fund.

Provided that the University shall have power in consultation with the Finance Committee and the Board to invest Provident Fund amount in such manner as it may determine.

Government Grants

The Government shall every year make the following lump sum grants to the University, namely:-

(i) A grant not less than the estimated expenditure of pay and allowances of the staff contingencies, supplies and services of the University for proper functioning of University.

(ii) A grant to meet the actual pensionary and all other retirement liabilities of the pensioners of the University.

(iii) The State Government shall also make non-lapsable lump sum grant to the University in respect to schemes included in the Five Year Plans and transferred to it for implementation by the University of an amount equal to the net outlay in the annual plan.

(iv) As recomended by the ICAR, each state should allocate atleast 1% of its Agriculture GDP to agricultural research and innovations for development.

Finance Committee

(1) The Board shall constitute a Finance Committee consisting of:-

(i) The Vice-Chancellor – Chairperson.

(ii) Principal Secretary/Secretary (Finance) to the State Government or his nominee not below the rank of Joint Secretary.

(iii) Principal Secretary / Secretary (Agriculture) to the Government.

(iv) One Director/Dean from amongst the Board Members to be nominated by the Vice-Chancellor.

(v) One nominee of the Board.

(vi) Comptroller - Member Secretary.

Registrar shall be the non-member invitee

(2) Finance Committee shall have the following functions:-

(i) To examine the annual accounts and budget estimates of the University and to advise the Board thereon.

(ii) To review the financial position of the University from to time.

(iii) To make recommendations to the Board on all matters relating to the finances of the University.

STATUTES AND REGULATIONS

Statutes

Subject to the provisions of this Act, the Statutes of the University may provide for any matter connected with the affairs of the University and shall, in particular, provide for the following, namely:

(1) Cnstitution, powers and duties of the Authorities.

(2) Creation, composition and functions of the other Bodies or Committees necessary or desirable for improving the academic life of the University.

(3) Designations, powers, functions, duties, manner of appointment and selections, and terms and conditions of service of the officers other than Chancellor and Vice-Chancellor.

(4) Classification, qualification and manner of appointment, terms and conditions of services and duties of teachers and non-teaching staff of the University.

(5) Terms and conditions of service of the Vice-Chancellor.

(6) Establishment, amalgamation, sub-division or abolition of faculties, Departments/Research Stations/Centres or other units of the University.

(7) Establishment of pension and insurance schemes for the benefit of officers, teachers and other employees of the University and rules, terms and conditions of such schemes.
(8) Holding of Convocation to confer degrees and diplomas.
(9) Conferment and withdrawal of honorary degrees and academic distinctions.
(10) Conditions of service, remunerations and allowances including travelling and daily allowances to be paid to officers, teachers and other persons employed under the University.
(11) Conditions and mode of appointment and the duties of examining bodies and examiners.
(12) Management of Colleges/Centres/Divisions/Departments/Regional Stations/other KVKs/ institutions founded or maintained by the University.
(13) Constitution of Selection Committee for appointment of teachers and other staff.
(14) All other matters which by this Act are to be provided by the Statutes.

Statues how made

(1) Statutes under this Act shall be proposed by the Board and submitted to the Chancellor for his assent and shall be valid only after the assent is received and notified by the Vice-Chancellor.
(2) Any Statute may be amended or repealed by the Board with the assent of the Chancellor.
(3) All Statutes made under this Act shall be published in the official gazette.

Regulations

(1) The authorities of the University may make regulations consistent with this Act and the statutes for:-
   (i) Laying down the procedure for their meetings and number of members required to form the quorum.
   (ii) Providing for matters which by this Act and the Statutes are to be regulated by Regulations.
   (iii) Providing for any other matter solely concerning the authority and not provided for by this Act and the Statutes.
(2) The Academic Council may subject to the provisions of Act and the Statutes, make regulations providing for courses of studies, system of examination, academic calendar, award of degrees and diplomas of the University and other matters related to Resident Instruction.
(3) The regulations made by any authority of the University shall be subject to such directions as the Board may from time to time give in this behalf.
(4) Academic Council of the University may make regulations for-
   (i) The holding of Convocations to confer degrees and diplomas.
   (ii) The conferment of honorary degrees, academic distinctions and withdrawal of degrees.
   (iii) The establishment and abolition of hostels maintained by the University.
   (iv) The institution of fellowships, scholarships, stipends, bursaries, medals and prizes and the conditions of award thereof.
   (v) The entrance or admission of the students to the University and their enrollment and continuance as such and the conditions and procedures for dropping students from enrollment.
   (vi) The fees which may be charged by the University.
   (vii) The course of study to be laid down for all degrees, diplomas and certificates of the

University.

(viii) The conditions under which students shall be admitted to the degrees, diplomas, or other courses and examinations of the University and their eligibility for the award of degrees and diplomas.

(ix) The conditions for conferment of degrees and other academic distinctions.

(x) The maintenance of discipline among the students of the University.

(xi) The special arrangements, if any, which may be made for residence, discipline and teaching of women students and the provision of special courses of study for women.

(xii) The conditions of residence of students of the University and the levy of fees for residence in hostels.

Miscellaneous

Residence of students

The students shall reside in the accommodation maintained by the university or approved by the Vice-Chancellor subject to the conditions as may be prescribed. However, the Vice-Chancellor or an authorized officer of the University may permit the student(s) to reside with their parents or in private accommodations when no such accommodation is available with the University.

Annual Report

The annual report of the University shall be prepared by the Registrar or any other officer, assigned under the direction of the Vice-Chancellor normally within six months from the close of the Financial Year and circulated to the Members of the Board before the meeting at which it is to be considered. The Board shall after consideration of the annual report forward a copy thereof to the Government.

Delegation of powers

The Vice-Chancellor may, by statute, delegate the powers exercisable under this Act or the Statute made there under, to any authority, officer, heads of colleges/divisions/departments/ institutions or units/office subject to such conditions and restrictions as the Vice-Chancellor may deem proper.

Constitution of *ad-hoc* committees

Notwithstanding anything in this Act and until such time as the authorities are duly constituted, the Vice-Chancellor may subject to the approval of the Board, after it has been constituted appoint committees temporarily to exercise, perform and discharge any of the powers, functions and duties of such authority under this Act.

Disputes as to constitution of Authorities or Bodies

If any question arises as to whether any person has been duly appointed or is entitled to be a member of any authority or other body of University, the matter shall be referred to the Chancellor whose decision thereon shall be final.

Provided that before taking any such decision, the Chancellor shall give the person affected thereby reasonable opportunity of being heard.

Legal Proceedings

All suits and other legal proceedings by or against the University shall be instituted, prosecuted or defended on behalf of the University by the Registrar or any other officer specifically nominated in this behalf by the Vice-Chancellor.

Appointment to posts in connection with the affairs of University

(1) Subject to the provisions of this Act and the Statute made there under, appointment to posts and services in connection with the affairs of the University may be made by the Vice-Chancellor with the approval of the concerned authority as prescribed.

Provided that such approval of Board shall not be necessary in respect of appointment of posts carrying scales of pay lower than the pay scale of an Assistant Professor.

(2) Notwithstanding anything contained in this Act and until such time as the Statutes are made or the authorities of the University are constituted, appointments to posts and services in connection with the affairs of the University may be made by the Vice-Chancellor on such terms and conditions as may be approved by the Chancellor.

State Coordination Committee/Council for Higher Agricultural Education and Research (For the States with more than one Agricultural University)

(1) There shall be State Coordination Committee/Council in the State with more than one Agricultural University for purpose of effective co-ordination in the activities of all Agricultural Universities in the State. The composition of coordination committee shall be as under:

(a) The Chancellor – Chairman.

(b) Agriculture Minister – Vice Chairman.

(c) The Committee/Council shall consist of the following other members-

(i) The Vice-Chancellors of the Agricultural Universities in the State.

(ii)The Principal Secretary/Secretary of Agriculture, Animal Husbandry, Horticulture, and Fisheries, Finance and Planning to Government as ex-officio members.

(iii) DDG (Education) or his nominee from ICAR.

(iv) Principal Secretary / Secretary to the Governor of the State – Convener.

(2) Functions of the State Coordination Committee/Council:

The Committee would act as a Coordinating body between agricultural universities in the State towards:

(i) Harmonization of Academic programmes and regulations.

(ii) Ensuring complementarity and synergy among Agricultural Universities in the State through planning and advisories in education, research and extension.

(iii) Suggesting new initiatives and action plans for joint endeavors of the State Agricultural Universities and development departments for accelerating agricultural growth.

(iv) Addressing the generic and inter-university issues/concerns.

(v) Ensuring autonomy of the Universities in the State.

(3) The Committee shall meet at least twice in a year.

Transitional Provisions

(1) Notwithstanding anything contained in this Act or in the other universities Act in the State or in the Statute or regulations made under any of these enactments any student who immediately before the commencement of this Act was studying in a college which has been or may hereafter be admitted to the privileges of the University for degree, diploma or certificate of the (other) Universities, in accordance with the regulations of the University be permitted:-

(a) to complete his course in accordance with the curriculum of studies of (other university in state) University.

(b) to be examined by the University and if on the results of such examination he qualifies, be entitled to be conferred a corresponding degree or diploma or certificate of the University.

(c) to appear at the examination within two years of the normal period required for completing the said course of studies.

(2) In the year of the establishment of the University, University examinations of all courses in different faculties and disciplines shall be conducted by other universities in the State as the case may be, and in subsequent years, the examination shall be conducted by the University.

(3) Notwithstanding anything contained in (other Universities in the state) Universities Act, or in Statute or Regulations made there under, College of Agriculture/Veterinary and other colleges in allied fields (as approved by Government) shall after the commencement of this Act, be dis-affiliated from other University in the state and shall be maintained by the University as constituent College.

(4) All employees of the College, Research Institutes and other offices and institutions of Government Departments whose services along with the unit have been transferred to the University shall be deemed to be transferred employees of the Government. Such transferred employees shall be governed in accordance with the terms and conditions as determined by the Board in consultation with the Government while those who have been employed by the University shall be subject to the provisions of this Act and the Statute made there under. The transferred Government employees may opt for the University service on such terms and conditions as may be prescribed through statutes.

Removal of difficulties

(1) If any difficulty arises in giving effect to the provisions of this Act, the Government may, by order do anything which appears to it necessary for the purpose of removing the difficulty.

(2) No order made under sub-section (1) shall be questioned in any Court of law on the ground that no difficulty, as is referred to in the said sub-section, existed to be removed.

(3) Every order published, under this section shall as soon as may be after its publication laid before both Houses of the State Legislature.

Disciplinewise Reports

AGRICULTURE

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i) **UG Degree :** B.Sc. (Hons) Agriculture

ii) **PG Degree :** M.Sc. and Ph.D

Recommendations on the uniform nomenclature of PG degree in Agriculture

Agriculture subjects	Horticulture	Food Science
M. Sc. Ag. (Agricultural Economics)	M. Sc. Ag. Horticulture (Fruit Science)	M. Sc.(Food Science & Technology)
M. Sc. Ag. (Agricultural Extension & Communication)	M. Sc. Ag. Horticulture (Vegetable Science)	
M.Sc. Ag. (Agrometeorology)	M. Sc. Ag. Horticulture (Floriculture & Landscaping)	
M. Sc. Ag. (Agronomy)		
M. Sc. Ag (Entomology)		
M. Sc. Ag. (Genetics & Plant Breeding)		
M. Sc. Ag. (Seed Science & Technology)		
M. Sc. Ag. (Nematology)		
M. Sc. Ag (Plant Pathology)		
M.Sc. Ag. (Soil Science and Agriculture Chemistry)		

Ph.D. with suffix: (Agronomy, Agricultural Economics, Agricultural Extension & Communication, Entomology, Genetics and Plant Breeding, Horticulture (Fruit Science), Horticulture (Vegetable Science), Horticulture (Floriculture and Landscaping), Soil Science and Agriculture Chemistry, Agro-meteorology and Environmental Sciences, Plant Pathology,

Agriculture Engineering, Agro-forestry, Seed Science and Technology, Agriculture Microbiology, Physiology and Biochemistry, Plant Biotechnology, Plant Virology, Plant Nematology and Sericulture) **Ph.D.** Food Science and Technology

N.B.

Post graduate degree nomenclatures will be maintained by all the colleges/universities/ institutes. In case some nomenclature other than the listed above is to be adopted, a prior approval of the ICAR may be obtained.

Restructuring of UG programmes for increased practical / practice contents

Discipline-wise Courses

Discipline/Course title	Credit Hours
Agronomy	
Fundamentals of Agronomy	4(3+1)
Introductory Agro-meteorology & Climate Change	2(1+1)
Crop Production Technology – I (*Kharif* crops)	2(1+1)
Crop Production Technology – II (*Rabi* crops)	2(1+1)
Farming System & Sustainable Agriculture	1(1+0)
Practical Crop Production - I *(Kharif* crops*)*	2(0+2)
Practical Crop Production - II *(Rabi* crops*)*	2(0+2)
Principles of Organic Farming	2(1+1)
Geoinformatics and Nanotechnology and Precision Farming	2(1+1)
Rainfed Agriculture & Watershed Management	2(1+1)
Genetics & Plant Breeding	
Fundamentals of Genetics	3(2+1)
Principles of Seed Technology	3(1+2)
Fundamentals of Plant Breeding	3(2+1)
Crop Improvement-I (*Kharif* crops)	2(1+1)
Crop Improvement-II (*Rabi* crops)	2(1+1)
Soil Science & Agricultural Chemistry	
Fundamentals of Soil Science	3(2+1)
Manures, Fertilizers and Soil Fertility Management	3(2+1)
Problematic soils and their Management	2(2+0)
Entomology	
Fundamentals of Entomology	4(3+1)
Pests of Crops and Stored Grain and their Management	3(2+1)
Management of Beneficial Insects	2(1+1)

Discipline/Course title	Credit Hours
Agricultural Economics	
Fundamentals of Agricultural Economics	2(2+0)
Agricultural Finance and Co-Operation	3(2+1)
Agricultural Marketing Trade & Prices	3(2+1)
Farm Management, Production & Resource Economics	2(1+1)
Agricultural Engineering	
Soil and Water Conservation Engineering	2(1+1)
Farm Machinery and Power	2(1+1)
Renewable Energy and Green Technology	2(1+1)
Protected Cultivation and Secondary Agriculture	2(1+1)
Plant Pathology	
Fundamentals of Plant Pathology	4(3+1)
Diseases of Field and Horticultural Crops and their Management-I	3(2+1)
Diseases of Field and Horticultural Crops and their Management-II	3(2+1)
Principles of Integrated Pest and Disease Management	3(2+1)
Horticulture	
Fundamentals of Horticulture	2(1+1)
Production Technology for Fruit and Plantation Crops	2(1+1)
Production Technology for Vegetables and Spices	2(1+1)
Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)
Food Science & Technology	
Principles of Food Science & Nutrition	2(2+0)
Agricultural Extension and Communication	
Fundamentals of Agricultural Extension Education	3(2+1)
Rural Sociology & Educational Psychology	2(2+0)
Entrepreneurship Development and Business Communication	2(1+1)
Communication Skills and Personality Development	2(1+1)
Biochemistry / Physiology / Microbiology/ Environmental Sciences	
Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
Fundamentals of Crop Physiology	2(1+1)
Agricultural Microbiology	2(1+1)
Environmental Studies & Disaster Management	3(2+1)
Introduction to Forestry	2(1+1)
Statistics, Computer Application and I.P.R.	
Statistical Methods	2(1+1)

Discipline/Course title	Credit Hours
Agri- Informatics	2(1+1)
Intellectual Property Rights	1(1+0)
Animal Production	
Livestock and poultry Management	4(3+1)
Language	
Comprehension & Communication Skills in English (Gradial course)	2(1+1)
Remedial Courses	
Agricultural Heritage	1(1+0)
Introductory Biology	2(1+1)
Elementary Mathematics	2(2+0)
Non-Gradial Courses	
NSS/NCC/Physical Education & Yoga Practices	2(0+2)
Human Values & Ethics	1(1+0)
Educational Tour	2(0+2)

Semester-wise distribution of courses

	I Semester	
1	Fundamentals of Horticulture	2 (1+1)
2	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
3	Fundamentals of Soil Science	3(2+1)
4	Introduction to Forestry	2 (1+1)
5	Comprehension & Communication Skills in English	2 (1+1)
6	Fundamentals of Agronomy	4(3+1)
7	Introductory Biology*/Elementary Mathematics*	2 (1+1)/ 2(2+0)*
8	Agricultural Heritage*	1(1+0)*
9	Rural Sociology & Educational Psychology	2 (2+0)
10	Human Values & Ethics (non gradial)	1(1+0)**
11	NSS/NCC/Physical Education & Yoga Practices**	2 (0+2)**
TOTAL ***R: Remedial course; **NC: Non-gradial courses**		**18+03*+03****
	II Semester	
1	Fundamentals of Genetics	3(2+1)
2	Agricultural Microbiology	2(1+1)
3	Soil and Water Conservation Engineering	2(1+1)
4	Fundamentals of Crop Physiology	2(1+1)
5	Fundamentals of Agricultural Economics	2(2+0)

6	Fundamentals of Plant Pathology	4(3+1)
7	Fundamentals of Entomology	4(3+1)
8	Fundamentals of Agricultural Extension Education	3(2+1)
9	Communication Skills and Personality Development	2(1+1)
Total		**24(16+8)**
	III Semester	
1	Crop Production Technology – I *(Kharif Crops)*	2 (1+1)
2	Fundamentals of Plant Breeding	3 (2+1)
3	Agricultural Finance and Cooperation	3 (2+1)
4	Agri- Informatics	2(1+1)
5	Farm Machinery and Power	2 (1+1)
6	Production Technology for Vegetables and Spices	2 (1+1)
7	Environmental Studies and Disaster Management	3(2+1)
8	Statistical Methods	2(1+1)
9	Livestock and Poultry Management	4 (3+1)
Total		**23(14+9)**
	IV Semester	
1	Crop Production Technology –II *(Rabi Crops)*	2(1+1)
2	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
3	Renewable Energy and Green Technology	2(1+1)
4	Problematic Soils and their Management	2(2+0)
5	Production Technology for Fruit and Plantation Crops	2(1+1)
6	Principles of Seed Technology	3(1+2)
7	Farming System & Sustainable Agriculture	1(1+0)
8	Agricultural Marketing Trade & Prices	3(2+1)
9	Introductory Agro-meteorology & Climate Change	2(1+1)
10	Elective Course	3 credit
Total		**19(11+8) + 3**
	V Semester	
1	Principles of Integrated Pest and Disease Management	3(2+1)
2	Manures, Fertilizers and Soil Fertility Management	3 (2+1)
3	Pests of Crops and Stored Grain and their Management	3 (2+1)
4	Diseases of Field and Horticultural Crops and their Management -I	3 (2+1)
5	Crop Improvement-I *(Kharif Crops)*	2 (1+1)
6	Entrepreneurship Development and Business Communication	2 (1+1)
7	Geoinformatics and Nano-technology and Precision Farming	2 (1+1)
8	Practical Crop Production – I (*Kharif* crops)	2 (0+2)

9	Intellectual Property Rights	1(1+0)
10	Elective Course	3 credit
Total		**21(12+09)+ 3**
	VI Semester	
1	Rainfed Agriculture & Watershed Management	2 (1+1)
2	Protected Cultivation and Secondary Agriculture	2 (1+1)
3	Diseases of Field and Horticultural Crops and their Management-II	3 (2+1)
4	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
5	Management of Beneficial Insects	2 (1+1)
6	Crop Improvement-II *(Rabi crops)*	2 (1+1)
7	Practical Crop Production –II (*Rabi* crops)	2 (0+2)
8	Principles of Organic Farming	2 (1+1)
9	Farm Management, Production & Resource Economics	2 (1+1)
10	Principles of Food Science and Nutrition	2(2+0)
11	Elective Course	3 credits
Total		**21 (11 + 10)+ 3**

VII Semester			
No.	**Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE &AIA)**		
	Activities	**No. of weeks**	**Credit Hours**
1	General orientation & On campus training by different faculties	1	14
2	Village attachment	8	
	Unit attachment in Univ./ College. KVK/ Research Station Attachment	5	
3	Plant clinic	2	02
	Agro-Industrial Attachment	3	04
4	Project Report Preparation, Presentation and Evaluation	1	
	Total weeks for RAWE & AIA	**20**	**20**

- **Agro- Industrial Attachment:** The students would be attached with the agro-industries for a period of 3 weeks to get an experience of the industrial environment and working.
- Educational tour will be conducted in break between IV & V Semester or VI & VII Semester

RAWE Component-I

Village Attachment Training Programme

Sl. No.	Activity	Duration
1	Orientation and Survey of Village	1 week
2	Agronomical Interventions	1 week

Sl. No.	Activity	Duration
3	Plant Protection Interventions	1 week
4	Soil Improvement Interventions (Soil sampling and testing)	1 week
5	Fruit and Vegetable production interventions	1 week
6	Food Processing and Storage interventions	
7	Animal Production Interventions	1 week
8	Extension and Transfer of Technology activities	1 week

RAWE Component –II

Agro Industrial Attachment

- Students shall be placed in Agro-and Cottage industries and Commodities Boards for 03 weeks.
- Industries include Seed/Sapling production, Pesticides-insecticides, Post harvest-processing-value addition, Agri-finance institutions, etc.

Activities and Tasks during Agro-Industrial Attachment Programme

- Acquaintance with industry and staff
- Study of structure, functioning, objective and mandates of the industry
- Study of various processing units and hands-on trainings under supervision of industry staff
- Ethics of industry
- Employment generated by the industry
- Contribution of the industry promoting environment
- Learning business network including outlets of the industry
- Skill development in all crucial tasks of the industry
- Documentation of the activities and task performed by the students
- Performance evaluation, appraisal and ranking of students

Modules for Skill Development and Entrepreneurship: A student has to register 20 credits opting for two modules of (0+10) credits each (total 20 credits) from the package of modules in the **VIII semester.**

Sl. No.	Title of the module	Credits
1	Production Technology for Bioagents and Biofertilizer	0+10
2	Seed Production and Technology	0+10
3	Mushroom Cultivation Technology	0+10
4	Soil, Plant, Water and Seed Testing	0+10
5	Commercial Beekeeping	0+10
6	Poultry Production Technology	0+10
7	Commercial Horticulture	0+10
8	Floriculture and Landscaping	0+10

Sl. No.	Title of the module	Credits
9	Food Processing	0+10
10	Agriculture Waste Management	0+10
11	Organic Production Technology	0+10
12	Commercial Sericulture	0+10

NOTE: In addition to above ELP modules other important modules may be given to the students by SAUs

Evaluation of Experiential Learning Programme/ HOT

S.No.	Parameters	Max. Marks
1.	Project Planning and Writing	10
2.	Presentation	10
3.	Regularity	10
4.	Monthly Assessment	10
5.	Output delivery	10
6.	Technical Skill Development	10
7.	Entrepreneurship Skills	10
8.	Business networking skills	10
9.	Report Writing Skills	10
10.	Final Presentation	10
	Total	**100**

Discipline-wise summary of credit hours

S.N.	Group	Credits
1	Agronomy	21(10+11)
2	Genetics & Plant Breeding	13(7+6)
3	Soil Science & Agricultural Chemistry	8(6+2)
4	Entomology	9(6+3)
5	Agricultural Economics	10(7+3)
6	Agricultural Engineering	8(4+4)
7	Plant Pathology	13(9+4)
8	Horticulture	10(5+5)
9	Food Science	2(2+0)
10	Agricultural Extension	9(6+3)
11	Biochemistry / Physiology / Microbiology/ Environmental Sciences	12(7+5)
12	Statistics, Computer Application and I.P.R.	5(3+2)
13	Animal Production	4(3+1)

S.N.	Group	Credits
14	English	2 (1+1)
15	Remedial Courses	03 (Biol/ Math); 01 (Agriculture)
16	NSS/NCC/Physical Education & Yoga Practices	2(0+2)
17	Human Values and Ethics	1(1+0)
18	Educational Tour	2(0+2)
Total		126 + 3 (for Bio / Math)/ 01(Agri) + 5 NC 126+3+1+5+ 9 credits elective
RAWE **ELP**		**20 +20**
Grand Total		144+20+20=184
New Courses		**24+4 (remedial)+1 (NC)**

NEW COURSES

Sl. No.	Course Title	Credit Hours
1.	Geoinformatics, Nanotechnology and Precision Farming	2(1+1)
2.	Rainfed Agriculture and Watershed Management	2(1+1)
3.	Problematic Soils and their Management	2(2+0)
4.	Renewable Energy and Green Technology	2(1+1)
5.	Management of Beneficial Insects	2(1+1)
6.	Fundamentals of Horticulture	2(1+1)
7.	Introduction to Forestry	2(1+1)
8.	Agri- Informatics	2(1+1)
9.	Intellectual Property Rights	1(1+0)
10.	Principles of Food Science & Technology	2(2+0)
11.	Communication Skills and Personality Development	2(1+1)
12.	Principles of Integrated Pest & Diseases Management	3(2+1)
13.	Agricultural Heritage	1(1+0)*
14.	Introductory Biology	2(1+1)*
15.	Elementary Mathematics	2(2+0)*
16.	Human Values & Ethics (NG)	1(1+0)**

* Remedial courses ** Non-gradial courses

Elective Courses : A student can select three elective courses out of the following and offer during 4th, 5th and 6th semesters.

S.N.	Courses	Credit Hours
1	Agribusiness Management	3(2+1)
2	Agrochemicals	3(2+1)
3	Commercial Plant Breeding	3(1+2)
4	Landscaping	3(2+1)
5	Food Safety and Standards	3(2+1)
6	Biopesticides & Biofertilizers	3(2+1)
7	Protected Cultivation	3(2+1)
8	Micro propagation Technologies	3(1+2)
9	Hi-tech. Horticulture	3(2+1)
10	Weed Management	3(2+1)
11	System Simulation and Agro-advisory	3(2+1)
12	Agricultural Journalism	3(2+1)

SYLLABUS

I. AGRONOMY

1. Fundamentals of Agronomy 4(3+1)

Theory

Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil-plant-water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, logging.

Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, study of agro-climatic zones of India, Identification of weeds in crops, Methods of herbicide and fertilizer application, Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements-reversible plough, one way plough, harrow, leveler, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, bulk density and infiltration rate, Measurement of irrigation water.

2. Introductory Agrometeorology & Climate Change 2(1+1)

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

3. Crop Production Technology-I (*Kharif* Crops) 2(1+1)

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses-pigeonpea, mungbean and urdbean; oilseeds- groundnut, and soybean; fibre crops- cotton & jute; forage crops-sorghum, cowpea, cluster bean and napier.

Practical

Rice nursery preparation, transplanting of rice, sowing of soybean, pigeonpea and mungbean. maize, groundnut and cotton, effect of seed size on germination and seedling vigour of *kharif* season crops, effect of sowing depth on germination of *kharif* crops, identification of weeds in *kharif* season crops, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of *kharif* season crops, study of crop varieties and important

agronomic experiments at experimental farm. study of forage experiments, morphological description of *kharif* season crops, visit to research centres of related crops.

4. Crop Production Technology-II (*Rabi* crops) 2(1+1)

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals –wheat and barley, pulses-chickpea, lentil, peas, oilseeds-rapeseed, mustard and sunflower; sugar crops-sugarcane; medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops-berseem, lucerne and oat.

Practical

Sowing methods of wheat and sugarcane, identification of weeds in *rabi* season crops, study of morphological characteristics of *rabi* crops, study of yield contributing characters of *rabi* season crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of *rabi* crops at experimental farms. Study of *rabi* forage experiments, oil extraction of medicinal crops, visit to research stations of related crops.

5. Farming System and Sustainable Agriculture 1(1+0)

Theory

Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

6. Practical Crop Production-I *(Kharif Crops)* 2(0+2)

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

7. Practical Crop Production-II *(Rabi Crops)* 2(0+2)

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

8. Principles of Organic Farming 2(1+1)

Theory

Organic farming, principles and its scope in India; Initiatives taken by Government (central/ state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

Practical

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management; Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling.

9. Geoinformatics, Nano-technology and Precision Farming 2(1+1)

Theory

Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture. Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Remote sensing concepts and application in agriculture; Image processing and interpretation; Global positioning system (GPS), components and its functions; Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs; STCR approach for precision agriculture; Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects, nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in seed, water, fertilizer, plant protection for scaling-up farm productivity.

Practical

Introduction to GIS software, spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. Generation of spectral

profiles of different objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS. Creation of productivity and management zones. Fertilizers recommendations based of VRT and STCR techniques. Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of GPS for agricultural survey. Formulation, characterization and applications of nanoparticles in agriculture. Projects formulation and execution related to precision farming.

10. Rainfed Agriculture and Watershed Management – (New) 2(1+1)

Theory

Rainfed agriculture: Introduction, types, History of rainfed agriculture and watershed in India; Problems and prospects of rainfed agriculture in India ; Soil and climatic conditions prevalent in rainfed areas; Soil and water conservation techniques, Drought: types, effect of water deficit on physio-morphological characteristics of the plants, Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices,Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought period in the country, effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress. Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

II. GENETICS AND PLANT BREEDING

1. Fundamentals of Genetics 3(2+1)

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; special types of chromosomes. Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example.

Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and

their implications, Use of haploids, dihaploids and doubled haploids in Genetics. Mutation, classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance. Genetic disorders. Nature, structure & replication of genetic material. Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope. Study of cell structure. Mitosis and Meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and cross-over analysis (through two point test cross and three point test cross data). Study on sex linked inheritance in Drosophila. Study of models on DNA and RNA structures.

2. Principles of Seed Technology 3(1+2)

Theory

Seed and seed technology: introduction, definition and importance. Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed. Foundation and certified seed production of important **cereals, pulses, oilseeds, fodder and vegetables**. Seed certification, phases of certification, procedure for seed certification, field inspection. Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Varietal Identification through Grow Out Test and Electrophoresis, Molecular and Biochemical test. Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production.

Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing. Seed storage; general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies.

Practical

Seed production in major cereals: Wheat, Rice, Maize, Sorghum, Bajra and Ragi. Seed production in major pulses: Urd, Mung, Pigeonpea, Lentil, Gram, Field bean, pea. Seed production in major oilseeds: Soybean, Sunflower, Rapeseed, Groundnut and Mustard. Seed production in important vegetable crops. Seed sampling and testing: Physical purity, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: Grow out test and electrophoresis. Seed certification: Procedure, Field inspection, Preparation of field inspection report. Visit to seed production farms, seed testing laboratories and seed processing plant.

3. Fundamentals of Plant Breeding 3(2+1)

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility- genetic consequences, cultivar options. Domestication, Acclimatization and Introduction; Centres of origin/ diversity, components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept. Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement Schemes- Ear to row method, Modified Ear to Row, recurrent selection schemes; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Maintenance of breeding records and data collection; Wide hybridization and pre-breeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and cross pollinated crops. Emasculation and hybridization techniques in self & cross pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

4. Crop Improvement – I (*Kharif*) 2(1+1)

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress

tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeonpea, etc. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species; viz., Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Seasame, Caster, Cotton, Cowpea, Tobacco, Brinjal, Okra and Cucurbitaceous crops. Maintenance breeding of different *kharif* crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

5. Crop Improvement – II (*Rabi*) 2(1+1)

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fodder crops and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation; study of genetics of qualitative and quantitative characters; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology of *rabi* crops. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species namely Wheat, Oat, Barley, Chickpea, Lentil, Field pea, Rajma, Horse gram, Rapeseed Mustard, Sunflower, Safflower, Potato, Berseem. Sugarcane, Tomato, Chilli, Onion; Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Rabi* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops

III. SOIL SCIENCE & AGRICULTURAL CHEMISTRY

1. Fundamentals of Soil Science 3(2+1)

Theory

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention, movement and availability; Soil air, composition, gaseous exchange, problem and plant

growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids - inorganic and organic; silicate clays: constitution and properties; sources of charge; ion exchange, cation exchange capacity, base saturation; soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Study of soil profile in field. Study of soil sampling tools, collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Determination of soil colour. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

2. Manures, Fertilizers and Soil Fertility Management 3(2+1)

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management.

Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order.

History of soil fertility and plant nutrition. criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions.

Practical

Introduction of analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of soil organic carbon, Estimation of alkaline hydrolysable N in soils. Estimation of soil extractable P in soils. Estimation of exchangeable K; Ca and Mg in soils . Estimation of soil extractable S in soils.. Estimation of DTPA extractable Zn in soils. Estimation of N in plants. Estimation of P in plants. Estimation of K in plants. Estimation of S in plants.

3. Problematic Soils and their Management (New) 2(2+0)

Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Their categorization based on properties. Reclamation and management of Saline and sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils.

Irrigation water – quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils.

Multipurpose tree species, bio remediation through MPTs of soils, land capability and classification, land suitability classification. Problematic soils under different Agro-ecosystems.

IV. ENTOMOLOGY

1. Fundamentals of Entomology 4(3+1)

Part – I

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

Part-II

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance.

Part III

Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control-importance, hazards and limitations. Recent methods of pest control, repellents, anti feed ants, hormones, attractants, gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes.

Part – IV

Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera:

Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae,Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

2. Pests of Crops and Stored Grains and their Management 3(2+1)

Theory

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice other important arthropod pests of various field crop, vegetable crop, fruit crop, plantation crops, ornamental crops, spices and condiments. Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; (d) Plantation, gardens, Narcotics, spices & condiments. Identification of insect pests and Mites associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides application technique. Fumigation of grain store / godown. Identification of rodents and rodent control operations in godowns. Identification of birds and bird control operations in godowns. Determination of moisture content of grain. Methods of grain sampling under storage condition. Visit to Indian Storage Management and Research Institute, Hapur and Quality Laboratory, Department of Food., Delhi. Visit to nearest FCI godowns.

3. Management of Beneficial Insects 2(1+1)

Theory

Importance of beneficial Insects, Beekeeping and pollinators, bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee. Role of pollinators in cross pollinated plants.

Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection.

Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac- products. Identification of major parasitoids and predators commonly being used in biological control.

Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinator, weed killers and scavengers with their importance.

Practical

Honey bee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.

V. AGRICULTURAL ECONOMICS

1. Fundamentals of Agricultural Economics 2(2+0)

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. *Demand:* meaning, law of demand, schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. *Laws of*

returns: Law of variable proportions and law of returns to scale. *Cost:* concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, schedule, supply curve, determinants of supply, elasticity of supply. Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break even points. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. *National income:* Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programmes on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy. Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure. *Tax:* meaning, direct and indirect taxes, agricultural taxation, VAT. *Economic systems:* Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

2. Agricultural Finance and Co-Operation 3(2+1)

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms – SWOT analysis.

Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

Practicals

Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business – A case study. Preparation and analysis of balance sheet – A case study. Preparation and analysis of income statement – A case study. Appraisal of a loan proposal

– A case study. Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Seminar on selected topics.

3. Agricultural Marketing, Trade and Prices 3(2+1)

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; product life cycle (PLC) and competitive strategies: Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits; marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel;number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

4. Farm Management, Production and Resource Economics 2(1+1)

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms. Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labour income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies**,** Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources. Positive and negative externalities in agriculture, Inefficiency and welfare loss, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India.

VI. AGRICULTURAL ENGINEERING

1. Introductory Soil and Water Conservation Engineering 2(1+1)

Theory

Introduction to Soil and Water Conservation, causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal Loss Soil Equation. Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways and their design. Water harvesting and its techniques. Wind

erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

General status of soil conservation in India. Calculation of erosion index. Estimation of soil loss. Measurement of soil loss. Preparation of contour maps. Design of grassed water ways. Design of contour bunds. Design of graded bunds. Design of bench terracing system. Problem on wind erosion.

Farm Machinery and Power 2(1+1)

Theory

Status of Farm Power in India, Sources of Farm Power , I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication ,fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor , Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage implement, Implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practicals

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow . Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter Familiarization with different types of sprayers and dusters Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

3. Renewable Energy and Green Technology 2(1+1)

Theory

Classification of energy sources, contribution of these of sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application, Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and biooil production and their utilization as bioenergy resource, introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application, introduction of wind energy and their application.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, To study gasifier, To study the production process of biodiesel, To study briquetting machine, To study the production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing. To study solar cooker, To study solar drying system. To study solar distillation and solar pond.

4. Protected Cultivation and Secondary Agriculture 2(1+1)

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Green house environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, typical applications, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis.

Important Engineering properties such as physical, thermal and aero & hydrodynamic properties of cereals, pulses and oilseed, their application in PHT equipment design and operation. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of green house equipments. Visit to various Post Harvest Laboratories. Determination of Moisture content of various grains by oven drying & infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

VII. PLANT PATHOLOGY

1. Fundamentals of Plant Pathology 4(3+1)

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes.

Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes.

Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction.

Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites.

Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (*Heterodera, Meloidogyne*, *Anguina, Radopholus* etc.)

Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants. Epidemiology: Factors affecting disease development. Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites.

Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting.

Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

2. Diseases of Field & Horticultural Crops & their Management-I 3(2+1)

Theory

Symptoms, etiology, disease cycle and management of major diseases of following crops:

Field Crops: Rice: blast, brown spot, bacterial blight, sheath blight, false smut, khaira and tungro;Maize: stalk rots, downy mildew, leaf spots; Sorghum: smuts, grain mold and anthracnose, Bajra :downy mildew and ergot; Groundnut: early and late leaf spots, wilt

Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Finger millet: Blast and leaf spot; black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Castor: Phytophthora blight;Tobacco: black shank, black root rot and mosaic. Horticultural Crops: Guava: wilt and anthracnose; Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top;Papaya: foot rot, leaf curl and mosaic, Pomegranate: bacterial blight; Cruciferous vegetables: Alternaria leaf spot and

black rot; Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight; Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic; Okra: Yellow Vein Mosaic; Beans: anthracnose and bacterial blight; Ginger: soft rot; Colocasia: Phytophthora blight; Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Note: Students should submit 50 pressed and well-mounted specimens.

3. Diseases of Field & Horticultural Crops & their Management-II 3(2+1)

Theory

Symptoms, etiology, disease cycle and management of following diseases:

Field Crops:

Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and ear cockle;

Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng;

Sunflower: Sclerotinia stem rot and Alternaria blight; Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot; Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Cotton: anthracnose, vascular wilt, and black arm; Pea: downy mildew, powdery mildew and rust.

Horticultural Crops:

Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis; Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl.

Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic;

Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch, and Stemphylium blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leaf spot.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

Note: Students should submit 50 pressed and well-mounted specimens.

4. Principles of Integrated Pest and Disease Management 3(2+1)

Theory

Categories of insect pests and diseases, IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management. Survey surveillance and forecasting of Insect pest and diseases. Development and validation of IPM module. Implementation and impact of IPM (IPM module for Insect pest and disease. Safety issues in pesticide uses. Political, social and legal implication of IPM. Case histories of important IPM programmes. Case histories of important IPM programmes.

Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM,Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of *Trichoderma, Pseudomona*s, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agro-ecosystem) dynamics of a selected insect pest and diseases. Plan & assess preventive strategies (IPM module) and decision making. crop monitoring attacked by insect, pest and diseases . Awareness campaign at farmers fields.

VIII. HORTICULTURE

1. Fundamentals of Horticulture (NEW) 2(1+1)

Theory

Horticulture - Its definition and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops; Plant propagation-methods and propagating structures; Seed dormancy, Seed germination, principles of orchard establishment; Principles and methods of training and pruning, juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy; medicinal and aromatic plants; importance of plant bio-regulators in horticulture. Irrigation – methods, Fertilizer application in horticultural crops.

Practical

Identification of garden tools. Identification of horticultural crops. Preparation of seed bed/ nursery bed. Practice of sexual and asexual methods of propagation including micro-propagation. Layout and planting of orchard. Training and pruning of fruit trees. Preparation of potting mixture. Fertilizer application in different crops. Visits to commercial nurseries/orchard.

2. Production Technology for Fruit and Plantation Crops 2(1+1)

Theory

Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, sapota, apple, pear, peach, walnut, almond and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, Important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

3. Production Technology for Vegetable and Spices 2 (1+1)

Theory

Importance of vegetables & spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas; Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic; Root crops such as Carrot, Raddish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables).

Practical

Identification of vegetables & spice crops and their seeds. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables & spices. Fertilizers applications. Harvesting & preparation for market. Economics of vegetables and spices cultivation.

4. Production Technology for Ornamental Crops, MAPs and Landscaping 2 (1+1)

Theory

Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, lilium and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Processing and value addition in ornamental crops and MAPs produce.

Practical

Identification of Ornamental plants. Identification of Medicinal and Aromatic Plants. Nursery bed preparation and seed sowing. Training and pruning of Ornamental plants. Planning and layout of garden. Bed preparation and planting of MAP. Protected structures – care and maintenance. Intercultural operations in flowers and MAP. Harvesting and post harvest handling of cut and loose flowers. Processing of MAP. Visit to commercial flower/MAP unit.

5. Post-harvest Management and Value Addition of Fruits and Vegetables 2(1+1)

Theory

Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Tomato products- Concepts and Standards; Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning -– Concepts and Standards, packaging of products.

Practical

Applications of different types of packaging, containers for shelf life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Preparation of jam, jelly, RTS, nectar, squash, osmotically dried products, fruit bar and candy and tomato products, canned products. Quality evaluation of products -- physico-chemical and sensory. Visit to processing unit/ industry.

IX. FOOD SCIENCE & TECHNOLOGY

1. Principles of Food Science and Nutrition 2(2+0)

Theory

Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.); Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions); Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.); Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/ modified diets, Menu planning, New trends in food science and nutrition.

X. AGRICULTURAL EXTENSION and COMMUNICATION

1. Fundamentals of Agricultural Extension Education 3(2+1)

Theory

Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning- Meaning, Process, Principles and Steps in Programme Development. Extension systems in India: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND,NATP, NAIP, etc.). New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc.

Rural Development: concept, meaning, definition; various rural development programmes launched by Govt. of India. Community Dev.-meaning, definition, concept & principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; handling and use of audio visual equipments and digital camera and LCD projector; preparation and use of AV aids, preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA and other development departments at district level; visit to NGO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; exposure to mass media: visit to community radio and television studio for understanding the process of programme production; script writing, writing for print and electronic media, developing script for radio and television.

2. Rural Sociology & Educational Psychology 2(2+0)

Theory

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in

agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

3. Entrepreneurship Development and Business Communication 2 (1+1)

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development, Impact of economic reforms on Agribusiness/ Agrienterprises, Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

4. Communication Skills and Personality Development 2 (1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

XI. BIOCHEMISTRY/ PHYSIOLOGY/ MICROBIOLOGY/ ENVIRONMENTAL SCIENCES

1. Fundamentals of Plant Biochemistry and Biotechnology 3(2+1)

Theory

Importance of Biochemistry. Properties of Water, pH and Buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Poly saccharides. Lipid:

Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: Importance of proteins and classification; Structures, titration and zwitterions nature of amino acids; Structural organization of proteins. Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Concepts and applications of plant biotechnology: Scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications; Micro-propagation methods; organogenesis and embryogenesis, Synthetic seeds and their significance; Embryo rescue and its significance; somatic hybridization and cybrids; Somaclonal variation and its use in crop improvement; cryo-preservation; Introduction to recombinant DNA methods: physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods; Transgenics and its importance in crop improvement; PCR techniques and its applications; RFLP, RAPD, SSR; Marker Assisted Breeding in crop improvement; Biotechnology regulations.

Practical

Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides. Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants. Micro-propagation, hardening and acclimatization. Demonstration on isolation of DNA. Demonstration of gel electrophoresis techniques and DNA finger printing.

2. Fundamentals of Crop Physiology 2(1+1)

Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; Photosynthesis: Light and Dark reactions, C3, C4 and CAM plants; Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism: Fatty acid synthesis and Breakdown; Plant growth regulators: Physiological roles and agricultural uses, Physiological aspects of growth and development of major crops: Growth analysis, Role of Physiological growth parameters in crop productivity.

Practical

Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, Separation of photosynthetic pigments through paper chromatography, Rate of transpiration, photosynthesis, respiration, tissue test

for mineral nutrients, estimation of relative water content, Measurement of photosynthetic CO_2 assimilation by Infra Red Gas Analyser (IRGA).

3. Agricultural Microbiology 2(1+1)

Theory

Introduction. Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination-transformation, conjugation and transduction, plasmids, transposon.

Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste.

Practical

Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and their preparations. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes. Methods of isolation and purification of microbial cultures. Isolation of *Rhizobium* from legume root nodule. Isolation of *Azotobacter* from soil. Isolation of *Azospirillum* from roots. Isolation of BGA. Staining and microscopic examination of microbes.

4. Environmental Studies and Disaster Management 3 (2+1)

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance.

Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

5. Introduction to Forestry (New) 2(1+1)

Theory

Introduction – definitions of basic terms related to forestry, objectives of silviculture, forest classification, salient features of Indian Forest Policies. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations. Crown classification. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning. Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement - shadow and single pole method; Instrumental methods of height measurement - geometric and trigonometric principles, instruments used in height measurement; tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees. Agroforestry – definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens. Cultivation practices of two important fast growing tree species of the region.

Practical

Identification of tree-species. Diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees. Height measurement of standing trees by shadow method, single pole method and hypsometer. Volume measurement of logs using various formulae. Nursery lay out, seed sowing, vegetative propagation techniques. Forest plantations and their management. Visits of nearby forest based industries.

XII. STATISTICS, COMPUTER APPLICATION AND IPR

1. Statistical Methods 2(1+1)

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data).

Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling.

2. Agri-Informatics 2(1+1)

Theory

Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations.

e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix/ Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

XIII. Intellectual Property Rights 1(1+0)

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.

Types of Intellectual Property and legislations covering IPR in India:-Patents, Copyrights,

Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database.

Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders.

Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

XIV. ANIMAL PRODUCTION

1. Livestock & Poultry Management 4 (3+1)

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers.

Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry.

Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry.

Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipments. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

XV. LANGUAGE

1. Comprehension and Communication Skills in English 2(1+1)

Theory

War Minus Shooting- The sporting Spirit. A Dilemma- A layman looks at science Raymond B. Fosdick. You and Your English – Spoken English and broken English G.B. Shaw. Reading Comprehension, Vocabulary- Antonym, Synonym, Homophones, Homonyms, often confused words. Exercises to Help the students in the enrichment of vocabulary based on TOEFL and other competitive examinations. Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement, Transformation, Synthesis, Direct and Indirect Narration. Written Skills: Paragraph writing, Precise writing, Report writing and Proposal writing. The Style: Importance of professional writing. Preparation of Curriculum Vitae and Job applications. Synopsis Writing. Interviews: kinds, Importance and process.

Practical

Listening Comprehension: Listening to short talks lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation: rate of speech, clarity of voice, speaking and Listening, politeness &Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: testing initiative, team spirit, leadership, intellectual ability. Group Discussions.

XVI. REMEDIAL COURSES

1. Agricultural Heritage (New Course) 1(1+0)

Theory

Introduction of Indian agricultural heritage; Ancient agricultural practices, Relevance of heritage to present day agriculture; Past and present status of agriculture and farmers in society; Journey of Indian agriculture and its development from past to modern era; Plant production and protection through indigenous traditional knowledge; Crop voyage in India and world; Agriculture scope; Importance of agriculture and agricultural resources available in India; Crop significance and classifications; National agriculture setup in India; Current scenario of Indian agriculture; Indian agricultural concerns and future prospects.

2. Introductory Biology (New) 2(1+1)

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology of flowing plants. Seed and seed germination. Plant systematic- viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Practical

Morphology of flowering plants – root, stem and leaf and their modifications. Inflorence, flower and fruits. Cell, tissues & cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - Brassicaceae, Fabaceae and Poaceae.

3. Elementary Mathematics (New) 2(2+0)

Theory

Straight lines : Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral. Circle: Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points (x_1, y_1) & (x_2,y_2), Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$. Differential Calculus : Definition of function, limit and continuity, Simple problems on limit, Simple problems on continuity, Differentiation of x^n , e^x , sin x & cos x from first principle, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problems based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form y=f (x) (Simple problems based on it).

Integral Calculus : Integration of simple functions, Integration of Product of two functions, Integration by substitution method, Definite Integral (simple problems based on it), Area under simple well-known curves (simple problems based on it).

Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.

XVII. NON-GRADIAL COURSES

1. NSS/NCC/Physical Education & Yoga Practices 2 (0+2)

Theory

Course aims at evoking social consciousness among students through various activities viz., working together, constructive and creative social work, to be skilful in executing democratic leadership, developing skill in programme development to be able for self employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Following activities are to be taken up under the NSS course:

- Introduction and basic components of NSS: Orientation
- NSS programmes and activities
- Understanding youth
- Community mobilisation
- Social harmony and national integration
- Volunteerism and shramdan
- Citizenship, constitution and human rights
- Family and society
- Importance and role of youth leadership
- Life competencies
- Youth development programmes
- Health, hygiene and sanitation
- Youth health, lifestyle, HIV AIDS and first aid
- Youth and yoga
- Vocational skill development
- Issues related environment
- Disaster management
- Entrepreneurship development
- Formulation of production oriented project
- Documentation and data reporting
- Resource mobilization
- Additional life skills
- Activities directed by the Central and State Government

All the activities related to the National Service Scheme course is distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load. The entire four courses should be offered continuously for two years. A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one day camp in a year and one special camp for duration of 7 days at any semester break period in the two year. Different activities will include orientation lectures and practical works.Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

SYLLABUS

Semester I

Course Title: National Service Scheme I

Introduction and basic components of NSS:

Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS,

organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

NSS programmes and activities

Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth

Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilisation

Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership

Social harmony and national integration

Indian history and culture, role of youth in nation building, conflict resolution and peace-building

Volunteerism and shramdan

Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

Citizenship, constitution and human rights

Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information

Family and society

Concept of family, community (PRIs and other community based organisations) and society

Semester II

Course Title: National Service Scheme II

Importance and role of youth leadership

Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

Life competencies

Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

Youth development programmes

Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organisations

Health, hygiene and sanitation

Definition needs and scope of health education; role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.

Youth health, lifestyle, HIV AIDS and first aid

Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid

Youth and yoga

History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Semester III

Course Title: National Service Scheme III

Vocational skill development

To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

Issues related environment

Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

Disaster management

Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.

Entrepreneurship development

Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production oriented project

Planning, implementation, management and impact assessment of project

Documentation and data reporting

Collection and analysis of data, documentation and dissemination of project reports

Semester IV

Course Title: National Service Scheme IV

Youth and crime

Sociological and psychological factors influencing youth crime, cyber crime, pear mentoring in preventing crime and awareness for juvenile justice

Civil/self defence

Civil defence services, aims and objectives of civil defence; needs and training of self defence

Resource mobilisation

Writing a project proposal of self fund units (SFUs) and its establishment

Additional life skills

Positive thinking, self confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

National Cadet Corps Credit hours: 2(0+2)

Semester I: National Cadet Corps

1. Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
2. Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
3. Sizing, numbering, forming in three ranks, open and close order march and dressing.
4. Saluting at the halt, getting on parade, dismissing and falling out.
5. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear.
6. Turning on the march and wheeling. Saluting on the march.
7. Marking time, forward march and halt.
8. Changing step, formation of squad and squad drill.
9. Command and control, organization, badges of rank, honours and awards
10. Nation Building- cultural heritage, religions, traditions and customs of India. National integration.
11. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen.
12. Leadership traits, types of leadership. Character/personality development.
13. Civil defense organization, types of emergencies, fire fighting, protection,
14. Maintenance of essential services, disaster management, aid during development projects.
15. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
16. Structure and function of human body, diet and exercise, hygiene and sanitation.
17. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.
18. Adventure activities
19. Basic principles of ecology, environmental conservation, pollution and its control.
20. Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self defense.

Semester II: National Cadet Corps

1. Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.

2. Shoulder from the order and vice-versa, present from the order and vice-versa.
3. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa.
4. Guard mounting, guard of honour, Platoon/Coy Drill.
5. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting.
6. Loading, cocking and unloading. The lying position and holding.
7. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
8. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing.
9. Characteristics of Carbine and LMG.
10. Introduction to map, scales and conventional signs. Topographical forms and technical terms.
11. The grid system. Relief, contours and gradients. Cardinal points and finding north. Types of bearings and use of service protractor.
12. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map.
13. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
14. Field defenses obstacles, mines and mine lying. Bridging, waterman ship
15. Field water supplies, tracks and their construction.
16. Nuclear, Chemical and Biological Warfare (NCBW)
17. Judging distance. Description of ground and indication of landmarks.
18. Recognition and description of target. Observation and concealment. Field signals. Section formations.
19. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
20. Types of communication, media, latest trends and developments.

Physical Education and Yoga Practices Credit hours: 2(0+2) (0+2)

Semester I: Physical Education and Yoga Practices

1. Teaching of skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
2. Teaching of different skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
3. Teaching of advance skills of Football – involvement of all the skills in game situation with teaching of rules of the game
4. Teaching of skills of Basketball – demonstration, practice of the skills, correction of skills, involvement in game situation
5. Teaching of skills of Basketball – demonstration, practice of the skills, involvement in game situation
6. Teaching of skills of Basketball – involvement of all the skills in game situation with teaching of rule of the game

7. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
8. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
9. Teaching of advance skills of Kabaddi – involvement of all the skills in game situation with teaching of rule of the game
10. Teaching of skills of Ball Badminton – demonstration, practice of the skills, correction of skills, involvement in game situation
11. Teaching of skills of Ball Badminton – involvement of all the skills in game situation with teaching of rule of the game
12. Teaching of some of Asanas – demonstration, practice, correction and practice
13. Teaching of some more of Asanas – demonstration, practice, correction and practice
14. Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation
15. Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation
16. Teaching of skills of Table Tennis – involvement of all the skills in game situation with teaching of rule of the game
17. Teaching – Meaning, Scope and importance of Physical Education
18. Teaching – Definition, Type of Tournaments
19. Teaching – Physical Fitness and Health Education
20. Construction and laying out of the track and field (*The girls will have Tennikoit and Throw Ball).

Semester II: Physical Education and Yoga Practices

1. Teaching of skills of Hockey – demonstration practice of the skills and correction.
2. Teaching of skills of Hockey – demonstration practice of the skills and correction. And involvement of skills in games situation
3. Teaching of advance skills of Hockey – demonstration practice of the skills and correction. Involvement of all the skills in games situation with teaching of rules of the game
4. Teaching of skills of Kho-Kho – demonstration practice of the skills and correction.
5. Teaching of skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of the skills in games situation
6. Teaching of advance skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of all the skills in games situation with teaching of rules of the game
7. Teaching of different track events – demonstration practice of the skills and correction.
8. Teaching of different track events – demonstration practice of the skills and correction.
9. Teaching of different track events – demonstration practice of the skills and correction with competition among them.
10. Teaching of different field events – demonstration practice of the skills and correction.
11. Teaching of different field events – demonstration practice of the skills and correction.
12. Teaching of different field events – demonstration practice of the skills and correction.

13. Teaching of different field events – demonstration practice of the skills and correction with competition among them.
14. Teaching of different asanas – demonstration practice and correction.
15. Teaching of different asanas – demonstration practice and correction.
16. Teaching of different asanas – demonstration practice and correction.
17. Teaching of different asanas – demonstration practice and correction.
18. Teaching of weight training – demonstration practice and correction.
19. Teaching of circuit training – demonstration practice and correction.
20. Teaching of calisthenics – demonstration practice and correction.

Note: 1) Compulsory Uniform: Half pants, Tee Shirts, Shoes and socks all white (Girls will have white Tee Shirt and Track pants) 2) The games mentioned in the practical may be inter changed depending on the season and facilities.

Course title: Human Value and Ethics 1(1+0)

Theory

Values and Ethics-An Introduction. Goal and Mission of Life. Vision of Life. Principles and Philosophy. Self Exploration. Self Awareness. Self Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

Course Title: Educational Tour 2 (0+2)

ELECTIVE COURSES

Agri-business Management 3 (2+1)

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries. Agri-value chain: Understanding primary and support activities and their linkages. Business environment: PEST & SWOT analysis. Management functions: Roles & activities, Organization culture. Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, polices procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital Management and Financial management of Agribusiness. Financial statements and their importance. Marketing Management: Segmentation, targeting & positioning. Marketing mix and marketing strategies. Consumer behaviour analysis, Product Life Cycle (PLC). Sales & Distribution Management. Pricing policy, various pricing methods. Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation. Project Appraisal and evaluation techniques.

Practical

Study of agri-input markets: Seed, fertilizers, pesticides. Study of output markets: grains, fruits, vegetables, flowers. Study of product markets, retails trade commodity trading, and value added products. Study of financing institutions- Cooperative, Commercial banks, RRBs, Agribusiness Finance Limited, NABARD. Preparations of projects and Feasibility reports for agribusiness entrepreneur. Appraisal/evaluation techniques of identifying viable project- Non-discounting techniques. Case study of agro-based industries. Trend and growth rate of prices of agricultural commodities. Net present worth technique for selection of viable project. Internal rate of return.

2. Agrochemicals 3 (2+1)

Theory

An introduction to agrochemicals, their type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture.

Herbicides-Major classes, properties and important herbicides. Fate of herbicides.

Fungicides - Classification – Inorganic fungicides - characteristics, preparation and use of sulfur and copper, Mode of action-Bordeaux mixture and copper oxychloride.

Organic fungicides- Mode of action- Dithiocarbamates-characteristics, preparation and use of Zineb and maneb.

Systemic fungicides- Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use. Introduction and classification of insecticides: inorganic and organic insecticides Organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids Neonicotinoids, Biorationals, Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil & plant. IGRs Biopesticides, Reduced risk insecticides, Botanicals, plant and animal systemic insecticides their characteristics and uses.

Fertilizers and their importance. Nitrogenous fertilizers: Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers. Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers: Natural sources of potash, manufacturing of potassiumchloride, potassium sulphate and potassium nitrate.

Mixed and complex fertilizers: Sources and compatibility–preparation of major, secondary and micronutrient mixtures. Complex fertilizers: Manufacturing of ammonium phosphates, nitrophosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing.

Plant bio-pesticides for ecological agriculture, Bio-insect repellent.

Practical

Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for identification of common fertilizers. Identification of anion and cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available kin market. Estimation of nitrogen in Urea. Estimation of

water soluble P_2O_5 and citrate soluble P_2O_5 in single super phosphate. Estimation of potassium in Muraite of Potash/ Sulphate of Potash by flame photometer. Determination of copper content in copper oxychloride. Determination of sulphur content in sulphur fungicide. Determination of thiram. Determination of ziram content.

3. Commercial Plant Breeding 3(1+2)

Theory

Types of crops and modes of plant reproduction. Line development and maintenance breeding in self and cross pollinated crops (A/B/R and two line system) for development of hybrids and seed production. Genetic purity test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line and cultivars: haploid inducer, tissue culture techniques and biotechnological tools. IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act. Variety testing, release and notification systems in India. Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Techniques of seed production in self and cross pollinated crops using A/B/R and two line system. Learning techniques in hybrid seed production using male-sterility in field crops. Understanding the difficulties in hybrid seed production, Tools and techniques for optimizing hybrid seed production. Concept of rouging in seed production plot. Concept of line its multiplication and purification in hybrid seed production. Role of pollinators in hybrid seed production. Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops. Sampling and analytical procedures for purity testing and detection of spurious seed. Seed drying and storage structure in quality seed management. Screening techniques during seed processing viz., grading and packaging. Visit to public private seed production and processing plants.

4. Landscaping 3(2+1)

Theory

Importance and scope of landscaping. Principles of landscaping, garden styles and types, terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery, water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes. Trees: selection, propagation, planting schemes, canopy management, shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture. Climber and creepers: importance, selection, propagation, planting, Annuals: selection, propagation, planting scheme, Other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement, management. Bio-aesthetic planning: definition, need, planning; landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions. Bonsai: principles and management, lawn: establishment and maintenance. CAD application.

Practical

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals, care and maintenance of plants, potting and repotting, identification of tools and implements used in landscape design, training and pruning of plants for special effects, lawn establishment and maintenance, layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software, visit to important gardens/ parks/ institutes.

5. Food Safety and Standards 3(2+1)

Theory

Food Safety – Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Types of hazards - Biological, Chemical, Physical hazards. Management of hazards - Need. Control of parameters. Temperature control. Food storage. Product design. Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control. Waste Disposal. Pest and Rodent Control. Personnel Hygiene. Food Safety Measures. Food Safety Management Tools- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP. ISO series. TQM - concept and need for quality, components of TQM, Kaizen. Risk Analysis. Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygiene. Food laws and Standards- Indian Food Regulatory Regime, FSSA. Global Scenario CAC. Other laws and standards related to food. Recent concerns- New and Emerging Pathogens. Packaging, Product labeling and Nutritional labeling. Genetically modified foods\ transgenics. Organic foods. Newer approaches to food safety. Recent Outbreaks. Indian and International Standards for food products.

Practical

Water quality analysis physico-chemical and microbiological. Preparation of different types of media. Microbiological Examination of different food samples. Assessment of surface sanitation by swab/rinse method. Assessment of personal hygiene. Biochemical tests for identification of bacteria. Scheme for the detection of food borne pathogens. Preparation of plans for Implementation of FSMS - HACCP, ISO: 22000.

6. Biopesticides & Biofertilizers 3(2+1)

Theory

History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides viz. pathogen, botanical pesticides, and biorationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes. Methods of application of biopesticides. Methods of quality control and Techniques of biopesticides. Impediments and limitation in production and use of biopesticide.

Biofertilizers - Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*; Cynobacterial biofertilizers- *Anabaena*, *Nostoc*, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Production

technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

Practical

Isolation and purification of important biopesticides: *Trichoderma Pseudomonas, Bacillus, Metarhyzium* etc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides.

Isolation and purification of *Azospirillum* , *Azotobacter, Rhizobium*, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi -Wet sieving method and sucrose gradient method. Mass production of AM inoculants.

7. Protected Cultivation 3(2+1)

Theory

Protected cultivation- importance and scope, Status of protected cultivation in India and World types of protected structure based on site and climate. Cladding material involved in greenhouse/ poly house. Greenhouse design, environment control, artificial lights, Automation. Soil preparation and management, Substrate management. Types of benches and containers. Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops – rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants, etc. Cultivation of economically important medicinal and aromatic plants. Off-season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, use of protrays in quality planting material production, Bed preparation and planting of crop for production, Inter cultural operations, Soil EC and pH measurement, Regulation of irrigation and fertilizers through drip, fogging ad misting.

8. Micro propagation Technologies 3(1+2)

Theory

Introduction, History, Advantages and limitations; Types of cultures (seed, embryo, organ, callus, cell), Stages of micropropagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture),Organogenesis (callus and direct organ formation), Somatic embryogenesis, cell suspension cultures, Production of secondary metabolites, Somaclonal variation, Cryopreservation

Practical

Identification and use of equipments in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for

explants, Preparation of stocks and working solution, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, Induction of somatic embryos regeneration of whole plants from different explants, Hardening procedures.

9. Hi-tech. Horticulture 3(2+1)

Theory

Introduction & importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods, Protected cultivation: advantages, controlled conditions, method and techniques, Micro irrigation systems and its components; EC, pH based fertilizer scheduling, canopy management, high density orcharding, Components of precision farming: Remote sensing, Geographical Information System (GIS), Differential Geo-positioning System (DGPS), Variable Rate applicator (VRA), application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practical

Types of polyhouses and shade net houses, Intercultural operations, tools and equipments identification and application, Micro propagation, Nursery-protrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

10. Weed Management 3(2+1)

Theory

Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicides and selectivity. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with agro-chemicals and their application. Integration of herbicides with non chemical methods of weed management. Herbicide Resistance and its management.

Practical

Techniques of weed preservation. Weed identification and their losses study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and agro-chemicals study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipments. Calculations of herbicide doses and weed control efficiency and weed index.

11. System Simulation and Agroadvisory 3(2+1)

Theory

System Approach for representing soil-plant-atmospheric continuum, system boundaries, Crop models, concepts & techniques, types of crop models, data requirements, relational diagrams.

Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis. Potential and achievable crop production- concept and modelling techniques for their estimation. Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance. Weather forecasting, types, methods, tools & techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop-Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast. Use of crop simulation model for preparation of Agro-advisory and its effective dissemination.

Practical

Preparation of crop weather calendars. Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts. Working with statistical and simulation models for crop growth. Potential & achievable production; yield forecasting, insect & disease forecasting models. Simulation with limitations of water and nutrient management options. Sensitivity analysis of varying weather and crop management practices. Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast. Feedback from farmers about the agroadvisory.

12. Agricultural Journalism 3(2+1)

Theory

Agricultural Journalism: The nature and scope of agricultural journalism characteristics and training of the agricultural journalist, how agricultural journalism is similar to and different from other types of journalism. Newspapers and magazines as communication media: Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers. Form and content of newspapers and magazines: Style and language of newspapers and magazines, parts of newspapers and magazines. The agricultural story: Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story. Gathering agricultural information: Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources. Writing the story: Organizing the material, treatment of the story, writing the news lead and the body, readability measures. Illustrating agricultural stories: Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions. Editorial mechanics: Copy reading, headline and title writing, proofreading, lay outing.

Practical

Practice in interviewing. Covering agricultural events. Abstracting stories from research and scientific materials and from wire services. Writing different types of agricultural stories. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading, headline and title writing, proofreading, layouting. Testing copy with a readability formula. Visit to a publishing office.

Minimum Standards for Establishing a College of Agriculture

1. **Degree Nomenclature:** B.Sc. (Hons.) Agriculture
2. **Eligibility Criteria :**10+2 or intermediate with PCMB, PCB, PCM or Agriculture (P - Physics, C - Chemistry, M - Mathematics, B – Biology) from a recognised Board/university.
3. **Medium of Instruction :** English
4. **MinimumIntake :** 60 students per year
5. **Divisions/Departments/Sections**
   1. Agronomy
   2. Agricultural Economics
   3. Agricultural Extension & Communication
   4. Entomology
   5. Genetics and Plant Breeding
   6. Horticulture
   7. Food Science and Technology
   8. Soil Science and Agricultural Chemistry
   9. Plant Pathology
   10. Animal Sciences
   11. Fisheries
   12. Biochemistry
   13. Crop Physiology
   14. Agricultural Engineering
   15. Agro-forestry
   16. Seed Science and Technology
   17. Agro-meteorology
   18. Environmental Sciences
   19. Microbiology
   20. Basic Sciences and Humanities
       a) Basic Economics
       b) Sociology and Psychology
       c) English
       d) Mathematics
       e) Computer Sciences
       f) Statistics

Note: To reduce the number, the subjects which have only one or two courses may be merged with major Division/Department. Colleges/Universities have liberty to do this at their level. However, for practical purposes following model has been proposed giving minimum teaching staff required for each Division/Department taking into account the merger of related subjects.

6. Divisions/Departments/Sections proposed along with Cadre-wise teaching staff required.

S. No.	Divisions/Departments/Sections including mergers shown in bracket	Minimum Requirement Professor	Teaching Staff required			
			Professor	Assoc Prof.	Asstt. Prof.	Total
A. Divisions/Departments						
1.	Agronomy + (Agro-forestry)	5	1	1	4+1	7
2.	Agricultural Economics + (Basic Economics, Maths & Computer Science and Statistics)	5	0	1	2+3	6
3.	Agriculture Extension & Communication + (Sociology and Psychology, English)	3	0	1	1+2	4
4.	Entomology	2	0	1	2+0	3
5.	Genetics & Plant Breeding + (Seed Science & Technology)	3	1	1	2+1	5
6.	Horticulture + (Food Science & Technology)	4	1	1	2+1	5
7.	Soil Science and Agricultural Chemistry + (Microbiology, Agro-meteorology, Environmental Sciences)	4	0	1	2+3	6
8.	Plant Pathology	2	0	1	2+0	3
	Total	28	3	8	17+11	39
B. Sections						
9.	Animal Sciences including Fisheries, Dairy Sciences & poultry units	1	0	0	1+1	2
10.	Agriculture Engineering + (Farm Management)	1	0	0	1+1	2
11.	Biochemistry and Crop Physiology	1	0	0	1+1	2
Total		**31**	**3**	**8**	**20+14**	**45**

Note: Total strength after four years should have 45 teachers as faculty. However, in extreme cases, it can be 31 and few courses viz. Basic Sciences, and Humanities, Maths, and Computer Sciences, etc. can be completed by hiring the teachers.

7. Administrative Staff requirement for Divisions/Departments/Sections

S. No.	Divisions/Departments/Sections	Assistant *	Lab Asstt.	Field Asstt.	Attendant/ Messenger	Total
1.	Agronomy + (Agro-forestry)	1	2	3	- **	6
2.	Agricultural Economics + (Basic Economics, Maths & Computer Science and Statistics)	1	3	-	-	4
3.	Agriculture Extension & Communication + (Sociology and Psychology, English)	1	1	-	-	2
4.	Entomology	1	1	1	-	3
5.	Genetics & Plant Breeding + (Seed Science & Technology)	1	2	2		5
6.	Horticulture + (Food Science & Technology)	1	2	2		5
7.	Soil Science and Agricultural Chemistry + (Microbiology, Agro-meteorology, Environmental Sciences)	1	3	1		5
8.	Plant Pathology	1	2	1		4
9.	Animal Sciences including Fisheries, Dairy Science&Poultry units)	1	1	1		3
10.	Agriculture Engineering + (Farm Management)	1	1	2		4
11.	Biochemistry and Crop Physiology	1	1	-		2
	Total	**11**	**19**	**13**		**43**

*Assistant should have computer literacy, accounts and store handling training
**Attendant/Messenger/Janitor/Security/watch and ward to be outsourced.

8. Manpower Requirement of Dean's Office

Sl. No.	Name of the Post	No. of Posts
1.	Dean	01
	A. Establishment	
1.	P.A./P.S. to Dean	01
2.	Asstt. Administrative Officer	01
3.	Asstt. Academic Officer	01
4.	Assistant Accounts Officer	01
5.	Assistants (one for each AAO)	03
6.	Steno/Computer Operators	01

Sl. No.	Name of the Post	No. of Posts
7.	Driver	01
8.	Farm Manager (Asstt. Prof.)	01*
9.	Store Keeper	01

*Will be with Engineering/Agronomy. Utility services like Wireman/Plumber/Janitors/ Attendants/Messengers, Landscaping, and Mechanic, etc. to be outsourced.

B. Central Instrumentation Laboratory		
1.	Instrumentation Asstt. Engineer	01
2.	Instrumentation Technician/Lab Asstt.	01
C. Library Staff		
1.	Asstt. Librarian(Asstt. Prof. cadre)	01
2.	Library Asstt./Clerk	01
3.	Shelf Asstt.	01
D. Students Welfare		
1.	Physical Education (Asstt. Prof.)	01
2.	Attendant	01
E. Hostel Staff		
1.	Warden	01+01
2.	Care taker/Asstt.	01+01
F. Estate Branch		
1.	Junior Engineer	01
2.	Security Asstt.	01

9. Land Required

(A) 1) Plain Regions : 30 ha

2) Hill, islands and coastal regions : 16 ha

(B) Land Utilization Pattern

		(hectares)	
		Plain	**Hill/Coastal Region**
1.	Main Building/Hostels/Residential Quarters (Including roads)	6.8	3.2
2.	Playground & other amenities	3.2	2.0
3.	Farm Area, including godown/ stores	20.0	10.8
Note: If land is not in one stretch, it should be at least within a radius of 5 kms			

(C) Division/Department/Section-wise land allocations (hectares)

1.	Agronomy & Farm Forestry	6.0	3.2
2.	Entomology	0.4	0.2
3.	Genetics & Plant Breeding + (Seed Science & Technology)	3.2	1.6
4.	Horticulture	6.0	3.6
5.	Soil Science and Associated Departments	0.8	0.2
6.	Plant Pathology	0.4	0.2
7.	Animal Sciences	2.0	1.2
8.	Biochemistry and Physiology	0.4	0.2
9.	Agricultural Engineering	0.8	0.4
10.	Total	20.0	10.8

10. Infrastructure facilities (Floor space required)

A. Central Facilities

S. No.	Details	No. of Rooms	Dimensions (ft)
1.	Dean Office	1	20x24
2.	P.A. Room	1	10x12
3.	Committee Room with video conferencing facility	1	20x30
4.	Assistant Administrative Officer including staff	1	20x12
5.	Assistant Accounts Officer including staff	1	20x12
6.	Assistant Academic Officer including staff	1	20x12
7.	Exam Cell (300 capacity)	1	20x12
8.	Evaluation Room	1	20x36
9.	Faculty Room (Ladies)	1	10x12
10.	Faculty Room (Gents)	1	20x12
11.	Placement Cell	1	20x12
12.	Smart Lecture Halls	5	40x30 (60 capacity)
13.	Exam Hall Cum Auditorium	1	100x50
14.	Library/Book Bank	1	30x72
15.	Common Utility Room	1	20x36
16.	Central Laboratory	1	50x36
17.	Hostels including Mess, Gym/Indoor, Reading Room, Warden Room, Store etc.	1 (boys)	150
		1 (girls)	150

S. No.	Details	No. of Rooms	Dimensions (ft)
18.	Canteen	1	20x12 (kitchen with store)
			20x36 Seating
19.	Wash room (with toilet & urinary facilities)	10	20x12 (keeping ladies requirements)
20.	Parking space		As per requirement
21.	Farm stores, threshing yards including implements and tractor sheds	One core complex	
22.	Vehicles		
	Car	1	
	Jeep/Car staff	2	
	Bus	1	
	Pickup van	1	
	Motor Bikes	2	
	Minibus (30 capacity)	1	
	Tractors	2	
23.	Drinking water and irrigation facilities		As per requirements
24.	Vehicles shed	1	10x80

B. Divisions/Departments/Sections – Requirements

No.	Details	No. of Rooms	Dimensions(ft)
1.	Office of Head	11	24x12 with wash room facility
2.	Faculty Rooms 1+1	12	12x10 + 18x12 24x10 depending on the strength of each deptt.
3.	Clerical/technical staff	12	12x10 to 24x10 depending on the strength of each deptt.
5.	Laboratories	12	30x 60 Larger deptt. will have two
6.	Field/Lab Stores	5	1. Agronomy 2. Gen. & Pl. Breeding 3. Soil Sci. 4. Horticulture 5. Pests & Chemicals
7.	Green house/poly house/ Nursery facilities (Hort. Deptt.)	0.02 ha	

Requirements of Lab/field equipment for each Division/Department/Section)

1. Agronomy + Agroforestry

1.	Crop Cafeteria	½ acre land small implements like spade, hoe, khurpi, darati etc.
2.	Museum for identification of seeds, fertilizer, weeds, commonly used agro-chemical and medicinal and aromatic plants etc.	Storage bottle Herbarium posting material
3.	Field of sowing method, fertilizer application, irrigation and soil productivity and yield estimation	Small equipment/ implement
4.	Irrigation water measurement, bulk density etc.	
	Equipment	**Number**
	i. Hot air oven	02
	ii Moisture box	30
	iii Moisture meter	05
	iv Tube Auger	10
	v Bucket auger	10
	vi Weighing Balance	01
	vii Seed Germinator	02
	viii Conductivity Meter	01
	ix pH Meter	02
	x Water Bath	01
	xi Shaker	01
	xii Chlorophyl Meter	01
	xiii Drip and Sprinkler System	03
	xiv Sprayer	03
	xv Spring Balance 50 Kg	05
	xvi Spring Balance 10 Kg	05
	xvii Top Pan Balance 1 kg capacity	05
	xviii Top Pan Balance 2 kg capacity	05
	xix Meter Scale	10
	xx Tape	05
	xxi Brix meter	02

2. Agricultural Economics + (Basic Economics, Maths & Computer Science and Statistics)

No.	Items	Nos.
1.	Computers	15
2.	Camera	01
3.	Software	As per requirement

3. Agriculture Extension & Communication + (Sociology and Psychology, English)

Audio-visual Lab

No.	Items	Nos.
1.	LCD projector	1
2.	Camera (SLR) with zoom, wide-angle, tele-photo lens	1
3.	Video camera with tripod, lighting accessories and editing facility	1
4.	Computers (workstation) with editing softwares	1
5.	Digital voice recorders	5
6.	Audio recording-mixing consoles	1
7.	Computation softwares for statistics	

4. Entomology

No.	Items	Nos.
1.	Binocular Microscope	20
2.	Insect Box	60
3.	Insect Collection Nets	60
4.	Collection Bottles	60
5.	Insect Collection Big Boxes for Museum (1 for each order)	29
6.	Insecticides for showing students/Representative for each group	As per requirement
7.	Stereomicroscope	01
8.	Electronic Balance	01
9.	Soxhlet Extraction Apparatus	01
10.	Bee keeping equipment	01 Set
11.	Oven	01
12.	PattersTower	01
13.	Sprayers	01 of each type
14.	Light traps	01 set
15.	Fumigation Chamber	01

No.	Items	Nos.
16.	Sides/cover slips	as per requirement
17.	pH meter	01
18.	Computer with printer	01 set

5. Genetics & Plant Breeding + (Seed Science & Technology)

Genetics

No.	Items	Nos.
1.	Microscope	10
2.	Binocular microscope	10
3.	Electronic Moisture Meter	02
4.	Electronic Balance	02
5.	Seed Germinator	02
6.	Automatic seed/grain counter	01

Biotechnology

No.	Items	Nos.
10.	Hot Air Oven	01
11.	BOD Incubator	01
12.	Fluorescence microscope	01
11.	Centrifuge	01
12.	Growth Chamber	01
13.	Distillation Assembly	01

6. Horticulture + (Food Science & Technology)

a. Labs (Post Harvest)

No.	Items	Nos.
1	Hand Refractometer	05
2	Digital Refractometer	02
3	Oven	01
4	Refrigerator	01
5	Electronic Weighing Balance	02
6	Pan Balance (1 kg & 10 kg. capacity each)	02
7	Deep Freezer	01
8	pH Meter	01

No.	Items	Nos.
9	Fruit crusher	01
10	Grinding and Mixing Machine	01
11	Distillation Assembly	01

b. Lab (UG Lab)

No.	Items	Nos.
1.	Seed Germinator	02
2.	Grafting and budding knife	60
3.	Secateur	60
4.	Saw	05
5.	Loppers	05
6.	Mist Chamber	01
7.	Poly house with drip irrigation system	02
8.	Microscope	

c. Food Science & Technology

No.	Items	Nos.
1.	Refrigerator	1
2.	Muffle furnace	1
3.	Weighing balance	2
4.	Water bath	2
5.	Hot air oven	2
6.	Fruit penetrometer	2
7.	Pulper	1
8.	Juice extractor	1
9.	Crown corking machine	1
10.	Spectrophotometer	1
12.	Microwave oven	1
13.	Baking oven	1
14.	Sieve shaker	1
15.	Poly pouch sealer	1
16.	Crusher	1

No.	Items	Nos.
17.	Masala grinder	1
18.	Dehydrator	1
19.	Cold room	1
20.	Vacuum pump	

7. Soil Science and Agricultural Chemistry + (Microbiology, Agro-meteorology, Environmental Sciences)

No.	Items	Nos.
1.	Electronic Top pan balance (0.1 g capacity)	02
2.	Electronic Top pan balance (1 mg capacity)	02
3.	Hot air oven	02
4.	pH Meter	05
5.	EC Meter	05
6.	Flame Photometer	01
7.	Visible spectrophotometer	01
8.	Hot Plate	02
9.	Distilled water unit	02
10.	Water Bath	01
11.	Rotary Shaker	02
12.	Binocular Microscope	20
13.	BOD Incubator	02
14.	Autoclave	02
15.	Laminar Air Flow	01
16.	Microwave oven	01
17.	Digestion block	02
18.	Hydrometer	05
19.	Infiltrometer	02
20.	Hydraulic conductivity meter	01
21.	Atterberg's limitsmeter	05
22.	Nitrogen Analyser	02

8. Agrometeorology

No.	Items	Nos.
1.	Thermometer Max	05
2.	Thermometer Min	05
3.	Digital Anemometer	02
4.	Cup Anemometer	02
5.	Pan Evaporimeter	01
6.	Soil thermometer 05 cm. 10 cm. 15 cm.	 05 05 05
7.	Rain gauge	01
8.	Self-recording Rain gauge	01
9.	Sunshine Recorder	01
10.	Stevenson's Screen	01
11.	Thermograph	01
12.	Hygrograph	01
13.	Soil Heat Flux Plate	01
14.	GPS	10
15.	AWS (optional)	01
16.	Lysimeter (optional)	01
17.	Luxmeter	02
18.	Solar Pyranometer	01

9. Plant Pathology

No.	Items	Nos.
1.	Microscope compound with photodisplay arrangement	03
2.	Sterobinocular	05
3.	Sample processing Board (Dry preservation of samples)	04
4.	Wet preservation Jars	50
5.	Autoclave	02
6.	Oven	01
7.	Deep Freeze	01
8.	Centrifuge (3000 rpm)	01

No.	Items	Nos.
9.	Refrigerator	01
10.	Water bath	02
11.	Electronic balance	02
12.	Weighing machine	01
13.	Incubator	02
14.	Occular meter	05
15.	Stage Micrometer	05
16.	Camera Lucida	05

10. Animal Sciences including Fisheries

No.	Items	Nos.
1.	5000/6500 Feed and Forage Analyzer	01
2.	Hand and electric centrifuge	01
3.	Analytical balance	01
4.	Hot air oven	01
5.	Micro kjeldahl N digestion & distillation apparatus	01
6.	Soxhlet unit for fat estimation	01
7.	Hot plate, Fiber Tech.	01
8.	Vacuum pump	01
9.	Willy mill grinder	01
10.	Platform balance (100 kg cap)	01
11.	Gerber centrifuge unit (for milk fat testing)	01
12.	Milk analyzer (automatic)	01
13.	Crude fiber estimation unit	01
14.	Distilled water unit	01

11. Dairy & Poultry

No.	Items	Nos.
1.	Incubator cum hatcher	01
2.	Brooder machine	01
3.	Feeder	01
4.	Waterer	01
5.	Egg candling machine	01

No.	Items	Nos.
6.	Debeaker	01
7.	Vaccinator	01
8.	Milking machine	As per requirements
9.	Milking bucket	As per requirement
10.	Milking can	As per requirements
11.	Animal and bird identification tools	As per requirement
12.	Chaff cutter	01
13.	Lactometer	01
14.	Castrator	01
15.	Shearer	01
16.	Electric dehorner	01
17.	Artificial vagina	01
18.	Common medication device	01
19.	Cattle crate	01

12. Agriculture Engineering + Farm Management

No.	Items	Nos.
1.	Working models of MB plough, Disk plough and indigenous plough	2 sets each
2.	Working model of different harrows	Actual
3.	Seed drill	01
4.	Different types of threshing drums	As per requirement
5.	Working models of reaper and mowers	02
6.	Different types of sprayers and dusters	As per requirement
7.	Cut model of CI & SI engine	01
8.	Cut model of Tractor	01

13. Central Library and Information System

No.	Items	Nos.
1.	Internet Server	01
2.	Intranet Server	01
3.	Computers for Reading Hall	20
4.	Heavy Duty Photocopiers	02

No.	Items	Nos.
5.	Computerized Issue and Catalogue Systems	02
6.	Wi-Fi facility in college/library/hostels	As per requirement
7.	CCTV monitoring system for library	01
8.	RFID and Access Control System (Optional)	01
9.	Broadband Internet Connectivity with minimum speed of 1Gbps	

AGRICULTURAL ENGINEERING

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

Possibility of change in UG degree nomenclature such as B. Tech. (Agricultural and Bio-systems Engineering) as proposed by the "Committee on Minimum Standards of Higher Agricultural Education-Agricultural Engineering" were discussed in detail. It was pointed out that, at present in our country, B. Tech. (Agril. Engg.) or B.E. (Agril. Engg.)is the approved required qualification for different jobs in the government sector. Majority of the delegates were of the view that changing the degree nomenclature would have adverse impact on the job opportunities of agricultural engineering graduates in various central and state government departments where they have to compete with other disciplines like with civil engineering/agriculture graduates in soil conservation. Similarly the recommendations of the "Essential Qualification and Degree Nomenclature Review Committee" were discussed for possible change in the PG degree nomenclature. Majority of the delegates were of the view that the PG degree nomenclature should be as per the nomenclature of different departments reflecting the major disciplines of Agricultural Engineering. Delegates were of the view that more departments may have to be created in future as per the need for specialisation in different aspect of agricultural engineering and as such the PG degree nomenclature should suit needed specialisation to avoid recruitment problems. Finally the following decision was taken regarding the UG and PG degree nomenclature for the disciple of Agricultural Engineering:

i) **UG Degree:** B. Tech. (Agricultural Engineering)

ii) **PG Degree:** M. Tech. / Ph.D (Agricultural Engineering) with specialisation in following streams:

S. No.	Specialization in M. Tech. / Ph.D.
1	Soil and Water Conservation Engineering
2	Irrigation and Drainage Engineering
3	Farm Machinery and Power Engineering
4	Processing and Food Engineering
5	Renewable Energy Engineering

Restructuring of UG programme for increased practical contents

Taking fourth Deans' Committee recommendations related to Agricultural Engineering as the base criteria, the issue was discussed at length. There was unanimous consensus on different aspects such as thorough restructuring of the distribution of different courses as per future challenges and recent developments, more emphasis on basic course of agricultural sciences for increased exposure of the student to the problems and practices of agricultural fields and inclusion of special courses on communication skills and personality development for increased employability of the graduating students. The delegates were also of the view that the total credit load as approved by fourth Deans' Committee for B. Tech. Agricultural Engineering is towards much higher side as compared to other degree programmes [e.g. 183 credits hours for B. Tech. (Agril. Engg.) as compared to 166 credit hours for B.Sc. (Ag.)] leaving practically no time for the B. Tech. (Agril. Engg.)students to engage themselves in innovative academic pursuits and detailed study of subjects of their interest. The proposed distribution of courses and credits hours for B. Tech. (Agril. Engg.) programme was discussed at length.

It was also decided to review the course titles/course contents in view of i) the proposed restructuring of B. Tech. (Agril. Engg.) programme, ii) feedback received by different institutes during their interaction with different stakeholders, iii) experience gained by different institutes in implementing the fourth Deans' Committee recommendations, iv) recent developments and emerging issues related to different aspects of Agricultural Engineering such as agricultural waste management, micro irrigation, increasing dependence on renewable energy sources etc., and v) job opportunities for agricultural engineering graduates in different industrial sectors. Considering the time constraint and more inclusive involvement of subject specialists, discipline wise coordinators were identified to review the course titles/course contents for different disciplines. The identified coordinators were asked to submit their respective report to the convener and co-convener for further necessary action.

Titles and Credit Hours of B. Tech. (Agricultural Engineering) Degree Programme

S. No.	Department with number of courses and Course title	Credit Hours
	Dept. of Basic Engineering Applied Sciences	**75 (45+30)**
	Basic Engineering (18)	**44 (25+19)**
1	Surveying and Levelling	3(1+2)
2	Engineering Mechanics	3(2+1)
3	Strength of Materials	2(1+1)
4	Design of Structures	2(1+1)
5	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
6	Building Construction and Cost Estimation	2(2+0)
7	Soil Mechanics	2(1+1)
8	Engineering Drawing	2(0+2)
9	Workshop Technology and Practice	3(1+2)
10	Heat and Mass Transfer	2(2+0)

11	Machine Design	2(2+0)
12	Auto CAD Applications	2(0+2)
13	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)
14	Theory of Machines	2(2+0)
15	Electrical Machines and Power Utilization	3(2+1)
16	Applied Electronics and Instrumentation	3(2+1)
17	Computer Programming and Data Structures	3(1+2)
18	Web Designing and Internet Applications	2(1+1)
	Applied Sciences (11)	**31(20+11)**
1	Principles of Agronomy	3(2+1)
2	Principles of Soil Science	3(2+1)
3	Principles of Horticultural Crops and Plant Protection	2(1+1)
4	Engineering Physics	3(2+1)
5	Engineering Chemistry	3(2+1)
6	Engineering Mathematics-I	3(2+1)
7	Engineering Mathematics-II	3(2+1)
8	Engineering Mathematics-III	3(2+1)
9	Communication Skills and Personality Development	2(1+1)
10	Entrepreneurship Development and Business Management	3(2+1)
11	Environmental Science and Disaster Management	3(2+1)
	Dept. of Soil and Water Conservation Engineering (4)	**10(6+4)**
1	Watershed Hydrology	2(1+1)
2	Soil and Water Conservation Engineering	3(2+1)
3	Water Harvesting and Soil Conservation Structures	3(2+1)
4	Watershed Planning and Management	2(1+1)
	Dept. of Irrigation and Drainage Engineering (4)	**10(6+4)**
1	Irrigation Engineering	3(2+1)
2	Drainage Engineering	2(1+1)
3	Groundwater, Wells and Pumps	3(2+1)
4	Sprinkler and Micro Irrigation Systems	2(1+1)
	Dept. of Farm Machinery and Power Engineering (5)	**14(8+6)**
1	Farm Machinery and Equipment-I	3(2+1)
2	Farm Machinery and Equipment-II	3(2+1)
3	Tractor and Automotive Engines	3(2+1)
4	Tractor Systems and Controls	3(2+1)
5	Tractor and Farm Machinery Operation and Maintenance	2(0+2)

	Dept. of Processing and Food Engineering (5)	**13(8+5)**
1	Engineering Properties of Agricultural Produce	2(1+1)
2	Agricultural Structures and Environmental Control	3(2+1)
3	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)
4	Post Harvest Engineering of Horticultural Crops	2(1+1)
5	Dairy and Food Engineering	3(2+1)
	Dept. of Renewable Energy Engineering (3)	**9(6+3)**
1	Fundamentals of Renewable Energy Sources	3(2+1)
2	Renewable Power Sources	3(2+1)
3	Bio-energy Systems: Design and Applications	3(2+1)
	Elective Courses (Any 3 courses)	**9 (6+3)**
1	Floods and Control Measures	3(2+1)
2	Wasteland Development	3(2+1)
3	Information Technology for Land and Water Management	3(2+1)
4	Remote Sensing and GIS Applications	3(2+1)
5	Management of Canal Irrigation System	3(2+1)
6	Minor Irrigation and Command Area Development	3(2+1)
7	Precision Farming Techniques for Protected Cultivation	3(2+1)
8	Water Quality and Management Measures	3(2+1)
9	Landscape Irrigation Design and Management	3(2+1)
10	Plastic Applications in Agriculture	3(2+1)
11	Mechanics of Tillage and Traction	3(2+1)
12	Farm Machinery Design and Production	3(2+1)
13	Human Engineering and Safety	3(2+1)
14	Tractor Design and Testing	3(2+1)
15	Hydraulic Drives and Controls	3(2+1)
16	Precision Agriculture and System Management	3(2+1)
17	Food Quality and Control	3(2+1)
18	Food Plant Design and Management	3(2+1)
19	Food Packaging Technology	3(2+1)
20	Development of Processed Products	3(2+1)
21	Process Equipment Design	3(2+1)
22	Photovoltaic Technology and Systems	3(2+1)
23	Waste and By-products Utilization	3(2+1)
24	Artificial Intelligence	3(3+0)
25	Mechatronics	3(2+1)
	Total course work Credit Hours (140)	**140 (85+55)**

	Educational tour (During first week of January)	**2 (0+2)**
	One-year Student READY (Rural and Entrepreneurship Awareness Development Yojana) programme	**40 (0+40)**
	8-weeks Skill Development Trainings (I and II, each of 4-weeks) during semester break after IVth and VIth semester	10 (0+10)
	10- weeks Industrial Attachment/ Internship	10 (0+10)
	10- weeks Experiential Learning On campus	10 (0+10)
	20-weeks Project Planning and Report Writing	10 (0+10)
	Total Credit Hours Load of B. Tech. (Agricultural Engineering)	**182 (85+97)**

Semester-wise Course Programme

No.	Course No.	Title of the Course	Credit Hour
		Semester I	
1.		Engineering Mathematics-I	3(2+1)
2.		Engineering Physics	3(2+1)
3.		Engineering Chemistry	3(2+1)
4.		Principles of Soil Science	3(2+1)
5.		Surveying and Levelling	3(1+2)
6.		Engineering Mechanics	3(2+1)
7.		Engineering Drawing	2(0+2)
8.		Heat and Mass Transfer	2(2+0)
		Total	**22(13+9)**
		Semester II	
1.		Engineering Mathematics-II	3(2+1)
2.		Environmental Science and Disaster Management	3(2+1)
3.		Entrepreneurship Development and Business Management	3(2+1)
4.		Fluid Mechanics and Open Channel Hydraulics	3(2+1)
5.		Strength of Materials	2(1+1)
6.		Workshop Technology and Practices	3(1+2)
7.		Theory of Machines	2(2+0)
8.		Web Designing and Internet Applications	2(1+1)
		Total	**21(13+8)**
		III Semester	
1.		Principles of Horticultural Crops and Plant Protection	2(1+1)
2.		Principles of Agronomy	3(2+1)
3.		Communication Skills and Personality Development	2(1+1)
4.		Engineering Mathematics-III	3(2+1)
5.		Soil Mechanics	2(1+1)

6.	Design of Structures	2(1+1)
7.	Machine Design	2(2+0)
8.	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)
9.	Electrical Machines and Power Utilization	3(2+1)
	Total	**22(14+8)**
	IV Semester	
1	Building Construction and Cost Estimation	2(2+0)
2	Auto CAD Applications	2(0+2)
3	Applied Electronics and Instrumentation	3(2+1)
4	Tractor and Automotive Engines	3(2+1)
5	Engineering Properties of Agricultural Produce	2(1+1)
6	Watershed Hydrology	2(1+1)
7	Irrigation Engineering	3(2+1)
8.	Sprinkler and Micro Irrigation Systems	2(1+1)
9.	Fundamentals of Renewable Energy Sources	3(2+1)
	Total	**22(13+9)**
Skill Development Training-I Summer break June-July after 4th Semester (Student READY)		
	V Semester	
1.	Tractor Systems and Controls	3(2+1)
2.	Farm Machinery and Equipment-I	3(2+1)
3.	Agricultural Structures and Environmental Control	3(2+1)
4.	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)
5.	Soil and Water Conservation Engineering	3(2+1)
6.	Watershed Planning and Management	2(1+1)
7.	Drainage Engineering	2(1+1)
8.	Renewable Power Sources	3(2+1)
9.	Skill Development Training-I (Student READY) Registration only	5(0+5)
	Total	**27(14+13)**
	VI Semester	
1.	Computer Programming and Data Structures	3(1+2)
2.	Farm Machinery and Equipment-II	3(2+1)
3.	Post Harvest Engineering of Horticultural Crops	2(1+1)
4.	Water Harvesting and Soil Conservation Structures	3(2+1)
5.	Groundwater, Wells and Pumps	3(2+1)
6.	Tractor and Farm Machinery Operation and Maintenance	2(0+2)
7.	Dairy and Food Engineering	3(2+1)
8.	Bio-energy Systems: Design and Applications	3(2+1)
	Total	**22(12+10)**

Skill Development Training-II in Summer break June-July after 6th Semester (Student READY)		
VII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)		
1.	10- weeks Industrial Attachment /Internship (Student READY)	10(0+10)
2.	10- weeks Experiential Learning On campus (Student READY)	10(0+10)
3.	Skill Development Training-II (Student READY) Registration only	5(0+5)
4.	Educational Tour (Registration only)	2 (0+2)
Total		**27(0+27)**
Educational tour during winter/January break		
VIII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)		
1.	Elective course	3(2+1)
2.	Elective course	3(2+1)
3.	Elective course	3(2+1)
4.	Project Planning and Report Writing (Student READY)	10(0+10)
Total		**19(6+13)**
Grand Total I to VIII semesters		**182(85+97)**

I. Department of Basic Engineering and Applied Sciences 73 (44+29)

A) Basic Engineering 44(25+19)

i) Civil Engineering Section 17(10+7)

1. Surveying and Levelling 3(1+2)

Theory

Surveying: Introduction, classification and basic principles, Linear measurements. Chain surveying. Cross staff survey, Compass survey. Planimeter, Errors in measurements, their elimination and correction. Plane table surveying. Levelling, Leveling difficulties and error in leveling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic Theodolite. Introduction to GPS survey

Practical

Chain survey of an area and preparation of map; Compass survey of an area and plotting of compass survey; Plane table surveying; Levelling. L section and X sections and its plotting; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; Theodolite surveying; Ranging by Theodolite, Height of object by using Theodolite; Setting out curves by Theodolite; Minor instruments. Use of total station.

References

- Punmia, B C 1987. Surveying (Vol.I). Laxmi Publications, New Delhi.
- Arora K R 1990. Surveying(Vol.I), Standard Book House, Delhi.
- Kanetkar T P 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.

2. Engineering Mechanics 3 (2+1)

Theory

Basic concepts of Engineering Mechanics. Force systems, Centroid, Moment of inertia, Free body diagram and equilibrium of forces. Frictional forces Analysis of simple framed structures using methods of joints, methods of sections and graphical method. Simple stresses. Shear force and bending moment diagrams. Stresses in beams. Torsion. Analysis of plane and complex stresses.

Practical

Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple; Problems relating to resultant of; Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space; Problems relating to centroids of composite areas; Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas; Equilibrium of concurrent – co-planer and non concurrent – co-planer force systems; Problems involving frictional forces; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Problems relating to simple stresses and strains; Problems on shear force and bending moment diagrams; Problems relating to stresses in beams; Problems on torsion of shafts; Analysis of plane and complex stresses.

References

- Sundarajan V 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Timoshenko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.
- Prasad I B 2004. Applied Mechanics. Khanna Publishers, New Delhi.
- Prasad I B 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
- Bansal R K 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.

3. Strength of Materials 2(1+1)

Theory

Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution methods.

Practical

To perform the tension test on metal specimen (M.S., C.I.), to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture; To perform the compression test on; Concrete cylinders &cubes, C.I., M.S. & Wood specimens and to determine various physical and mechanical properties; To perform the bending test on the specimens; M.S. Girder, Wooden beam, Plain concrete beams

& R.C.C. beam, and to determine the various physical and mechanical properties; To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre & quarter points; To study the behaviour of materials (G.I. pipes, M.S., C.I.) under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens; To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens; To determine compressive & tensile strength of cement after making cubes and briquettes; To measure workability of concrete (slump test, compaction factor test); To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates; To determine fatigue strength of a given specimen; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

References

- Khurmi R.S. 2001. Strength of Materials S. Chand & Co., Ltd., New Delhi.
- Junarkar S.B. 2001.Mechanics of Structures (Vo-I). Choratar Publishing House, Anand.
- Ramamrutham S. 2003. Strengths of Materials. Dhanpat Rai and Sons, Nai Sarak, New Delhi.

4. Design of Structures 2(1+1)

Theory

Loads and use of BIS Codes. Design of connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Practical

Design and drawing of single reinforced beam, double reinforced beam, Design and drawing of steel roof truss; Design and drawing of one way, two way slabs, Design and drawing of RCC building; Design and drawing of Retaining wall. To measure workability of cement by slump test

Suggested Readings

- Junarkar, S.B. 2001. Mechanics of Structures Vol. I Charotar Publishing Home, Anand.
- Khurmi R. S. 2001. Strength of materials. S. Chand & Company Ltd., 7361, Ram Nagar, New Delhi – 110055.
- Kumar Sushil 2003. Treasure of R.C.C. Design. R.K. Jain. 1705-A, Nai Sarak , Delhi-110006, P.B.1074.

5. Fluid Mechanics and Open Channel Hydraulics 3(2+1)

Theory

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines,

streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon; Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices (Measurement of Discharge, Measurement of Time),Flow through Mouthpieces, Flow over Notches , Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

Practical

Study of manometers and pressure gauges; Verification of Bernoulli's theorem; Determination of coefficient of discharge of venturi-meter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Measurement of force exerted by water jets on flat and hemispherical vanes; Determination of meta-centric height; Determination of efficiency of hydraulic ram; Performance evaluation of Pelton and Francis turbine; Study of current meter; Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

Suggested Readings

- Khurmi, R .S. 1970. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines S. Chand & Company Limited, New Delhi.
- Modi P M and Seth S.M.1973. Hydraulics and Fluid Mechanics. Standard Book House, Delhi.
- Chow V T 1983. Open Channel Hydraulics. McGraw Hill Book Co., New Delhi.
- LalJagadish 1985. Fluid Mechanics and Hydraulics. Metropolitan Book Co.Pvt. Ltd., New Delhi.

6. Building Construction and Cost Estimation 2(2+0)

Theory

Building Materials: Rocks, Stones, Bricks Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber. Building components: Lintels, Arches, stair cases, Different types of floors, Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering – Painting, Building design, Design procedures, Technology, building construction, Types of agricultural buildings and related needs, application of design theory and practice to the conservation, sloped and flat roof buildings, construction economics: Preliminary estimates, Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design, Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development,

Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback

Suggested Readings

- Punmia B.C. Ashok Kumar Jain and Arun Kumar Jain. Building Construction. Laxmi Publications (P) ltd., New Delhi.
- Duggal S K. Building material. New Age International Publishers.
- Sane Y.S. Planning and Designing of Buildings.
- Rangwala S C. 1994. Engineering Materials. Charotar Publishing House, Anand.
- Dutta B.N. 2000. Estimating and Costing. UBS publishers.

7. Soil Mechanics 2(1+1)

Theory

Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, elementary concept of Boussinesq and Wester guards analysis, new mark influence chart. Seepage Analysis; Quick condition-two dimensional flow-Laplace equation, Velocity potential and stream function, Flow net construction. Shear strength, Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests. Compaction, composition of soils standard and modified protector test, abbot compaction and Jodhpur mini compaction test field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method, determination of coefficient of consolidation. Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number.

Practical

Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Grain size analysis by hydrometer method; Determination of liquid limit by Casagrande's method; Determination of liquid limit by cone penetrometer and plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.

Suggested Readings

- Punmia B C, Jain A K and Jain A K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi.
- Ranjan Gopal and Rao A S R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.
- Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.

ii) Mechanical Engineering Section 16 (9+7)

1. Engineering Drawing 2(0+2)

Practical

Introduction of drawing scales; First and third angle methods of projection. Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique sections. Sectional drawing of simple machine parts. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts. Forms of screw threads, representation of threads, Bolts- headed centre, stud screws, set screws, butt, hexagonal and square; keys-types, taper, rank taper, hollow saddle etc.

Suggested Readings

- Bhat N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
- Bhatt N D and Panchal V M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
- Narayana K L and Kannaiah P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.

2. Workshop Technology and Practice 3(1+2)

Theory

Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes or operations in wood working; Introduction to Smithy tools and operations; Introduction to welding, types of welding, Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Casting processes; Classification, constructional details of center lathe, Main accessories and attachments. Main operations and tools used on center lathes. Types of shapers, Constructional details of standard

shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

Practical

Preparation of simple joints: Cross half Lap joint and T-Halving joint; Preparation of Dovetail joint, Mortise and tenor joint; Jobs on Bending, shaping etc.; Jobs on Drawing, Punching, Rivetting. Introduction to tools and measuring instruments for fitting; Jobs on sawing, filing and right angle fitting of MS Flat; Practical in more complex fitting job; Operations of drilling,, reaming, and threading with tap and dies; Introduction to tools and operations in sheet metal work; Making different types of sheet metal joints using G.I. sheets. Introduction to welding equipment, processes tools, their use and precautions; Jobs on ARC welding – Lap joint, butt joint; T-Joint and corner joint in Arc welding; Gas welding Practice – Lab, butt and T-Joints; Introduction to metal casting equipment, tools and their use; Mould making using one-piece pattern and two pieces pattern; Demonstration of mould making using sweep pattern, and match plate patterns; Introduction to machine shop machines and tools; Demonstration on Processes in machining and use of measuring instruments; Practical jobs on simple turning, step turning; Practical job on taper turning, drilling and threading; Operations on shaper and planer, changing a round MS rod into square section on a shaper; Demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing; Any additional job.

Suggested Readings

- Hazra, Choudari S K and Bose S K. 1982. Elements of Workshop technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd., Mumbai.
- Chapman W A J. 1989. Workshop Technology (Part I and II). Arnold Publishers (India) Pvt. Ltd., AB/9 Safdarjung Enclave, New Delhi.
- Raghuwamsi B S. 1996. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682 Nai Darak, New Delhi.

3. Heat and Mass Transfer 2(2+0)

Theory

Concept, modes of heat transfer, thermal conductivity of materials, measurement. General differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation. Electrical analogy. Insulation materials. Fins, Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Useful non dimensional numbers. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection. Introduction. Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks. Types of heat exchangers, fouling

factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

Suggested Readings

- Geankoplis C.J. 1978. Transport Port Processes and Unit Operations. Allyn and Bacon Inc., Newton, Massachusetts.
- Holman J P. 1989. Heat Transfer. McGraw Hill Book Co., New Delhi.
- Incropera F P and De Witt D P. 1980. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York.
- Gupta C P and Prakash R. 1994. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.

4. Machine Design 2(2+0)

Theory

Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys. Design of gears. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anti-friction bearings.

Suggested Readings

- Jain R K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
- Khurmi R S and Gupta J K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.

5. Auto CAD Applications 2(0+2)

Practical

Application of computers for design. CAD- Overview of CAD window – Explanation of various options on drawing screen. Study of draw and dimension tool bar. Practice on draw and dimension tool bar. Study of OSNAP, line thickness and format tool bar. Practice on OSNAP, line thickness and format tool bar. Practice on mirror, offset and array commands. Practice on trim, extend, chamfer and fillet commands. Practice on copy, move, scale and rotate commands. Drawing of 2 D- drawing using draw tool bar. Practice on creating boundary, region, hatch and gradient commands. Practice on Editing polyline- PEDIT and Explode commands. Setting of view ports for sketched drawings. Printing of selected view ports in various paper sizes. 2D-drawing of machine parts with all dimensions and allowances- Foot step bearing and knuckle joint. Sectioning of foot step bearing and stuffing box. Drawing of hexagonal, nut and bolt and other machine parts. Practice on 3-D commands- Extrusion and loft. Practice on 3-D commands-

on sweep and press pull. Practice on 3-D Commands- revolving and joining. Demonstration on CNC machine and simple problems.

Suggested Readings

- Rao P.N.. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.
- Sareen Kuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand & Company Ltd., New Delhi.
- Zeid Ibrahim. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi.
- Lee Kunwoo. 1999. Principles of CAD/CAM/CAE Systems. Addison Vesley Longman, Inc.

6. Thermodynamics, Refrigeration and Air Conditioning 3(2+1)

Theory

Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle. Vapour refrigeration-mechanism, P-V,P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

Practical

Tutorials on thermodynamic air cycles, Study and application of P V and T S chart in refrigeration, P H chart (or) Mollier diagram in refrigeration, Numerical on air refrigeration cycle systems, Numerical on vapour compression cycle refrigeration system, Study of domestic water cooler, Study of domestic household refrigerator, Study of absorption type solar refrigeration system, Study cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters using refrigeration tutor – II, Numerical on design of air conditioning systems, Study of window air conditioner, Study on repair and maintenance of refrigeration and air-conditioning systems. Visit to chilling or ice making and cold storage plants.

Suggested Readings

- Kothandaraman C P Khajuria P R and Arora S C. 1992. A Course in Thermodynamics and Heat Engines. Dhanpet Rai and Sons, 1682 Nai Sarak, New Delhi.
- Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi.
- Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. Dhanpat Rai and Sons 1682 Nai Sarak, New Delhi.
- Ballney P. L. 1994. Thermal Engineering. Khanna Publishers, New Delhi.
- Nag P K.1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co.Ltd., 12/4 Asaf Ali Raod, New Delhi.

7. Theory of Machines 2(2+0)

Theory

Elements, links, pairs, kinematics chain, and mechanisms. Classification of pairs and mechanisms. Lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration using graphical (relative velocity and acceleration) method. Instantaneous centers. Types of gears. Law of gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear, nomenclature, interference and undercutting. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted, and epicyclic trains. Determining velocity ratio by tabular method. Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension, creep and slip on power transmission, Chain drives. Types of friction, laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti friction bearings. Types of governors. Constructional details and analysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting, iso-chronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes.

Suggested Readings

- Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi.
- Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
- Rao J S and Dukkipatti R V. 1990. Mechanisms and Machine Theory. Wiley astern Ltd., New Delhi.
- Lal Jagdish. 1991. Theory of Mechanisms and Machines. Metropolitan Book Co. Pvt.Ltd., 1 Netaji Subash Marg, New Delhi..
- Rattan S B. 1993. Theory of Machines. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
- Khurmi R S and Gupta J K. 1994. Theory of Machines. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.

iii) Electrical and Computer Engineering Section 11(6+5)

1. Electrical Machines and Power Utilization 3(2+1)

Theory

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses, Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, polyphase induction motor: construction, operation, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors, various methods of three phase power measurement; power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits; Series and parallel resonance.

Practical

To obtain load characteristics of d.c. shunt/series /compound generator; To study characteristics of DC shunt/ series motors; To study d.c. motor starters; To Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics; To perform no-load & blocked –rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram; To study the speed control of 3 ph. induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor; To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M.; To start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque –speed characteristics; To perform no load & blocked –rotor test on 1 ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory; To perform load –test on 1 ph. induction motor & plot torque –speed characteristics; To study power consumed in a three-phase circuit; Two lights in series controlled by one switch; Two lights in parallel controlled by one switch.

Suggested Readings

- Thareja B L & Theraja AK. 2005. A text book of Electrical Technology. Vol. I S. Chand & Company LTD., New Delhi.
- Theraja B L & Theraja AK 2005. A text book of Electrical Technology. Vol. II S.Chand & Company LTD., New Delhi.
- Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall of India Private LTD., New Delhi.
- Anwani M L. 1997. Basic Electrical Engineering. Dhanpat Rai & Co.(P) LTD. New Delhi.

2. Applied Electronics and Instrumentation 3(2+1)

Theory

Semiconductors. p—n junction. V—I characteristics of p—n junction. diode as a circuit element. rectifier. clipper. damper, voltage multiplier, capacitive filter. diode circuits for OR &AND (both positive and negative logic), bipolar junction transistor: operating point. classification (A.B & C) of amplifier. various biasing methods (fixed. self potential divider). h-parameter model of a transistor. analysis of small signal. CE amplifier. phase shift oscillator, analysis of differential amplifier using transistor. ideal OP-AMP characteristics. linear and non-linear applications of OP-AMP (adder. subtractor. integrator, active rectifier. comparator. differentiator. differential, instrumentation amplifier and oscillator). zener diode voltage regulator. transistor series regulator. current limiting. OP-AMP voltage regulators. Basic theorem of Boolean algebra. Combinational logic circuits(basic gates. SOP rule and Kmap). binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement. temperature. velocity, force and pressure using potentiometer. resistance thennometer. thermocouples. Bourclen tube. LVDT. strain gauge and tacho-generator.

Practical

To study V-I characteristics of p-n junction diode: To study half wave. full wave and bridge rectifier: To study transistor characteristics in CE configurations: To design and study fixed and self bias transistor: To design and study potential divider bias transistor: To study a diode as clipper and clamper: To study a OP-AMP IC 741 as inverting and non- inverting amplifier: To study a OP-AMP IC 741 as differentiator and integrator to study a differential amplifier using two transistor: To study a OP-AMP IC 741 as differential amplifier: To study a zener regulator circuit: To study a OP-AMP IC 741 as a active rectifier: To study a OP-AMP IC 741 as a comparator: To familiarize with various types of transducers.

Suggested Readings

- Mehta V K. Principles of Electronics. S. Chand and Co., New Delhi.
- Shaney A K. Measurement of Electronics and Electronic Instrumentation. Khanna Publications.
- Roy Chowdary. Integrated Electronics. John Wiley International.
- Kumar Anand. Digital Electronics. A. PHI.
- Gupta Sanjeev, Sonthosh Gupta. Electronic Devices and Circuits. Danapath Rai Publications.

3. Computer Programming and Data Structures 3(1+ 2)

Theory

Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

Practical

Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.

Suggested Readings

- Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.
- Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
- Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt.Ltd., New Delhi.
- Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi
- Sahni S.. Data Structures, Algorithms and Applications in C++. University press (India) Pvt Ltd / Orient Longman Pvt. Ltd.
- Michael T. Goodrich, R. Tamassia and D Mount. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
- Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education.
- Augenstein, Langsam and Tanenbaum. Data structures using C and C++. PHI/Pearson Education.
- Drozdek Adam. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
- Agarwal, Ajay. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

4. Web Designing and Internet Applications 2(1+1)

Theory

Basic principles in developing a web designing, Planning process, Five Golden rules of web designing, Designing navigation bar, Page design, Home Page Layout, Design Concept. Basics in Web Design, Brief History of Internet, World Wide Web , creation of a web site, Web Standards, Audience requirement. Introduction to Java Script, variables & functions, Working with alert, confirm and prompt, Connectivity of Web pages with databases; Project.

Practical

FLASH: Animation concept FPS, Understanding animation for web, Flash interface, Working with tools, DREAM WEAVER :Exploring Dreamweaver Interface, Planning & Setting Web Site Structure, Working with panels, Understanding and switching views, Using property inspector, Formatting text, JAVA SCRIPT: Working with alert, confirm and prompt, Understanding loop, arrays, Creating rollover image, Working with operator, GIF ANIMATION: Learning to use FTP,

Setting FTP, Uploading of site, Using Control panel, FTP UPLOADING SITE: Understanding gif animation interface, Knowing GIf file format, Creating basic web banners, Creating web banners with effects, Creating animated web buttons.

Suggested Readings

- Jennifer Niederst Robbins. Developing web design latest edition.
- Frain and Ben. Responsive Web Design with HTML5..
- Nicholas c.Zakas. Java Script for Web Developers.
- George Q. Huang, K. L Mak. Internet Applications in Product Design and Manufacturing. ISBN:3540434658.

B) Applied Sciences 31(20+11)

1. Principles of Agronomy 3(2+1)

Theory

Introduction and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. Principles of tillage, tilth and its characteristics. Crop seasons. Methods, time and depth of sowing of major field crops. Methods and time of application of manures and fertilizers. Organic farming-Sustainable agriculture. Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation, weeds and their control, crop rotation, cropping systems, Relay cropping and mixed cropping.

Practical

Identification of crops and their varieties, seeds, manures, fertilizers and weeds; Fertilizer application methods; Different weed control methods; Practice of ploughing, Practice of Puddling, Practice of sowing.

Suggested Readings

- William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
- Arnon L. 1972. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.
- Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
- Gupta O P. 1984. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.
- Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
- Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers Ludhiana.

2. Principles of Soil Science 3(2+1)

Theory

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders; important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their

composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acidic, saline and sodic soils; quality or irrigation water; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. Use of saline and sodic water for crop production, Gypsum requirement for reclamation of sodic soils and neutralising RSC; Liquid fertilisers and their solubility and compatibility.

Practical

Identification of rocks and minerals; Examination of soil profile in the field; Collection of Soil Sample; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Determination of Nitrogen, Determination of Phosphorus and Determination of Potassium; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Determination of water quality parameters.

Suggested Readings

- Brady Nyle C and Ray R Well. 2002. Nature and properties of soils. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi.
- Sehgal J.. A. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
- Hillel D. 1982. Introduction to Soil Physics. Academic Press, London.

3. Principles of Horticultural Crops and Plant Protection 2(1+1)

Theory

Scope of horticultural. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/hybrids, sowing and planting times and methods, seed rate and seed treatment for vegetable crops; macro and micro propagation methods, plant growing structures, pruning and training, crop coefficients, water requirements and critical stages, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture crops.

Practical

Judging maturity time for harvesting of crop; Study of seed viability and germination test; Identification and description of important fruits, flowers and vegetable crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops, visit to commercial greenhouse/ polyhouse; cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); seed extraction techniques; identification of important pests and diseases and their control.

Suggested Readings

- Bansal. P.C. 2008. Horticulture in India. CBS Publishers and Distributors, New Delhi.

- Saraswathy, S., T.L. Preethi, S. Balasubramanyan, J. Suresh, N. Revathy and S. Natarajan. 2007. Postharvest management of Horticultural Crops. Agrobios Publishers, Jodhpur.
- Arjunan, G., Karthikeyan, G, Dinakaran, D. and Raguchander, T. 1999. Diseases of Horticultural Crops. AE Publications, Coimbatore.
- Sharma Neeta and Mashkoor Alam. 1997. Postharvest diseases of Horticultural crops. International Book publishing Co. UP.

4. Engineering Physics 3(2+1)

Theory

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de-Broglie concept, uncertainty principle. Wave function. Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function. Bands iii solids, velocity of Bloch's electron and effective mass. Distinction between metals. insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect. Isotope effect. Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high T_c superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients. Population inversion, He-Ne and Ruby lasers. Ammonia and Ruby masers, Holography-Note. Optical fiber. Physical structure. basic theory. Mode type, input output characteristics of optical fiber and applications. Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

Practical

To find the frequency of A.C. supply using an electrical vibrator; To find the low resistance using Carey Foster bridge without calibrating the bridge wire; To determine dielectric constant of material using De Sauty's bridge; To determine the value of specific charge (e/m) for electrons by helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil; To determine the energy band gap in a semiconductor using a p-n Junction diode; To determine the slit width from Fraunhofer diffraction pattern using laser beam; To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo emf of a copper-constantan thermo-couple with temperature; To find the wave length of light by prism.

Suggested Readings

- Brijlal and Subrahmanyam. Text Book of optics. S. Chand and Co., New Delhi.
- Sarkar Subir Kumar. Optical State Physics and Fiber Optics. S. Chand and Co., New Delhi.
- Gupta S L, Kumar V Sharma R C. Elements of Spectroscopy. Pragati Prakasam, Meeruth.

- Saxena B S and Gupta R C. Solid State Physics. Pragati Prakasam, Meeruth.
- Srivastava B N. Essentials of Quantum Mechanics. Pragati Prakasam, Meeruth.
- Vasudeva D N. Fundamentals of Magnetism and Electricity. S. Chand and Co., New Delhi.

5. Engineering Chemistry 3(2+1)

Theory

Phase rule and its application to one and two component systems. Fuels: classification. calorific value. Colloids: classification. properties. Corrosion: causes. types and method of prevention. Water: temporary and permanent hardness. disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion. Analytical methods like thermo-gravimetric. polarographic analysis. nuclear radiation. detectors and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Principles of food chemistry. Introduction to lipids, proteins, carbohydrates, vitamins, food preseltators, colouring and flavouring reagents of food. Lubricants: properties. mechanism. classification and tests. Polymers. types of polymerization. properties. uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy.

Practical

Determination of temporary and permanent hardness of water by EDTA method: Estimation of chloride in water: Estimation of dissolved oxygen in water: Determination of BOD in water sample: Determination of COD in water sample: Estimation of available chlorine in bleaching powder: Determination of viscosity of oil: Estimation of activity of water sample: Estimation of alkalinity of water sample: Determination of carbonate and non- carbonate hardness by soda reagent: Determination of coagulation of water and chloride ion content: Determination of specific rotation of an optically active compound: Determination of Xnax and verification of Beer Lambert Law: Determination of calorific value of fuel: Identification of functional groups (alcohol, aldelyde, ketones, carboxylic acid and amide) by IR: Chromatographic analysis: Determination of molar refraction of organic compounds.

Suggested Readings

- Jain P L and Jain M. 1994. Engineering Chemistry. Danpat Rai publishing company Pvt. Ltd., Delhi.
- Bahl B S, Arun Bahl and Tuli B D. 2007. Essentials of Physical Chemistry. S. Chand and Co. Ltd., Delhi.

6. Engineering Mathematics – I 3(2+1)

Theory

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelon form, Solution of linear equations, nature of rank, using Cayley-Hamilton theorem to find inverse of A. Differential calculus: Taylor's and Maclaurin's expansions; indeterminate form; curvature, function of two or more independent variables,

partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, maxima and minima. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume. Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Stoke's, divergence and Green's theorems (without proofs).

Practical

Tutorials on rank of a matrix, reduction to normal form, consistency and solution of linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms; Taylor's and Maclaurin's expansion, indeterminate form, curvature, tracing of curves, partial differentiation, maxima and minima, volume and surface of revolution, multiple integrals, Beta and Gama functions, differentiation of vectors, gradient, divergence and curl of a vector point function, line, surface and volume integrals, Stoke's divergence and Green's Theorems.

Suggested Readings

- Narayan Shanti. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
- Narayan Shanti. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
- Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
- Narayan Shanti. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.

7. Engineering Mathematics – II 3(2+1)

Theory

Ordinary differential equations: Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, Differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations. Functions of a Complex variable: Limit, continuity and analytic function, Cauchy-Riemann equations, Harmonic functions. Infinite series and its convergence, periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, Harmonic analysis. Fourier Sine and Cosine Series, Fourier series for function having period 2L, Elimination of one and two arbitrary function. Partial differential equations: Formation of partial differential equations Higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, Laplace Equation.

Practical

Tutorials on solution of ordinary differential equations of first and higher orders. Series solutions of differential equations. Bessel's and Legendre's differential equations, Convergence of infinite series. Fourier series, harmonic analysis, analytical functions, Cauchey-Riemann

equations, harmonic functions, Solution of partial differential equations, Application of partial differential equations.

Suggested Readings

- Narayan Shanti. 2004. A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi.
- Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
- Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi.

8. Engineering Mathematics – III 3(2+1)

Theory

Numerical analysis and Laplace transformation: finite difference, various difference operators and their relationships. factorial notation, interpolation with equal integrals. Newton's forward and backward interpolation formula. Bessel's and Stirling's difference interpolation formulae. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula. numerical differentiations, numerical integrations, difference equations and their solutions, numerical solutions of ordinary differential equations by Picard's Taylor's series. Fuller's and modified Fuller's methods. Runga-Kutta method; Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations. Testing of Hypothesis-Level of Significance-Degrees of freedom-Statistical errors, Large sample test (Z-test), Small sample test t-test (One tailed, two tailed and Paired tests), Testing of Significance through variance (F-test), Chi -Square test, contingency table, Correlation, Regression.

Practical

Interpolation, Numerical differentiation and integration solutions of difference equations, numerical solution of ordinary differential equations of first order and first degree, Laplace and inverse Laplace transformations and their application to solution of ordinary and simultaneous differential equations. Problems on One Sample, Two sample Z-tests when Population S.D. is known and unknown, Problems on one sample, Two sample and paired t-test Chi-Square test – 2x2 and m x n, Calculation of Correlation coefficient and its testing, Contingency Table and F-test.

Suggested Readings

- Chandel SRS. A Hand book of Agricultural Statistics. Achal Praskasam Masndir, Kanpur.
- Agrawal B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
- Nageswara Rao G. Statistics for Agricultural Sciences. BS Publications.
- Rangaswamy R. A Text Book of Agricultural Statistics. New Age Int. publications Ltd.
- Gupta S.C. Fundamental Applied Statistics.

9. Communication Skills and Personality Development 2(1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing,

abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations.

Suggested Readings

- Balasubramanian T. 1989. A Text book of Phonetics for Indian Students. Orient Longman, New Delhi.
- Balasubrmanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
- Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
- Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
- Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
- Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
- Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.

10. Entrepreneurship Development and Business Management 3(2+1)

Theory

Entrepreneurship, management – Management functions – planning- Organizing -Directing – motivation – ordering – leading – supervision-Communication and control – Capital – Financial management – importance of financial statements – balance sheet – profit and loss statement, Analysis of financial statements – liquidity ratios – leverage ratios, Coverage ratios – turnover ratios – profitability ratios, Agro-based industries – Project – project cycle – Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay, Discounted measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio) – sensitivity analysis-Importance of agribusiness in Indian economy International trade-WTO agreements – Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Development (ED): Concept of entrepreneur and entrepreneurship Assessing overall business environment in Indian economy– Entrepreneurial and managerial characteristics- Entrepreneurship development Programmes (EDP)- Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment- Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs- Economic

system and its implications for decision making by individual entrepreneurs- Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract farming (CF) and joint ventures (JV), public-private partnerships (PPP)- Overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

Practical

Preparation of business – Strengths Weaknesses Opportunities and Threats (SWOT) analysis, Analysis of financial statements (Balance Sheet, Profit loss statement). Compounding and discounting, Break-even analysis Visit to agro-based industries – I, Visit to agro-based industries – II Study of Agro-industries Development Corporation , Ratio analysis – I, Ratio analysis – II, Application of project appraisal technique – I(Undiscounted measures), Application of project appraisal technique – II(Discounted Measures), Formulation of project feasibility reports – Farm Machinery Project proposals as entrepreneur – individual and group - Presentation of project proposals in the class.

Suggested Readings

- Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981. Management of the Farm Business. Prentice Hall Inc., New Jersey.
- Joseph, L. Massie. 1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi.
- Omri Rawlins, N. 1980. Introduction to Agribusiness. Prentice Hall Inc., New Jersey
- Gittenger Price, J. 1989. Economic Analysis of Agricultural Projects. John Hopkins University, Press, London.
- Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall, New Jersey.
- Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover, New Jersey.
- Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
- Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.

11. Environmental Science and Disaster Management 3(2+1)

Theory

Environmental Studies:Scope and importance. Natural Resources: Renewable and non-renewable resources Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation

of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management: Natural Disasters and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters-Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Case Studies and Field work. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Expected impact of climate change on agricultural production and water resources, Mitigation Strategies, Economics of climate change. Disaster Management introduction, Natural and Manmade Disaster Studies, Informatics for Disaster Management, Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.

Suggested Readings

- Bharucha Erach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants Commission, University Press, Hyderabad.
- Sharma J P. 2003. Introduction to Environment Science. Lakshmi Publications.
- Chary Manohar and Jaya Ram Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad.
- Kaul S N, Ashuthosh Gautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.
- Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air. Agro bios, Jodhpur.
- Climate change.1995: Adaptation and mitigation of climate change-Scientific Technical Analysis Cambridge University Press, Cambridge.
- Sharma, R.K. & Sharma, G. 2005. Natural Disaster. APH Publishing Corporation, New Delhi.
- Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. online book.

II. Department of Soil and Water Conservation Engineering 10(6+4)

1. Watershed Hydrology 2(1+1)

Theory

Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequency analysis of point rainfall. Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship. Hydrologic processes-Interception, infiltration -factors influencing, measurement and indices. Evaporation - Estimation and measurement. Runoff - Factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method. Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency. Hydrograph - Components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations. Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing – channel and reservoir routing. Drought – classification, causes and impacts, drought management strategy.

Practical

Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity - frequency - duration curves. Exercise on depth - area - duration and double mass curves. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments - current meter and stage level recorder. Exercise on geomorphic parameters of watersheds. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

Suggested Readings

- Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.
- Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.
- Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
- Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
- Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
- Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
- Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi.
- Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

2. Soil and Water Conservation Engineering 3(2+1)

Theory

Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI_{30} methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.

Practical

Study of different types and forms of water erosion. Exercises on computation of rainfall erosivity index. Computation of soil erodibility index in soil loss estimation. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE. Exercises on soil loss estimation/measuring techniques. Study of rainfall simulator for erosion assessment. Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor. Determination of sediment concentration through oven dry method. Design and layout of contour bunds. Design and layout of graded bunds. Design and layout of broad base terraces. Design and layout of bench terraces. Design of vegetative waterways. Exercises on rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Suggested Readings

- Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
- Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.
- Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

3. Water Harvesting and Soil Conservation Structures 3(2+1)

Theory

Water harvesting - principles, importance and issues. Water harvesting techniques - classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - terracing and bunding, rock and ground catchments. Long-term harvesting techniques - purpose and design criteria. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

Practical

Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds. Design of percolation pond and *nala* bunds. Runoff measurement using H-flume. Exercise on hydraulic jump. Exercise on energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop spillway and stability analysis. Design

of SAF stilling basins in chute spillway. Hydrologic, hydraulic and structural design of drop inlet spillway. Design of small earthen embankment structures. Practice on softwares for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation measures / structures.

Suggested Readings

- Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
- Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London.
- Studer Rima Mekdaschi and Hanspeter Liniger. 2013. Water Harvesting - Guidelines to Good Practice. Centre for Development and Environment, University of Bern, Switzerland.

4. Watershed Planning and Management 2(1+1)

Theory

Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting in a watershed. Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

Practical

Exercises on delineation of watersheds using toposheets. Surveying and preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed

investigations for planning and development. Analysis of hydrologic data for planning watershed management. Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures. Study of watershed management technologies. Practice on softwares for analysis of hydrologic parameters of watershed. Study of role of various functionaries in watershed development programmes. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.

Suggested Readings

- Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
- Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
- Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
- Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
- Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
- Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.
- Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.
- Tideman,E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.

III. Department of Irrigation and Drainage Engineering 10(6+4)

1. Irrigation Engineering 3(2+1)

Theory

Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country; measurement of irrigation water: weir, flumes and orifices and other methods; open channel water conveyance system : design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution; underground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work; soil water plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies; surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations.

Practical

Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration characteristics; determination of bulk density, field capacity and wilting point; estimation of evapotranspiration; land grading methods; design of underground pipeline system; estimation of irrigation efficiency; study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method.

Suggested Readings

- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
- Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.
- Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.
- Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
- Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.

2. Drainage Engineering 2(1+1)

Theory

Water logging- causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state; surface drainage coefficient, types of surface drainage, design of surface drains; sub-surface drainage: purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table; derivation of Hooghoudt's and Ernst's drain spacing equations; design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains; drainage structures; vertical drainage; bio-drainage; mole drains; salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

Practical

In-situ measurement of hydraulic conductivity by single auger hole and inverse auger hole method; Estimation of drainage coefficients; installation of piezometer and observation wells; preparation of iso-bath and isobar maps; determination of drainable porosity; design of surface drainage systems; design of gravel envelop; design of subsurface drainage systems; determination of chemical properties of soil and water; study of drainage tiles and pipes; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.

Suggested Readings

- Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles , Methods and Applications. Vikas Publication House, Noida (UP).

- Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised).
- Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.
- Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage-Principles and Practices, Westville Publishing House.
- FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

3. Groundwater, Wells and Pumps 3(2+1)

Theory

Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

Practical

Verification of Darcy's Law; study of different drilling equipments; sieve analysis for gravel and well screens design; estimation of specific yield and specific retention; testing of well screen; estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method; Theis Recovery method; well design under confined and unconfined conditions; well losses and well efficiency; estimating ground water balance; study of artificial ground water recharge structures; study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps; installation of centrifugal pump; testing of centrifugal pump and study of cavitations; study of hydraulic ram; study and testing of submersible pump.

Suggested Readings

- Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill.
- Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).
- Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.

4. Sprinkler and Micro irrigation Systems 2(1+1)

Theory

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;

Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system; study of different components of drip irrigation; design and installation of drip irrigation system; determination of pressure discharge relationship and emission uniformity for given emitter; study of different types of filters and determination of filtration efficiency; determination of rate of injection and calibration for chemigation/fertigation; design of irrigation and fertigation schedule for crops; field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.

Suggested Readings

- Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .
- Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.
- Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.
- Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.
- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.
- Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.

IV. Department of Farm Machinery and Power Engineering 14(8+6)

1. Farm Machinery and Equipment-I 3(2+1)

Theory

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills. Introduction to planters, bed-planters and other planting equipment. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.

Practical

Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements. Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments. Study of transplanters – paddy, vegetable, etc. Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.

Suggested Readings

- Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
- Smith HP and LH Wilkey. Farm Machinery and Equipment.
- Culpin Claude. Farm Machinery.
- Srivastava AC. Elements of Farm Machinery.
- Lal Radhey and AC Datta. Agricultural Engineering.

2. Farm Machinery and Equipment-II 3(2+1)

Theory

Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application

rates. Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment. Study of harvesting operation – harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical

Familiarization with plant protection and interculture equipment. Study of sprayers, types, functional components. Study of dusters, types and functional components. Calculations for chemical application rates. Study of nozzle types and spread pattern using patternator. Familiarization with manual and powered weeding equipment and identification of functional components. Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters. Study of various types of mowers, reaper, reaper binder. Study of functional components of mowers and reapers. Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers. Familiarization with functional units of Grain combines and their types. Calculations for grain losses in a combine. Study of root crop diggers and familiarization with the functional units and attachments. Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.

Suggested Readings

- Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
- Smith HP and LH Wilkey. Farm Machinery and Equipment.
- Culpin Claude. Farm Machinery.
- Srivastava AC. Elements of Farm Machinery.
- Lal Radhey and AC Datta. Agricultural Engineering Principles of Farm Machinery.

3. Tractor and Automotive Engines 3(2+1)

Theory

Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI)

engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions. Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system. Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines. Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing – need of governors, governor types and governor characteristics. Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing

Practical

Introduction to different systems of CI engines; Engine parts and functions, working principles etc. Valve system – study, construction and adjustments; Oil & Fuel – determination of physical properties; Air cleaning system; Fuel supply system of SI engine; Diesel injection system & timing; Cooling system, and fan performance, thermostat and radiator performance evaluation; Part load efficiencies & governing; Lubricating system & adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.

Suggested Readings

- Liljedahl J B and Others. Tractors and Their Power Units.
- Rodichev V and G Rodicheva. Tractors and Automobiles.
- Mathur ML and RP Sharma. A course in Internal Combustion Engines.
- Singh Kirpal. Automobile Engineering – Vol II.
- Heitner Joseph. Automotive Mechanics : Principles and Practices.

4. Tractor Systems and Controls 3(2+1)

Theory

Study of need for transmission system in a tractor. Transmission system – types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio. Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive.

Study of Brake system – types, principle of operation, construction, calculation for braking torque. Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC. Study of tractor power outlets – PTO. PTO standards, types and functional requirements. Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device. Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids. Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing. Deciphering the engine test codes.

Practical

Introduction to transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trainer and some design problems; Appraisal of various controls in different makes tractors in relation to anthropometric measurements. Determination of location of CG of a tractor, Moment of Inertia of a tractor. Traction performance of a traction wheel.

Suggested Readings

- Liljedahl J B and Others. Tractors and Their Power Units.
- Rodichev V and G Rodicheva. Tractors and Automobiles.
- Singh Kirpal. Automobile Engineering – Vol I.
- Heitner Joseph. Automotive Mechanics: Principles and Practices.
- C.B.Richey. Agricultural Engineering Handbook.
- John Deere. Fundamentals of Service Hydraulics.
- Relevant BIS Test Codes for Tractors.

5. Tractor and Farm Machinery Operation and Maintenance 2(0+2)

Practical

Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement. Hitching & De-hitching of mounted and trail type implement to the tractor. Driving practice with a trail type trolley – forward and in reverse direction. Introduction to tractor

maintenance – precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of agricultural machinery workshop.

Suggested Readings

- Ghosh RK and S Swan. Practical Agricultural Engineering.
- Black PO and WE Scahill. Diesel Engine Manual.
- Southorn N. Tractor operation and maintenance.
- Jain SC and CR Rai. Farm Tractor Maintenance and Repair.
- Operators manuals of tractors.
- Service manuals provided by manufacturers.

V. Department of Processing and Food Engineering 13(8+5)

1. Engineering Properties of Agricultural Produce 2(1+1)

Theory

Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures

Practical

Determination of the shape and size of grains, fruits and vegetables, Determination of bulk density and angle of repose of grains, Determination of the particle density/true density and porosity of solid grains, Finding the co-efficient of external and internal friction of different crops, Finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel, Finding the thermal conductivity of different grains, Determination of specific heat

of some food grains, Determination of hardness of food material and determination of viscosity of liquid foods.

Suggested Readings

- Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science
- Publishers , New York.
- Mohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York.
- Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.
- Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.
- Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.

2. Agricultural Structures and Environmental Control 3(2+1)

Theory

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods, Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds. Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing.

Practical

Measurements for environmental parameters and cooling load of a farm building, Design and layout of a dairy farm, Design and layout of a poultry house, Design and layout of a goat house/ sheep house, Design of a farm fencing system, Design of a feed/fodder storage structures, Design of grain storage structures, Design and layout of commercial bag and bulk storage facilities, Study and performance evaluation of different domestic storage structure, Estimation of a Farm building.

Suggested Readings

- Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
- Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
- Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.
- Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
- Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.
- Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.
- Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi.
- Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.
- Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi.

3. Post Harvest Engineering of Cereals, Pulses and Oil Seeds 3(2+1)

Theory

Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.

Practical

Performance evaluation of different types of cleaners and separators, Determination of separation efficiency, Study of different size reduction machines and performance evaluation, Determination of fineness modulus and uniformity index, Study of different types of conveying and elevating equipments, Study of different types of mixers. Measurement of moisture content: dry basis and wet basis, Study on drying characteristics of grains and determination of drying constant, Determination of EMC (Static and dynamic method), Study of various types of dryers, Study of different equipments in rice mills and their performance evaluation, Study of different equipments in pulse mills and their performance evaluation, Study of different equipments in oil mills and their performance evaluation, Type of process flow charts with examples relating to processing of cereals pulses and oil seeds, Visit to grain processing industries.

Suggested Readings

- Chakraverty, A. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
- Dash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
- Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.
- Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi
- Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
- Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London
- McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill.
- Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.

4. Post Harvest Engineering of Horticultural Crops 2(1+1)

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration,

Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers, Quality control in fruit and vegetable processing industry. Food supply chain.

Practical

Performance evaluation of peeler and slicer, Performance evaluation of juicer and pulper, Performance evaluation of blanching equipment, Testing adequacy of blanching, Study of cold storage and its design, Study of CAP and MAP storage, Minimal processing of vegetables, Preparation of value added products, Visit to fruit and vegetable processing industry, Visit to spice processing plant.

Suggested Readings

- Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.
- Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.
- Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad.
- Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New india Publishing House.

5. Dairy and Food Engineering 3(2+1)

Theory

Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Nanotechnology: History, fundamental concepts, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology. Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow charts for product manufacture, Unit operation of various dairy and food processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, *paneer*, butter and ice cream, Filling and packaging of milk and milk products; Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression, Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze

drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Non-thermal and other alternate thermal processing in Food processing.

Practical

Study of pasteurizers, Study of sterilizers, Study of homogenizers, Study of separators, Study of butter churns, Study of evaporators, Study of milk dryers, Study of freezers, Study of filtration, Design of food processing plants & preparation of layout, Visit to multi-product dairy plant, Estimation of steam requirements, Estimation of refrigeration requirements in dairy & food plant, Visit to Food industry.

Suggested Readings

- Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.
- McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
- Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.
- Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
- Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.

VI. Department of Renewable Energy Engineering 9(6+3)

1. Fundamentals of Renewable Energy Sources 3(2+1)

Theory

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Practical

Study of different types of solar cookers, solar water heating system, natural convection solar dryer, forced convection solar dryer, solar desalination unit, solar greenhouse for agriculture production, biogas plants, biomass gasifiers, biomass improved cook-stoves, solar photovoltaic system.

Suggested Readings

- Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
- Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
- Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
- Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications.
- Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
- Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

2. Renewable Power Sources 3(2+1)

Theory

Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant. Solar thermal and photovoltaic Systems for power generation. Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification & Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters.

Practical

Performance evaluation of solar water heater; Performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of biomass gasifier engine system (throatless & downdraft), Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of biogas & producer gas; Testing of diesel engine operation using dual fuel and gas alone.

Suggested Readings

- Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.
- Alan L: Farredbruch & R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.
- Bansal N.K., Kleemann M. & Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.
- Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications.
- Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.
- Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology.
- Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
- Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

3. Bio-Energy Systems: Design and Applications 3(2+1)

Theory

Fermentation processes and its general requirements, An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying). Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics. Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Practical

Study of anaerobic fermentation system for industrial application, Study of gasification for industrial process heat, Study of biodiesel production unit, Study of biomass densification technique (briquetting, pelletization, and cubing), Integral bio energy system for industrial application, Study of bio energy efficiency in industry and commercial buildings, Study and demonstration of energy efficiency in building, Measuring efficiency of different insulation technique, Study of Brayton, Striling and Rankine cycles, Study of modern greenhouse technologies.

Suggested Readings

- British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.
- Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.
- Centre for biomass energy. 1998. Straw for energy production; Technology- Environment-Ecology. Available: www.ens.dk.

ELECTIVE COURSES

Each Institute will have option to offer 3 (three) need based elective courses equivalent to 9 Credit Hours as per the need of the state/industries/other stake holders under the proposed list of Elective Courses.

1. Floods and Control Measures 3(2+1)

Theory

Floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum

method, reservoir routing, modified Pul's method. Flood control - history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement. Gully erosion and its control structures - design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc., stability of slopes - analysis of failure by different methods. Subsurface dams - site selection and constructional features. Check dam - Small earthen embankments - types and design criteria. Subsurface dams - site selection and constructional features.

Practical

Determination of flood stage-discharge relationship in a watershed. Determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution. Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution. Determination of probable maximum flood, standard project flood and spillway design flood. Design of levees for flood control. Design of jetties. Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost- benefit analysis of a flood control project. Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition etc. Stability of slopes of earth dams by friction circle and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods. Determination of settlement of earth dam. Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.

Suggested Readings

- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
- Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
- Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA.
- Arora, K.R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.

- Garg, S.K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi.
- Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

2. Wasteland Development 3(2+1)

Theory

Land degradation – concept, classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands. Wastelands - factors causing, classification and mapping of wastelands, planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans. Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods. Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints. Shifting cultivation, optimal land use options. Wasteland development – hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands. Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management. Micro-irrigation in wastelands development. Sustainable wasteland development - drought situations, socio-economic perspectives. Government policies. Participatory approach. Preparation of proposal for wasteland development and benefit-cost analysis.

Practical

Mapping and classification of wastelands. Identification of factors causing wastelands. Estimation of vegetation density and classification. Planning and design of engineering measures for reclamation of wastelands. Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions. Planning and design of micro-irrigation in wasteland development. Cost estimation of the above measures / structures. Visit to wasteland development project sites.

Suggested Readings

- Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.
- Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.
- Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.
- Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
- Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.

- Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.
- Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.
- The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.
- Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.

3. Information Technology for Land and Water Management 3(2+1)

Theory

Concept of Information Technology (IT) and its application potential. Role of IT in natural resources management. Existing system of information generation and organizations involved in the field of land and water management. Application and production of multimedia. Internet application tools and web technology. Networking system of information. Problems and prospects of new information and communication technology. Development of database concept for effective natural resources management. Application of remote sensing, geographic information system (GIS) and GPS. Rational data base management system. Object oriented approaches. Information system, decision support systems and expert systems. Agricultural information management systems - use of mathematical models and programmes. Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information.

Practical

Multimedia production. Internet applications: E-mail, voice mail, web tools and technologies. Handling and maintenance of new information technologies and exploiting their potentials. Exercises on database management using database and spreadsheet programmes. Usage of remote sensing, GIS and GPS survey in information generation and processing. Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc. Exercises on simple decision support and expert systems for management of natural resources. Multimedia production using different softwares. Exercises on development of information system on selected theme(s). Video-conferencing of scientific information.

Suggested Readings

- Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome.
- Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.
- Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.
- FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.

- Fuling Bian and Yichun Xie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.
- ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.
- Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York.
- Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi.
- Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi.

4. Remote Sensing and GIS Applications 3(2+1)

Theory

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; use of software for image interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study of various features of GIS software package; scanning, digitization of maps and data editing; data base query and map algebra. GIS supported case studies in water resources management.

Suggested Readings

- Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.

- Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
- George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
- Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
- Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
- Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
- Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
- Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

5. Management of Canal Irrigation System 3(2+1)

Theory

Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment; canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation, Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting duty and method of improving duty; silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory, maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials; design of lined canals; functions of distributary head and cross regulators; canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet.

Practical

Estimation of water requirement of canal commands; determination of canal capacity; layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and partial banking; determination of longitudinal section of canals; design of irrigation canals based on silt theories; design of lined canals; formulation of warabandhi; Study of canal outlets, regulators, escapes and canal falls.

Suggested Readings

- Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
- Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

- Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

6. Minor Irrigation and Command Area Development 3(2+1)

Theory

Factors affecting performance of irrigation projects; types of minor irrigation systems in India; lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; tank Irrigation: grouping of tanks, storage capacity, supply works and sluices; command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities-functions and responsibilities; on farm development works, reclamation works, use of remote sensing techniques for CAD works; water productivity: concepts and measures for enhancing water productivity; Farmers' participation in command area development;

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops; Preparation of irrigation schedules; Planning and layout of water conveyance system; design of surplus weir of tanks; determination of storage capacity of tanks; design of intake pipe and pump house.

Suggested Readings

- Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
- Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.
- Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

7. Precision Farming Techniques for Protected Cultivation 3(2+1)

Theory

Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment, Design and construction of green houses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc. Greenhouse heating – necessity, components, methods, design of heating system. Root media – types – soil and soil less media, composition, estimation, preparation and disinfection,

bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post harvest techniques; Economic analysis.

Practical

Estimation of material requirement for construction of greenhouse ; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques ; Design and installation of irrigation system; Design and installation of fogging system ; Greenhouse heating; Study of different greenhouse environment control instruments; Study of operation maintenance and fault detection in irrigation system; Study of operation maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Suggested Readings

- Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
- Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

8.Water Quality and Management Measures 3(2+1)

Theory

Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria, point and non-point water pollution sources, water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures, water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

Practical

Water quality analysis and classification according to USSL and AICRP criteria; soil chemical analysis and estimation of lime and gypsum requirements; study of salinity development under shallow and deep water table conditions; study of contamination movement and transport in soil profile; study of different water decontamination techniques; study of different cultural and management practices for using poor quality water for irrigation; field visit to industrial effluent disposal sites.

Suggested Readings

- FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55.
- Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
- Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
- Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
- McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.
- Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.
- Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.

9. Landscape Irrigation Design and Management 3(2+1)

Theory

Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems, types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical

Study of irrigation equipments for landscapes; Design and installation of irrigation system for landscape, determination of water requirement. Determination of power requirement, pump selection. Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments, Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc., Visit to landscape irrigation system and its evaluation.

Suggested Readings

- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.
- Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore.
- Smith Stepehen W. Landscape Irrigation and Management. Amazon. com.

10. Plastic Applications in Agriculture 3(2+1)

Theory

Introduction of plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status

and future prospective of plasticulture in India. Water management - use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Drip and sprinkler irrigation systems. Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation. Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers. Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products. Plastic cap covers for storage of food grains in open. Use of plastics as alternate material for manufacturing farm equipment and machinery. Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Silage film technique for fodder preservation. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticutlure applications.

Practical

Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds. Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Study of components of subsurface drainage system. Study of different colour plastic mulch laying. Design, estimation and installation of green, poly and shade net houses, low tunnels etc. Study on cap covers for food grain storage, innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP and estimation. Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation. Study of plastic parts in making farm machinery. Visits to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shadehouse/ nethouse etc. Visits to farmers' fields with these installations.

Suggested Readings

- **Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014.**Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
- Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.
- Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.
- Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
- Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.
- Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.
- Ojha,T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.
- Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.

- Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri-Horticulture Systems, 241-247.
- Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

11. Mechanics of Tillage and Traction 3(2+1)

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and application of GIS in soil dynamics.

Practical

Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Suggested Readings

- Vandenberg and Gill. Tillage and Traction.
- Liljedahl JB and others. Tractor and Power Units.
- Daniel Hill. Fundamentals of Soil Physics.
- Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.

12. Farm Machinery Design and Production 3(2+1)

Theory

Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits & Tolerances, Jigs & Fixtures. Industrial lay-out planning, Quality production management. Reliability. Economics of process selection. Familiarization with Project Report.

Practical

Familiarization with different design aspects of farm machinery and selected components. Solving design problems on farm machines & equipment Visit to Agricultural machinery manufacturing industry, Tractor manufacturing industry Jigs and Fixtures study in relation to

agricultural machinery. Fits, tolerances and limits; Layout planning of a small scale industry; Problems on Economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

Suggested Readings

- Richey, C.B. Agricultural Engineering Handbook.
- Adinath M and AB Gupta. Manufacturing Technology.
- Sharma PC and DK Aggarwal. Machine Design.
- Narula V. Manufacturing process.
- Singh S. Mechanical Engineer's Handbook.
- Chakrabarti NR. Data book for Machine Design.

13. Human Engineering and Safety 3(2+1)

Theory

Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view. Use of Heart Rate Monitor. Study of general fatigue of the subject using Blink ratio method, Familiarization with electro-myograph equipment, anthropometric measurements of a selected subjects. Optimum work space layout and locations of controls for different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.

Suggested Readings

- Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
- Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
- Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
- Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
- Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
- Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal;72:50~5.

- Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.

14. Tractor Design and Testing 3(2+1)

Theory

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, traction theory, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman Steering and tractor hydraulic steering. Study of special design features of tractor engines and their selection viz. cylinder, piston, piston pin, crankshaft, etc. Design of seat and controls of an agricultural tractor. Tractor Testing.

Practical

Design problem of tractor clutch – (Single/ Multiple disc clutch). Design of gear box(synchromesh/constant mesh), variable speed constant mesh drive; Selection of tractor tires – Problem solving. Problem on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/ industry.

Suggested Readings

- Liljedahl J B & Others. Tractors and Their Power Units.
- Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.
- Maleev VL. Internal Combustion Engines.
- Kirpal Singh. Automobile Engineering – Vol I and Vol II.
- Richey C.B. Agricultural Engineering Handbook.
- Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.

15. Hydraulic Drives and Controls 3(2+1)

Theory

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, operation, performance, Displacement, Design ofGear Pumps, Vane Pumps, Piston Pumps. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting of Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

Practical

Introduction to hydraulic systems. Study of hydraulic pumps, hydraulic actuators. Study of hydraulic motors, hydraulic valves, colour codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.

Suggested Readings

- Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
- Anthony E. Fluid Power and Applications.
- Majumdar. Oil Hydraulic System.
- Merit. Hydraulic Control Systems.
- John Deere. Fundamentals of Service Hydraulics.

16. Precision Agriculture and System Management 3(2+1)

Theory

Precision Agriculture – need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, straw-chopper, straw-balers, grain combines, etc. Introduction to GIS based precision agriculture and its applications. Introduction to sensors and application of sensors for data generation. Database management. System concept. System approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management

Practical

Familiarization with precision agriculture problems and issues. Familiarization with various machines for resource conservation. Solving problems related to various capacities, pattern efficiency, system limitation, etc. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

Suggested Readings

- Kuhar J E. The Precision Farming Guide for Agriculturist.
- Dutta SK. Soil Conservation and land management.
- Sigma and Jagmohan. Earth Moving Machinery.
- Wood and Stuart. Earth Moving Machinery.
- DeMess MN. Fundamentals of Geographic Information System.
- Hunt Donnell. Farm Power and Machinery Management.
- Sharma DN and S Mukesh. Farm Power and Machinery Management Vol I.

17. Food Quality and Control 3(2+1)

Theory

Basics of Food Science and Food Analysis, Concept, objectives and need of food quality. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food

quality and composition. Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials, Quality control, Quality control tools, Statistical quality control, Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Instrumental method for testing quality. Food adulteration and food safety. TQM and TQC, consumer preferences and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point), Sanitation in food industry (SSOP), Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. CAC (Codex Alimantarious Commission),Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism.

Practical

Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications, Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards, Detection of adulteration and examination of spices for AGMARK and BIS standards, Detection of adulteration and examination of milk and milk products for BIS standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

Suggested Readings

- Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products.
- Srilakshmi B, Food Science.
- Sharma Avanthi. A text book of Food Science and Technology.
- Mudambi Sumati R, Rao Shalini M and Rajagopal M.V. Food Science.
- Potter NN and Hotchkiss JH, Food Science.
- Dev Raj, Rakesh Sharma and Joshi V.K, Quality for Value Addition in Food Processing.
- The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.

18. Food Plant Design and Management 3(2+1)

Theory

Food plant location, selection criteria, Selection of processes, plant capacity, Requirements of plant building and its components, Project design, flow diagrams, selection of equipment, process and controls, Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Introduction to Finance, Food Product Marketing, Food Business Analysis and Strategic Planning, Introduction to Marketing, Food Marketing Management, Supply chain management for retail food products, Entrepreneurship development in food industry, SWOT analysis, generation, incubation and commercialization of ideas and innovations, New product development process, Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies

relevant to food processing sector, procedure of obtaining license and registration under FSSAI, Cost analysis and preparation of feasibility report.

Practical

Preparation of project report, Preparation of feasibility report, Salient features and layout of pre processing house, Salient features and layout of Milk and Milk product plants, Evaluation of given layout, Salient features, design and layout of modern rice mill, Salient features, design and layout of Bakery and related product plant, Study of different types of records relating to production of a food plant, Study of different types of records relating to finance of a food plant, Study of different types of records relating to marketing of a food business, Brain storming and SWOT analysis to start a food processing business.

Suggested Readings

- Hall, H.S. and Rosen, Y.S. Milk Plant Layout. FAO Publication, Rome.
- López Antonio. Gómez. Food Plant Design.
- Robberts Theunis C. Food plant engineering systems by, CRC Press, Washington.
- Maroulis Z B and Saravacos G D. Food plant economics. Taylor and Francis, LLC
- Mahajan M. Operations Research. Dhanpat Rai and Company Private Limited, Delhi
- Maroulis Z B. Food Process Design. Marcel Dekker, Inc ,Cimarron Road, Monticello, New York 12701, USA.

19. Food Packaging Technology 3(2+1)

Theory

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations, Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems, Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials, Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination, Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply

bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

Practical

Identification of different types of packaging materials, Determination of tensile/ compressive strength of given material/package, To perform different destructive and non-destructive tests for glass containers, Vacuum packaging of agricultural produces, Determination of tearing strength of paper board, Measurement of thickness of packaging materials, To perform grease-resistance test in plastic pouches, Determination of bursting strength of packaging material, Determination of water-vapour transmission rate, Shrink wrapping of various horticultural produce, Testing of chemical resistance of packaging materials, Determination of drop test of food package and visit to relevant industries.

Suggested Readings

- Coles, R., McDowell, D., Kirwan, M .J. 2003. Food Packaging Technology. Blackwell Publishing Co.
- Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication
- John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House,
- Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill
- Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
- Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.

20. Development of Processed Products 3(2+1)

Theory

Process design, Process flow chart with mass and energy balance, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds, Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from fruits, vegetables and spices, Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, spice extracts, Technology for animal produce processing , meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food.

Practical

Process design and process flow chart preparation, preparation of different value added products, Visit to roller wheat flour milling, rice milling, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plants & study of operations and machinery, Process flow diagram and study of various models of the machines used in a sugar mill.

Suggested Readings

- Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
- Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.
- Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.
- Acharya, K T Everyday Indian Processed foods. National Book Trust.
- Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers.
- Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal technology. Kalyani Pub.

21. Process Equipment Design 3(2+1)

Theory

Introduction on process equipment design, Application of design engineering for processing equipments, Design parameters and general design procedure, Material specification, Types of material for process equipments, Design codes, Pressure vessel design, Design of cleaners. Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger, Design of belt conveyer, screw conveyer and bucket elevator, Design of dryers. Design of milling equipments. Optimization of design with respect to process efficiency, energy and cost, Computer Aided Design.

Practical

Design of pressure vessel, cleaners, milling equipments, tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger, dryer, belt conveyor, bucket elevator, screw conveyor.

Suggested Readings

- Mahajani, V. V. and Umarji, S. B., Process equipment design, Macmillan.
- Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors.
- Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
- Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

22. Photovoltaic Technology and Systems 3(2+1)

Theory

Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell. Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module. Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters, Charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller, Converters: DC to DC converter and DC to AC type converter. Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, Roof top solar photovoltaic power plant and smart grid.

Practical

Study of V-I characteristics of solar PV system, smart grid technology and application, manufacturing technique of solar array, different DC to DC and DC to AC converter, domestic solar lighting system, various solar module technologies, safe measurement of PV modules electrical characteristics and Commissioning of complete solar PV system.

Suggested Readings

- Rai GD. 1998. Non-conventional Sources of Energy. Khanna Pub.
- Rathore N.S., Kurchania A.K., Panwar N.L. 2006. Renewable Energy: Theory & Practice, Himanshu Publications,.
- Solanki C.S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.
- Meinel & Meinel. Applied Solar Energy.
- Derrick, Francis and Bokalders, Solar Photo-voltaic Products.

23. Waste and By-Products Utilization 3(2+1)

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc., Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters , phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants, Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Study about briquetting of agricultural residues, Estimation of excess air for better combustion of briquettes, Study of extraction of oil from rice bran, Study on bioconversion of agricultural wastes, Recovery of germ and germ oil from by-products of cereals, Visit to various industries using waste and food by-products.

Suggested Readings

- Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
- Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
- Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.
- USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
- Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
- V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
- Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
- Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
- Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
- Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

24. Artificial Intelligence 3(3+0)

Theory

Foundation and history of artificial intelligent, problems and techniques – AI programming languages, introduction to LISP and PROLOG- problem spaces and searches, blind search strategies, Breadth first- Depth first- heuristic search techniques Hill climbing: best first-A* algorithm AO* algorithm- game tree, Min max algorithms, game playing- alpha beta pruning. Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning. Planning and planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.

Suggested Readings

- Russell, S. and P. Norvig. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.
- Rich, Elain and Kevin Knight. 1991. Artificial Intelligence. TMH.
- Patrick Henry Winston. 1992. Artificial intelligence. Addition Wesley 3rd Ed.
- Nilson Nils J. Principles of Artificial Intelligence. Norsa Publishing House.

25. Mechatronics 3(2+1)

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and transducers, performance terminology, Displacement, Position & Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers. Actuators, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems. System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic-mechanical Systems, Modelling Dynamic Systems, Transfer Functions, Control Modes, PID Controller. Micro-processor & computer, Computer and Interfacing, Micro-computer Structure, Micro-controllers, Application of Microcontrollers, PLC. Robotics, Robot components, robot classification and specification, Work envelopes, other basic parameters of robots. Robot applications, Robot applications in manufacturing, Material transfer and machine loading/ unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Future applications.

Practical

Selection of sensor for a particular application from Catalogue/Internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

Suggested Readings

- Bolton, W. Mechatronics. Pearson Education Asia.
- Wolfram, Stadler. Analytical Robotics and Mechatronics. Mc-Graw Hill.
- Doeblin E.O. Measurement Systems. Mc-Graw Hill.
- Mahind, A.P. Introduction to Digital Computer Electronics. TMH.
- Niku, S.Y. Introduction to Robotics: Analysis, systems and applications", Pearson Education Asia.
- Craig, J.J. Introduction to Robotics. Pearson Education Asia.

Minimum Standards for Establishing a College of Agriculture Engineering

These are the minimum standards required for establishing a College of Agricultural Engineering with an intake of 40 students per year. However, the Agricultural University will be at liberty to enhance admission intake with appropriate addition of human resources, equipments, facilities, etc.

1. **Degree Nomenclature :** B. Tech. (Agricultural Engineering)
2. **Eligibility Criteria :** 10+2/Intermediate with PCM (P- Physics, C-Chemistry, M-Mathematics) from a recognised Board/university
3. **Medium of Instruction :** English
4. **Minimum Intake :** 40 students per year
5. **Departments**
    1. Department of Farm Machinery and Power Engineering (FMPE)
    2. Department of Processing and Food Engineering (PFE)
    3. Department of Soil and Water Conservation Engineering (SWCE)
    4. Department of Irrigation and Drainage Engineering (IDE)
    5. Department of Renewable Energy Engineering (REE)
    6. Department of Basic Engineering and Applied Science (BEAS)

6. Human Resource Requirement of College of Agricultural Engineering

	Dean	SWCE	IDE	FMPE	PFE	REE	BEAS	Total
Faculty								**45**
Professor	1	1	1	1	1	1	1	7
Associate Professors	-	2	2	2	2	2	3	13
Assistant Professors	-	3	3	3	3	3	9	24
Placement Officer	1	-	-	-	-	-	-	1
Office Staff	-							29
AO/Suptd.	1	-	-	-	-	-	-	1
Clerk	6	1	1	1	1	1	1	12
PA/Steno	2	1	1	1	1	1	1	8
Messenger/Peon	2	1	1	1	1	1	1	8
Laboratory staff								41
Laboratory Assistant	-	2	2	2	2	2	4	14
Workshop Staff/ Computer operator/ Driver/Technicians	3	3	3	6	3	3	6	27
Total	**16**	**14**	**14**	**17**	**14**	**14**	**26**	**115**

Note: Additional Common Staff for Security, Medical, Library, Hostel, Canteen, Common room for girls, Cleaning and General Maintenance.

7. Land Requirement: 20 hectares

8. Floor Space Requirement

a) Offices

S.N.	Office	Number	Size
1	Dean/Principal	1	20' x 30'
2	Head of Department	6 (one for each department)	15' x 20' each
3	Admin. Staff	8 (2 for Dean office and one each for 6 departments)	10' x 15' each
4	Faculty rooms/chambers	45	10' x 12' each

b) Laboratories

S. No.	Department	Number	Dimensions
1	SWCE	1 1 Field Lab	20' x 30' each 1 Acre
2	IDE	1 1 Field Lab	20' x 30' each 1 Acre
3	FMPE	2	20' x 30' each
4	PFE	3	20' x 30' each
5	REE	2	20' x 30' each
6	BE& AS	8 (1 Physics, 1 Chemistry, 2 Civil, 2 Mechanical, 1 Computer, 1 Electrical & Electronics) 1 Drawing hall 1 Workshop	20' x 30' each 40' x 30' 60' x 30'

9. College Building Requirement (Infrastructure)

S. No.	Description	Number	Remarks
1	Class rooms	8	Sitting capacity of 60
2	Examination Hall	1	Sitting capacity of 200
3	Auditorium	1	Sitting capacity of 500
4	Hostels	2	1 for Boys (100 residents) 1 for Girls (100 residents)
5	Sports complex	1	Outdoor
		1	Indoor
		1	Gymnasium
6	Guest house	1	10 rooms
7	Dispensary	1	
8	Library	1	
9	Canteen	1	
10	Toilets	1 set (1 for Ladies and 1 for Gents)	Every wing of each floor should have 1 set
11	Parking space	As per requirement	For college and hostels

10. Department wise Laboratories

S. No.	Department	Name of the laboratory
1	Soil & Water Conservation Engineering	• Soil and Water Conservation Lab • Field Lab
2	Irrigation and Drainage Engineering	• Irrigation and Drainage Lab • Field Lab
3	Farm Machinery and Power Engineering	• Tractor and Power Lab • Farm Equipment Lab • Field Lab
4	Processing and Food Engineering	• Process Engineering Lab • Food Engineering Lab • Agricultural Structures and Environmental Control Lab
5	Renewable Energy Engineering	Renewable Energy Lab
6	Basic Engineering and Applied Sciences	• Physics Lab • Chemistry Lab • Civil Engineering Lab (Surveying, Strength of Material, Soil Mechanics) • Mechanical Engineering Lab (Engineering Drawing, CAD/CAM, Refrigeration & Air conditioning, Heat Engines, Fluid Mechanics) • Workshop (Carpentry, welding, Foundry, Machining, Fitting, Sheet metal) • Computer Lab • Electrical Engineering Lab • Electronics Lab

11. Department wise List of Laboratory Equipments

a) Department of Soil and Water Conservation Engineering Lab

S. No.	Name of Equipment	Quantity
	Soil & Water Conservation Lab	
1	Rain Gauges	2
2	50 kg capacity Weighing Balance	1
3	1 kg capacity electronic balance	1
4	Models of Soil Water Conservation Structures (Drop Spillway, Chute Spillway and Drop Inlet Spillway)	1 each
5	Stage Recorder	1
6	Coshocton Wheel runoff sampler	1
7	Multi slot runoff sampler	1
8	H flume, Hydraulic Flume and Parshall Flume	1 each
	Field Lab	

S. No.	Name of Equipment	Quantity
1	Runoff plots	-
2	Runoff harvesting structures	-
3	Bunds/terraces	-

b) Department of Irrigation and Drainage Engineering Lab

S. No.	Name of Equipment	Quantity
1	Oven	1
2	Tensiometer	5
3	Electrical Conductivity Meter	2
4	Distillation apparatus	1
5	Double Ring Infiltrometer	
6	pH Meter	
7	Water Quality Testing Kit	2
8	Moisture Boxes	2
9	Augers	2
10	Current meter	50
11	Darcy Apparatus	4
12	Porous cup & Measuring Flask	1
13	Sieve shaker	1
14	Filters & Strainers	5
15	Cut section of centrifugal pump, submersible pump and Turbine pump	1
16	Positive displacement pump (Hand Pump)	5
17	Water level Indicator	1 each
18	Tachometer	1
19	Pump Testing Rig	2
	Field Lab	
1	Diesel Engine with Centrifugal Pump	1
2	Sprinkler Irrigation System (for one acre area)	1
3	Drip Irrigation System (for One acre area)	1
4	Submersible Pump	1
5	Weather Station	1
6	Irrigation Water Measuring Devices (V-Notch, Parshall Flume, H-Flume, Orifice Plate)	1 each
7	Hydraulic Ram	1
8	Underground Pipeline system	1

c) Department of Farm Machinery and Power Engineering Lab

S. No.	Name of Equipment	Quantity
	Tractor and Power lab	
1	Tractor – 45 hp	1
2	Power Tiller	1
3	Work bench	1
4	Grinder	1
5	Air compressor	1
6	Mechanical jacks	2
7	Tool kits with box (having tools : Ellen key set, Open end spanner set , Pliers, Nose pliers, Circlip pliers)	3 sets
8	Welding machine	1
9	• Feeler gauges • Piston ring expander • Piston ring compressor • Plastic mallet • Weighing balances (mechanical and digital) • Oil pans • Grease gun • Bearing puller • Nozzle compression tester • Cylinder pressure gauge • Battery charger • Anvil	1 each
10	Cut sections of: • Tractor • Single cylinder engine • Multi cylinder engine • Air cleaner • Gear box • Differential • Battery • Fuel injection pump	1 each
11	Models of: • Electrical system • Lubrication system • Cooling system • Tractor hydraulic system	1 each
12	Engine for dismantling	1

S. No.	Name of Equipment	Quantity
13	Display boards: • Fuel feed pumps • Oil pumps • Types of pistons • Fuel injection pumps	1 each
14	Models of • Mould board • Standard disc plough • One way plough • Different types of disc harrows • Different types of agricultural discs • Furrow openers • Seed metering mechanism • Seed drill calibration set-up • Cutter bar cut section • Tangential flow thresher • Axial flow thresher • Knap sack sprayer • Sprayer nozzles • Set of manually operated sprayer and dusters	1 each
15	Hot air oven	1
16	Mechanical sieve shaker	1
17	Cone penetrometer	1
18	Load cells- various capacities	4
	Farm Machinery Lab and Field Lab	
1	Mould board plough	1
2	Sub soiler	1
3	Rotary tiller	1
4	Cultivator	1
5	Seed-cum fertilizer drill	1
6	Inclined plate planter	1
7	Potato planter	1
8	Sugarcane cutter planter	1
9	Vertical conveying reaper	1
10	Wheat thresher	1
11	Paddy thresher	1
12	Multi crop thresher	1
13	Potato digger	1
14	Laser leveler	1

S. No.	Name of Equipment	Quantity
15	Hand tools including Khurpis, Sickles, spades, Scythe	As per need
16	Set of animal drawn implements : disc harrow and cultivator	1 each

d) Department of Processing and Food Engineering Lab

S. No.	Name of Equipment	Quantity
	Food Engineering Laboratory	
1	Weighing Balance	3
2	Texture analyzer	1
3	Apparatus for angle of repose, coefficient of friction measurement, anemometer, nitrogen analyzer	1
4	Apparatus for measurement of properties of milk and milk products	1
5	Bod incubator, ,	1
6	Seed germinator,	1
7	Autoclave	1
8	Mini Oil Expeller	1
9	Refrigeration and freezing tutor	1
10	Fruit penetrometer	1
11	Plate heat exchanger	1
12	Soxhlet apparatus,	1
13	Boiler	1
	Process Engineering Laboratory	
1	Moisture meter	3
2	Hammer Mill	1
3	Bur Mill (Vertical & Horizontal Plate Type)	1
4	Aspirator Column	1
5	Vibratory Screen Cleaner With Aspirator	1
6	V – Mixer	1
7	Tyler Sieve Set	3
8	Manual sieve set	2
9	Ro – Tap Shaking Machine	2
10	Indented cylinder grader	1
11	Pneumatic Grader	1
12	Illuminated Purity Table	1
	Agricultural Structures & Environmental Control Laboratory	
1	Weighing Balance	2
2	Digital Thermo-hygrometer with data logger	1
3	Wet & Dry bulb Thermometer	1

S. No.	Name of Equipment	Quantity
4	Anemometer	1
5	Luxmeter	1
6	Solar power meter	1
7	Muffle Furnace	1
8	Hot air Oven	1
9	Thermal conductivity apparatus	1

e) Department of Renewable Energy Engineering Lab

S. No.	Name of Equipment	Quantity
	Biomass Energy Lab	
1	Hot air oven	1
2	Muffle Furnace	1
3	pH meter	1
4	Bacteriological Incubator	1
5	Autoclave	1
6	Atomic Absorption Spectrophotometer	1
7	High Performance Liquid Chromatograph	1
8	Portable Gas Analyser	1
9	Glassware and chemicals	1
10	Models and cut-section of Fixed Dome and floating drum Type Biogas Plants	1
11	Biomass Gasifier Model	1
12	Thermo Gravimetric Analyser	1
13	Bomb Calorimeter	1
14	Biomass Pyrolyser	1
15	Moisture analyser	1
16	Fuel Cell Model and Testing kit	1
17	MHD Model	1
18	Biogas Engine Generator set and Testing Rig	1
19	Bio-diesel based engine Testing Rig	1
20	Improved Cook stoves Model and Testing set up	1
	Solar and Wind Energy Lab	
1	Solar Cooker - Box Type and Concentrating type	1
2	Solar Water Heating System 100-125 lpd - Flat Plate Collector and Evacuated Tube Collector Type	1
3	Natural Convection Solar Dryer - 5 kg capacity	1
4	Solar Photovoltaic panel	1
5	Solar PV Testing kit	1

S. No.	Name of Equipment	Quantity
6	Atomic Absorption Spectrophotometer	1
7	High Performance Liquid Chromatograph	1
8	Gas Analyser	1
9	Glassware and chemicals	1
10	Solar Data Logger	1
11	Solar Radiations Measurement Equipments	1
12	Solar Thermal Testing kit	1
13	Solar Pump Demonstration Unit	1
14	Wind Turbine model	1
15	Cut model of Aero-generator	1
16	Wind Mapping Software	1
17	Automatic Weather Station	1

f) Department of Basic Engineering and Applied Sciences Labs

S. No.	Name of Equipment	Quantity
	Civil Engineering	
	Material Testing Lab	
1	Universal Testing Machine	1
2	Deflection of Beam Apparatus	1
3	Torsion Testing Machine	1
4	Drop Hammer testing apparatus	1
5	Charpy's Test Apparatus	1
6	Curing Tank (Temperature controlled)	1
7	Cement Testing Moulds (70.5mmX70.5mmX70.5mm)	1
8	Cube Moulds (150 mmX150mmX150mm)	1
9	Concrete Mixer	1
10	Vibrating Table	1
11	Cement storing drums	2
12	Weighing Balance (5 kg.)	1
13	Weighing Balance (200 kg.)	1
	Soil Mechanics Lab	
1	Pycnometer	5
2	Core Cutter Apparatus	5
3	Sand Replacement Apparatus	5
4	Sieve Set	2
5	Liquid Limit Apparatus (Cassagrande)	5

S. No.	Name of Equipment	Quantity
6	Compaction Test Apparatus	5
7	Direct Shear Test Apparatus (2'x 2')	1
8	Unconfined Compression Test	1
9	Constant Head Permeability Apparatus	1
10	Variable Head Permeability Apparatus	1
11	Mercury	200 ml
12	Weighing Balance (100 g)	1
13	Sieve shaker	1
14.	Oven	1
15	Sample Containers for moisture content	25
16	Auger	2
17	Hammer	2
18	Split spoon sampler	2
19	Desiccators	1
20	Straight edge	4
21	Trowel	2
22	Sieve Brush	2
23	Hydrometer	2
24	Measuring Cylinders (1000 ml)	4
25	Thermometer	2
26	Shrinkage limit Test Kit	4
27	Sample Box	25
	Survey Lab	
1	Chain (30 m)	5
2	Metallic Tape (30 m)	7
3	Arrow	100
4	Cross-staff	5
5	Wooden Pegs	100
6	Wooden Mallet	5
7	Ranging Rods	50
8	Offset Rod	10
9	Surveyor's Compass with stand	5
10	Prismatic Compass with stand	5
11	Plane table with accessories	5
12	Theodolite with stand	5
13	Total survey station	2

S. No.	Name of Equipment	Quantity
14	Planimeter	5
15	Dumpy Level with stand	5
16	Levelling Staff	10
17	Abney Level	2
18	Hand Level	2
19	Ceylon Ghat Tracer	2
20	Plumb Bob	5

g) Mechanical Engineering

S. No.	Name of Equipment	Quantity
	Fluid Mechanics Lab	
1	Venturimeter and an orifice meter setup	1
2	Bernoulli's Theorem Apparatus	1
3	Different vanes for measuring impact of water jet	1
4	Mouthpiece to determine the coefficient of discharge	1
5	Triangular and rectangular notches arrangement	1
6	Meta-centric height Apparatus	1
7	Pipes friction apparatus	1
8	Current meter	1
	Workshops	
1	Wood Working Machine	1
2	Bend Saw (Small)	1
3	Wood Working Lathe	2
4	Wood Working Bench	5
5	Black Smith Hearth	3
6	Power Hammer	1
7	Work bench	4
8	Fitter's Table	4
9	Surface Plate	2
10	Power Hacksaw	1
11	Bench Grinder	1
12	Arc Welding Machines	3
13	Gas Welding Equipment	1
14	Resistance Welding Machine	1
15	Work Table	5

S. No.	Name of Equipment	Quantity
16	Shear (Manually Operated)	1
17	Bench Grinder	1
18	Cupola (Small Size)	1
19	Crucibles	2
20	Lathe	2
21	Shaper	1
22	Universal Milling Machine	1
23	Bench Drilling Machine	1
24	Radial Drilling Machine	1
25	Bench Grinder	1
26	Work Bench	1
27	Surface Plate	1
28	Power Hacksaw	1
	Refrigeration and Air Conditioning Lab	
1	Set up for determination of the coefficient of performance of vapour compression refrigeration system	1
2	Set up for determination of the coefficient of performance of vapour absorption (electrolux) refrigeration system	1
3	Set up for determination of humidifying efficiency	1
4	Set up for determination of dehumidifying efficiency	1
5	Set up for determination of the coefficient of performance of a domestic refrigerator	1
6	Set up for determination of the coefficient of performance of air conditioning system	1
	Theory of Machine & Machine Design Lab	
1	Epicyclic Gear Train	1
2	Clutch Models 1) Single Plate Clutch 2) Multi Plate Clutch 3)Cone Clutch	1 each
3	Models of Knuckle Joint Assembly, Cotter Joint Assembly, Muff Coupling, Flange Coupling, Leaf Spring, Oldham coupling	1 each
4	Centrifugal and inertia governors working models	1
5	Model of different types of mechanisms	1 each
6	Model of different types of key sets	1 each
7	Different type of gears, pulleys, sprockets, chains, ropes , springs etc	1 each

h) Computer Science and Electrical Engineering

S. No.	Name of Equipment	Quantity
	Computer Lab	
1	Computers	15
2	MFP-Printer	1
3	Networking equipment – (Like router, LAN card for each computer)	1
4	Uninterrupted power supplies	15
5	Integrated projection system	1
	CAD Lab	
1	Computers	16
2	Server	1
3	2-D software(AutoCAD)	1
4	3-D software (Catia/Solid works/Unigraphics/Delcam/ etc)	1
5	CAM software (Master CAM/Delcam/etc.)	1

i) Electrical and Electronics Engineering Lab

S. No.	Name of Equipment	Quantity
1	Bread Board	10
2	D.C. Power supply	6
3	Multi-meters	10
4	Cathode ray oscilloscopes (Dual Channel)	5
5	Passive components (Resistors, Inductors, Capacitors)	20 each
6	Small signal active components	10 each
7	Various transducers	10 each
8	Single Phase transformers	Four
9	DC series motor	One
10	Energy meter	2
11	Resistive load box	2
12	Micro processor kits – 8085	10
13	Micro controller kits 8051, 89c52	4
14	DAC AND ADC	4 each
15	DC series Generator (with DC drive)	1
16	DC shunt motor	1
17	Three phase Induction motor (complete set)	1
18	Single Phase induction motor	1
19	Slip Ring Induction motor (Three phase)	1
20	Tachometer	5

S. No.	Name of Equipment	Quantity
21	Digital multi-meters	5
22	Digital Power factor meter	2
23	Wattmeters of various ratings (5A, 10A, 20A, 40A)	2 each
24	Ammeter (Analog type) (0-10A)	5
25	Voltmeter (Analog type) (0-300V)	5
26	Rheostats of various ratings (2.5A, 5A,10A)	2 each
27	Variac single phase or Dimmer Set (0-250V)	2
28	Three phase Dimmer Set	2

ii) Physics & Chemistry Labs

S. No.	Name of Equipment	Quantity
	Physics Lab	
1	Photocell kit	1
2	Energy Band Gap kit using PN Junction diode	1
3	Hysteresis curve (BH curve) set-up including CRO	1
4	Induced emf study (with simple harmonic motion of magnet fitted on semi-circular arc) as a function of velocity	1
5	Specific charge (e/m) set-up by Helical method	1
6	Desauty Bridge set-up including oscillator, diode etc	1
7	Carey Foster Bridge set-up including resistance boxes, resistance coils, galvanometer, jockey, connecting wires etc.	1
8	Electrical vibrator apparatus including weight box, pulley etc	1
9	Magnetometer (Stewart & Gee Tangent galvanometer) set-up with battery, reversing key, rheostat etc.	1
10	Probe kit	4
	Chemistry Lab	
1	Viscometer	1
2	Stalagomometer	1
3	Refractrometer	1
4	Spectrophotometer	1
5	Polarimeter	1
6	FT-IR Spectrometer	1
7	Fuel properties measuring apparatus : bomb calorimeter, gas calorimeter, flash and fire point apparatus, cloud point apparatus, etc	1 each

BIOTECHNOLOGY

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i). UG Degree: B.Tech. Biotechnology

ii). PG Degrees: M.Tech. and Ph.D (Biotechnology)

Both UG and PG degree will have four areas of choice for elective *viz.* Plant Biotechnology, Animal Biotechnology, Microbial & Environmental Biotechnology, and Bioinformatics.

S. No.	Specialization in B.Tech/M.Tech./Ph.D.
1	Plant Biotechnology
2	Animal Biotechnology
3	Microbial & Environmental Biotechnology
4	Bioinformatics

Restructuring of UG programmes for increased practical and practice contents

- The curriculum has a total of 183 credit hours including non-credit hours for the Biotechnology UG degree programme and various SAUs offering the degree would have a maximum of only 20 per cent relaxation catering to local needs and based on infrastructural availability.
- Four electives, each of 18 credit hours have been finalized for the degree programme and the students will have to opt for one of these electives during their sixth semester of the degree. The electives finalized are as listed below:
  1. Plant Biotechnology
  2. Animal Biotechnology
  3. Microbial and Environmental Biotechnology
  4. Bioinformatics
- The finalized curriculum has more than 68 per cent courses from biotechnology discipline itself.

- **There will not be any Rural Agricultural Work Experience Programme (RAWE)** in Biotechnology degree programme. But. It will include a well-structured two-semester '**Student READY Programme**' for a maximum of 40 credit hours divided as follows:
- 24 weeks 'Student Ready In-house Skill Development Modules' of 20 credit hours which includes four modules (only one to be opted):
  - Plant Biotechnology
  - Animal Biotechnology
  - Microbial and Environmental Biotechnology
  - Bioinformatics
- 10 weeks 'Student READY Project Formulation, Execution and Presentation' of 10 credit hours
- 10 weeks On-campus/Off-campus 'Student READY Entrepreneurial Development in Biotechnology' of 10 credit hours

Outline of Curriculum

Deficiency/Remedial Courses **Total Credit hours= 6**

Course No.	Course Title	Credit hours
Bot. 101	Basic Botany	2+1
Zoo. 101	Basic Zoology	2+1
Math. 101	Basic Mathematics – I	3+0
Math.102	Basic Mathematics - II	3+0

Bot. 101 + Zoo. 101 or Math. 101 + Math. 102

General Courses **Total Credit Hours= 18**

Course No.	Course Title	Credit hours
CSPD 101	Communication Skills and Personality Development	1+1
EDBM 201	Entrepreneurship Development and Business Management	1+1
Econ. 201	Economics and Marketing	2+1
Env.101	Environmental Studies and Disaster Management	2+1
FT 101	Food Science and Processing	1+1
HD 101	Human Ethics	1+0
ICT 201	Information and Communication Technology	1+1
ICT 301	Agricultural Informatics	2+1

Biotechnology Core Courses (23) **Total Credit Hours=64**

Course No.	Course Title	Credit hours
Biotech. 101	Cell Biology	2+0
Biotech. 102	Basic Genetics	2+1
Biotech. 103	Introduction to Biotechnology	2+1
Biotech. 104	Plant Tissue Culture	2+1
Biotech. 105	Molecular Biology	2+1
Biotech. 201	Recombinant DNA Technology	2+1
Biotech. 202	Introductory Bioinformatics	2+1
Biotech. 203	Plant Genetic Transformation	2+1
Biotech./ECE 204	Electronics and Instrumentation in Biotechnology	1+1
Biotech. 205	Classical and Molecular Cytogenetics	2+1
Biotech. 301	Immunology	2+1
Biotech. 302	Molecular Genetics	2+0
Biotech. 303	Nanobiotechnology	2+0
Biotech. 304	Animal Biotechnology	3+1
Biotech. 305	Molecular Marker Technology	2+0
Biotech. 306	Genomics and Proteomics	3+0
Biotech. 307	IPR, Biosafety and Bioethics	2+0
Biotech. 308	Computational Biology	2+1
Biochem. 201	General Biochemistry	3+1
Biochem. 301	Enzymology and Enzyme Technologies	2+1
Bot./Zoo. 102	Biodiversity and its Conservation	2+0
Micro. 101	Microbiology	2+1
Micro. 201	Microbial Genetics	2+1

Elective Courses in Biotechnology (one to choose); Each Elective :Total Credit Hours=18

Course No.	Course Title	Credit hours
	Elective I. Plant Biotechnology	
Biotech. 411	Plant Tissue Culture and its Applications	2+1
Biotech. 412	Principles and Applications of Plant Genetic Transformation	2+1
Biotech. 413	Applications of Genomics and Proteomics	2+1
Biotech. 414	Molecular Breeding in Field Crops	2+1
Biotech. 415	Molecular Breeding of Horticultural Crops and Forest Trees	2+1
Biotech. 416	Epigenetics and Gene Regulation	2+1
	Elective II. Animal Biotechnology	
Biotech. 421	Principles and Procedures of Animal Cell Culture	2+1

Course No.	Course Title	Credit hours
Biotech. 422	Animal Genomics	2+1
Biotech. 423	Embryo Transfer Technologies	2+1
Biotech. 424	Transgenic Animal Production	3+0
Biotech. 425	Molecular Diagnostics	2+1
Biotech. 426	Molecular Virology and Vaccine Production	2+1
Elective III. Microbial and Environmental Biotechnology		
Biotech. 431	Microbial Biotechnology	2+1
Biotech. 432	Bio-prospecting of Molecules and Genes	3+0
Biotech. 433	Molecular Ecology and Evolution	3+0
Biotech. 434	Fundamentals of Molecular Pharming and Biopharmaceuticals	2+1
Biotech. 435	Food Biotechnology	2+1
Biotech. 436	Green Biotechnology	2+1
Elective IV. Bioinformatics		
Biotech. 441	Programming for Bioinformatics	2+2
Biotech. 442	Bioinformatics Tools and Biological Databases	2+1
Biotech. 443	Structural Bioinformatics	2+1
Biotech. 444	Pharmacogenomics	2+1
Biotech. 445	Metabolomics and System Biology	2+1
Biotech. 446	Computational Methods for Data Analysis	1+1

Basic Science Courses (5) **Total Credit Hours=14**

Course No.	Course Title	Credit hours
Bot. 201	Plant Physiology	2+1
Math. 201	Biomathematics	2+1
Phy. 201	Biophysics	2+1
Stat. 101	Basic Statistics	1+1
Stat. 301	Biostatistics	2+1

Agriculture Courses (5) **Total Credit Hours= 15**

Course No.	Course Title	Credit hours
Agron. 101	Crop Production Technology	2+1
*Hort. 101	Production Technologies for Horticultural Crops	2+1
*PB 101	Basics of Plant Breeding	2+1
*PB 201	Breeding of Field Crops	2+1
*Ent-Pl.Path. 201	Fundamentals of Crop Protection	2+1

Courses marked * are optional to the package of Animal Science courses marked as **

Animal Science Courses (5) **Total Credit Hours= 15**

Course No.	Course Title	Credit hours
**AS 101	Anatomy and Physiology of Livestock	3+0
**AS 102	Introduction to Animal Breeding	2+1
AS 201	Livestock Production and Management	2+1
**AS 202	Livestock Product Technology	2+1
**AS203	Animal Health Care	2+1

Courses marked ** are optional to the package of Agriculture Courses marked as *

Student READY Programme (2 Semesters) **Total Credit Hours=40**

Course No.	Course Title	Credit hours
Biotech. 491	In-house Skill Development Modules	20
Biotech. 492	Project Formulation, Execution and Presentation	10
Biotech. 493	Entrepreneurial Development in Biotechnology (on campus /off campus)	10

Non Credit Courses (2) **Total Credit Hours=6**

Course Title	Non Credit hours
Educational Tour	2
NCC/NSO/NSS	4

COURSES SCHEDULE FOR B.TECH. BIOTECHNOLOGY IN SAUs

Semester-wise Distribution of Courses		
Semester I		
Course No.	**Course Title**	**Cr hrs**
Bot. 101/ Math. 101	Basic Botany/ Basic Mathematics - I	2+1/ 3+0
Agron. 101	Crop Production Technology	2+1
Biotech.101	Cell Biology	2+0
Biotech. 102	Basic Genetics	2+1
Biotech. 103	Introduction to Biotechnology	2+1
CSPD 101	Communication Skills and Personality Development	1+1
Env. 101	Environmental Studies and Disaster Management	2+1
FT 101	Food Science and Processing	1+1
HD 101	Human Ethics	1+0
	NCC/NSO/NSS	0+1 NC
Total		**16+6/15+7 (22) +1NC=23**

Semester II		
Course No.	**Course Title**	**Cr hrs**
Zoo. 101/ Math. 102	Basic Zoology/ Basic Mathematics - II	2+1/3+0
Biotech. 104	Plant Tissue Culture	2+1
Biotech. 105	Molecular Biology	2+1
Bot. / Zoo. 102	Biodiversity and its Conservation	2+0
*Hort. 101/ **AS 101	Production technologies for Horticultural Crops/ Anatomy and Physiology of Livestock	2+1/3+0
Micro. 101	Microbiology	2+1
*PB 101/ **AS 102	Basics of Plant Breeding/ Introduction to Animal Breeding	2+1
Stat. 101	Basic Statistics	1+1
	NCC/NSO/NSS	0+1 NC
Total		**16+6/ 15+7(22)+1 NC=23**

Semester III		
Course No.	**Course Title**	**Cr hrs**
AS 201	Livestock Production and Management	2+1
Biotech. 201	Recombinant DNA Technology	2+1
Bot. 201	Plant Physiology	2+1
ICT 201	Information and Communication Technology	1+1
Econ. 201	Economics and Marketing	2+1
*Ent.-Pl.Path. 201/ **AS 202	Fundamentals of Crop Protection/ Livestock Product Technology	2+1
Math. 201	Biomathematics	2+1
*PB 201/ **AS 203	Breeding of Field Crops/ Animal Health Care	2+1
	NCC/NSO/NSS	0+1 NC
Total		**15+8(23)+1 NC=24**

Semester IV		
Course No.	**Course Title**	**Cr hrs**
EDBM 201	Entrepreneurship Development and Business Management	1+1
Biochem. 201	General Biochemistry	3+1
Biotech. 202	Introductory Bioinformatics	2+1
Biotech. 203	Plant Genetic Transformation	2+1
Biotech./ECE 204	Electronics and Instrumentation in Biotechnology	1+1
Biotech. 205	Classical and Molecular Cytogenetics	2+1

Micro. 201	Microbial Genetics	2+1
Phy. 201	Biophysics	2+1
	NCC/NSO/NSS	0+1 NC
Total		**15+8 (23) +1 NC=24**

Semester V		
Course No.	**Course Title**	**Cr hrs**
Biochem. 301	Enzymology and Enzyme Technologies	2+1
Bioteh. 301	Immunology	2+1
Bioteh. 302	Molecular Genetics	2+0
Bioteh. 303	Nanobiotechnology	2+0
Bioteh. 304	Animal Biotechnology	3+1
Bioteh. 305	Molecular Marker Technology	2+0
Bioteh. 306	Genomics and Proteomics	3+0
Bioteh. 307	IPR, Biosafety and Bioethics	2+0
ICT 301	Agricultural Informatics	2+1
Total		**20+4=24**

Semester VI		
Course No.	**Course Title**	**Cr hrs**
Biotech. 308	Computational Biology	2+1
Stat. 301	Biostatistics	2+1
Optional/ Elective Courses (6)	Electives (4): Only one to be chosen (each with six courses)	18
	1. Plant Biotechnology	12+6
	2. Animal Biotechnology	13+5
	3. Microbial and Environmental Biotechnology	14+4
	4. Bioinformatics	11+7
Total		**16+8/17+7 18+6/15+9=24**

Semester VII		
Course No.	**Module***	**Cr hrs**
Biotech. 491 Student READY - In-house Skill Development Modules	1. Plant Biotechnology 2. Animal Biotechnology 3. Microbial and Environmental Biotechnology 4. Bioinformatics *To opt only one module as per the chosen elective	0+20
	Educational Tour	2NC
Total		**20+2NC =22**

Semester VIII		
Course No.	**Course Title**	**Cr hrs**
Biotech. 492	Student READY - Project Formulation, Execution and Presentation	0+10
Biotech. 493	Student READY - Entrepreneurial Development in Biotechnology (- On-campus/Off Campus)	0+10
Total		**0+20 =20**

SYLLABUS

1. Deficiency/ Remedial Courses

Students joining degree programme with +2 in medical stream will take Math. 101 and Math. 102 as remedial courses, while the students joining B.Tech. Biotechnology with +2 in Non-Medical stream will take Bot. 101 and Zoo. 101 as remedial courses. These courses will cover syllabus for +1 & +2 classes. There will be a total of six credit hours in each of the deficiency/remedial courses package.

i) Basic Botany 3(2+1)

Theory

UNIT I

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination.

UNIT II

Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf.

UNIT III

Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Practical

Description of one plant species from each group of plant kingdom; Study of morphology and modifications of root, stem, leaf, flower; Types of inflorescence; Structure of various types of seeds and fruits; Demonstration of cell structure, tissue types; Structure of monocot and dicot root, stem and leaf; One flower from each family.

Suggested Readings

- Bendre A & Kumar A. 1999. *Textbook of Practical Botany.* Vol. 2, 7th Ed., Rastogi Publications.
- Bendre AM & Pande PC. 2009. *Introduction to Botany*. Rastogi publications.
- Dutta AC. 1995. *A Class Book of Botany*, 16th Edition. Oxford University Press.

2. Basic Zoology 3(2+1)

Theory

UNIT I

Introduction to Zoology; Structure and functions of cell and cell organelles; Difference between prokaryotic and eukaryotic cell; Cell division – mitosis and meiosis; Structure and function of biomolecules; Types of simple and compound tissues.

UNIT II

Binomial Nomenclature; Classification and general survey of animal kingdom; Functional organization of various systems of a mammal: digestive, circulatory, respiratory, excretory, nervous and reproductive; Laws of inheritance; Multiple allelism - blood groups; Genetic disorders in human and their inheritance.

Practical

Study of animal cell structure and cell division; Histological preparation of simple and compound tissues; General survey of animal kingdom up to phyla in invertebrates and up to classes in vertebrates; Demonstration of mammalian anatomy; Blood grouping.

Suggested Readings

- Bhatia KN & Tyagi MP. 2012. *Trueman's Elementary Biology*. 24th ed. Trueman Book
- Company.
- Dhami PS & Mahindru RC. 1996. *A Text Book of Biology for 10+2.* Pradeep Publications.

3. Basic Mathematics-I 3(3+0)

Theory

UNIT I

Complex numbers: Properties of real numbers, complex numbers, their addition, multiplication and division, square root of complex numbers, cube roots of unity and their properties, De-Moivre's theorem; Theory of equations: Solution of quadratic equation, equation reducible to quadratic equation, relation between roots and coefficients, nature of roots and formation of quadratic equation with given roots.

UNIT II

Geometric series: nth term of G.P. series, sum of G.P. series, geometric mean; Harmonic series, harmonic mean; Arithmetico geometric series and special series $\sum n$, $\sum n^2$, $\sum n^3$. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, general term, terms independent of x.

UNIT III

Trigonometry: Trigonometric ratios, allied angles, graphs of trigonometric functions;

Addition and subtraction formulae; Product and sum formulae; Multiple and sub-multiple angles, sine, cosine and projection formulae; Area of a triangle.

Suggested Readings

- NCERT 2012. *Mathematics of Class XI.* NCERT India.
- Sharma RD. 2014. *Mathematics of Class XI.* Dhanpat Rai Publisher.

4. Basic Mathematics-II (3+0)

Theory

UNIT I

Functions; Limit: Introduction, left handed and right handed limits, general rules for calculation of limits Standard limits $\underset{x\to a}{\mathrm{Lt}}\frac{x^n-a^n}{x-a}$, $\underset{x\to 0}{\mathrm{Lt}}\frac{\sin x}{x}$, $\underset{x\to 0}{\mathrm{Lt}}(1+x)^{\frac{1}{x}}$, $\underset{x\to 0}{\mathrm{Lt}}\frac{a^x-1}{x}$, $\underset{x\to 0}{\mathrm{Lt}}\frac{\log(1+x)}{x}$. Continuity: Definition of continuity, continuity of algebraic functions, Continuity of trigonometric and exponential functions.

UNIT II

Differentiation: Differentiation by first principle, sum, difference, product and quotient formulae, differentiation using chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative, Successive differentiation, geometrical interpretation of derivative, maxima and minima, tangent and normal.

UNIT III

Integration: Integration by substitution, integration by partial fractions, integration by parts, integration by trigonometric substitution.

UNIT IV

Matrices and Determinants: Definition of matrix, addition, subtraction and multiplication, inverse of matrix; Solution of linear equations: By Crammer's rule and inverse of matrix.

Suggested Readings

- NCERT 2012. *Mathematics of Class XII.* NCERT India.
- Sharma RD. 2014. *Mathematics of Class XII.* Dhanpat Rai Publisher.

General / Common Courses

1. Communication Skills and Personality Development 2(1+1)

Theory

UNIT I

Communication skills: Structural and functional grammar; Meaning and process of

communication; Verbal and nonverbal communication; Listening and note taking; Writing skills; Oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles; Precise writing, summarizing, abstracting; Individual and group presentations; Impromptu presentation; Public speaking; Group discussion and interviews; Organizing seminars and conferences.

UNIT II

Voice modulation basics and their usage for meaningful impact on people; Attributes of an effective leader; Stress and conflict management; Time management: Personal organization, prioritizing and balancing; Cosmopolitan culture; Impact of non verbal communication; Science of body language; Role of team work.

Practical

Listening and note taking, writing skills, oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; Individual and group presentations; Video recorded mock group discussions and interviews; Attitude management; Setting and achieving a short term goal; Creating a personal vision statement of life; Voice modulation; Practicing conscious body postures and movements; Rapport building; Video recorded practical to evaluate change in confidence level; Team work exercises; Time management.

Suggested Readings

- Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.
- Covey Stephen R. 1989. *TheSeven Habits of Highly Successful People*. Free Press.
- Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills.*Wadsworth.
- Verma, KC. 2013. *The Art of Communication*. Kalpaz.

2. Entrepreneurship Development and Business Management 2(1+1)

Theory

UNIT I

Concept of entrepreneur; Entrepreneurship development; Assessment of entrepreneurship skills; SWOT analysis and achievement motivation; Entrepreneurial behaviour; Government policy and plan for entrepreneurship development; Setting up of a new entrepreneurial venture; Environmental factors influencing entrepreneurship; Constraints in setting up of agro based industries;

UNIT II

Definition of business; Value chain concept in business; Stakeholders in business; Stages of Indian business; Importance of agribusiness in Indian economy and factors ransforming Indian agribusiness; Government as a regulatory body in agribusiness; Opportunities and challenges to Indian agribusiness.

UNIT III

Management: Definition, importance and functions; Levels of management; Planning: Definition, steps in planning, types of plan; Organizing: Meaning of organizing and organization; Developing leadership skills; Encoding and decoding communication skills; Developing organizational and managerial skill; Problem solving skill; Supply chain management and total quality management; Project planning, formulation and report preparation.

Practical

Preparation of project report for starting a new venture; Case studies of successful entrepreneurs, analysis and discussion; Preparation of complete marketing plan of selected product/service; Case studies related to project management; Visits to industrial and agri-business houses; Numerical problems; Preparation of project report for various business ventures.

Suggested Readings

- Harold Koontz & Heinz Weihrich. 2004. *Essentials of Management: An International Perspective,* 2nd Ed. Tata Mc-Graw Hill Publishing Pvt Ltd.
- Mukesh Pandey & Deepali Tewari. 2010. *The Agribusiness Book.* IBDC Publishers.
- Nandan H. 2011. *Fundamentals of Entrepreneurship.* PHI Learning Pvt Ltd India.
- Philip Kotler, Kavin Lane Keller, Abraham Koshy & Mithileshwar Jha. 2012. *Marketing Management: A South Asian Perspective.* Pearson Education.
- Poornima Charantimath. 2006. *Entrepreneurship Development: Small Business Enterprise.* Pearson Education.
- Stephans P Robbins & Mary Coulter. 2003. *Management*. Pearson Education.

3. Economics and Marketing 3(2+1)

Theory

UNIT I

Economics – Terms and definitions; Consumption, demand, price and supply; Factors of production; Gross Domestic Product; Role of Biotechnology/ Agriculture sector in national GDP.

UNIT II

Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence.

UNIT III

Basic guidelines for preparation of project reports; Bank norms; Insurance; SWOT analysis; Crisis management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value added products; Identification of marketing channel; Calculation of price spread; Identification of market structure; Visit to

different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

Suggested Readings

- Acharya SS & Aggarwal NL. 2011. *Agricultural Marketing in India*. Fifth Edition. Oxford and IBH Publishing Company Pvt. Ltd.
- Ahuja HL. 2007. *Advanced Economic Theory*. S Chand and Company.
- Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.
- Dewett KK. 2005. *Modern Economic Theory.* S Chand and Company.
- Gupta RD & Lekhi RK. 1982. *Elementary Economic Theory.* Kalyani Publishers.
- Sampat Mukherjee. 2002. *Modern Economic Theory.* New Age International.

4. Environmental Studies and Disaster Management 3(2+1)

Theory

Environmental Studies

UNIT I

Multidisciplinary nature of environmental studies; Definition, scope and importance.

UNIT II

Natural Resources: Renewable and non-renewable resources; Natural resources and associated problems.

a) Forest resources: Use and over-exploitation; Deforestation; Case studies. Timber extraction, mining; Dams and their effects on forest and tribal people.
b) Water resources: Use and over-utilization of surface and ground water; Floods; Drought; Conflicts over water; Dams-benefits and problems.
c) Mineral resources: Use and exploitation; Environmental effects of extracting and using mineral resources; Case studies.
d) Food resources: World food problems; Changes caused by agriculture and overgrazing; Effects of modern agriculture; Fertilizer-pesticide problems; Water logging; Salinity; Case studies.
e) Energy resources: Growing energy needs; Renewable and non-renewable energy sources; Use of alternate energy sources; Case studies.
f) Land resources: Land as a resource; Land degradation; Man induced landslides; Soil erosion and desertification.

Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT III

Ecosystems; Concept of an ecosystem; Structure and function of ecosystem; Producers, consumers and decomposers; Energy flow in ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

UNIT IV

Biodiversity and its conservation; Introduction, definition, genetic, species and ecosystem diversity and biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.

UNIT V

Environmental Pollution: definition, cause, effects and control measures air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies.

UNIT VI

Social issues and the environment; From unsustainable to sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

UNIT VII

Human population and environment: population growth, variation among nations, population explosion, Family Welfare Programme; Environment and human health: human rights, value education, HIV/AIDS; Women and child welfare; Role of information technology in environment and human health; Case studies.

Disaster Management

UNIT I

Natural disasters - Meaning and nature of natural disasters; their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves; Climatic change: global warming, sea level rise, ozone depletion.

UNIT II

Man-made disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster management - Effect to migrate natural disaster at national and global levels; International strategy for disaster reduction; Concept of disaster management; National disaster management framework; Financial arrangements; Role of NGOs, community-based organizations

and media; Role of central, state, district and local administration; Armed forces, police and other organizations in disaster response.

Practical

Visit to a local area to document environmental assets: river/ forest/ grassland/ hill/ mountain; Visit to a local polluted site - urban/ rural/ industrial/ agricultural; Study of common plants, insects, birds and study of simple ecosystems - pond, river, hill slopes, etc.; Visit to disaster management organizations; Collection of statistics of national disasters occurred since 20th century.

Suggested Readings

- Ahluwalia VK & Malhotra S. 2006. *Environmental Science*. Ane Books India.
- Anjaneyulu Y. 2004. *Introduction to Environmental Science.* BS Publications.
- Chauhan AS. 2009. *Environmental Studies.* 3rd Edition. Jain Brothers.
- Das RC & Behera DK. 2008. *Environmental Science - Principles and Practice.* Prentice –Hall of India Pvt Ltd.
- Dhaliwal GS & Kukal SS. 2005. *Essentials of Environment Science.* Kalyani Publishers.
- Santra

5. Food Science and Processing 2(1+1)

Theory

UNIT I

Definition: Food and nutrition; Food production and consumption trends in India; Major deficiencies of calories, proteins, vitamins and micronutrients; Food groups and concept of balanced diet; RDA.

UNIT II

Causes of food spoilage; Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; Preservation through ultraviolet and ionizing radiations.

UNIT III

Post-harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration and food laws; Status of food industry in India

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry; Value added products from cereals, millets, fruits, vegetables, milk, egg and meat; Visit to local processing units.

Suggested Readings

- Potter NN & Hotchkiss JH. 1995. *Food Science.* Chapman and Hall Publishers.
- Swaminathan M. 2005. *Handbook of Foods and Nutrition.* Ganesh and Co. Pvt. Ltd.
- Swaminathan M. 1990. *Food Science, Chemistry and Experimental Foods.* BAPPCO.

- Vickie A.,Vaclavik & Elizabeth W. Christian. 2003. Essentials of Food Science, 2nd Ed. Kluwer Academic/ Plenum Publishers, New York.

6. Human Ethics 1(1+0)

Theory

UNIT I

Universal human aspirations: Happiness and prosperity; Human values and ethics: Concept, definition, significance and sources; Fundamental values: Right conduct, peace, truth, love and non-violence; Ethics: professional, environmental, ICT; Sensitization towards others particularly senior citizens, developmentally challenged and gender.

UNIT II

Spirituality, positive attitude and scientific temper; Team work and volunteering; Rights and responsibilities; Road safety; Human relations and family harmony; Modern challenges and value conflict: Sensitization against drug abuse and other social evils; Developing personal code of conduct (SWOT Analysis); Management of anger and stress.

Suggested Readings

- Gaur RR, Sangal R & Bagaria GP. 2011. A *Foundation Course in Human Values and Professional Ethics.* Excel Books.
- Mathur SS. 2010. *Education for Values, Environment and Human Rights.* RSA International.
- Sharma RA. 2011. *Human Values and Education -Axiology, Inculcation and Research.* R. Lall Book Depot.
- Sharma RP & Sharma M. 2011. *Value Education and Professional Ethics.* Kanishka Publishers.
- Srivastava S. 2011. *Human Values and Professional Ethics.* S K Kataria & Sons.
- Srivastava S. 2011. *Environmental Science*. S K Kataria & Sons.
- Tripathi A.N. 2009. *Human Values.* New Age International (P) Ltd Publishers.

7. Information and Communication Technology 2(1+1)

Theory

UNIT I

IT and its importance; IT tools; IT-enabled services and their impact on society; Computer fundamentals; Hardware and software; Input and output devices; Word and character representation.

UNIT II

Features of machine language, assembly language, high-level language and their advantages and disadvantages; Principles of programming - algorithms and flowcharts.

UNIT III

Operating systems (OS) - definition, basic concepts; Introduction to WINDOWS and LINUX

Operating Systems; Local area network (LAN); Wide area network (WAN); Internet and World Wide Web; HTML and IP.

UNIT IV

Introduction to MS Office - Word, Excel, Power Point; Audio visual aids - definition, advantages, classification and choice of A.V. aids; Criteria for selection and evaluation of A.V aids; Video conferencing; Communication process, Berlo's model, feedback and barriers to communication.

Practical

Exercises on binary number system; Algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: web browsing, creation and operation of email account; Analysis of data using MS Excel; Handling of audio visual equipments; Planning, preparation, presentation of posters, charts, overhead transparencies and slides; Organization of an audio visual programme.

Suggested Readings

- Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology.* Kalyani Publishers.
- Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics.* Tata McGraw-Hill Education.
- Kumar A 2015. *Computer Basics with Office Automation.* IK International Publishing House Pvt Ltd.
- Rajaraman V & Adabala N. 2015. *Fundamentals of Computers.* PHI
- Recommended Latest Online Tutorials (over Internet).

8. Agricultural Informatics 3(2+1)

Theory

UNIT I

Introduction to computers; Anatomy of computers; Memory concepts, units of memory; Operating system, definition and types; Applications of MS-Office for creating, editing and formatting a document; Data presentation, tabulation and graph creation; Statistical analysis, mathematical expressions; Database, concepts and types, creating database; Uses of DBMS in Agriculture; Internet and World Wide Web (WWW), concepts, components and creation of web; HTML & XML coding.

UNIT II

Computer programming, concepts; Documentation and programme maintenance; Debugging programmes; Introduction to Visual Basic, Java, Fortran, C/ C++, etc.; Standard input/output operations; Variables and constants; Operators and expressions; Flow of control; Inbuilt and user defined functions; Programming techniques for agriculture.

UNIT III

e-Agriculture, concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in agriculture; ICT for data collection; Formation of development programmes, monitoring and evaluation; Computer models in agriculture: statistical, weather analysis and crop simulation models - concepts, structure, input-output files, limitations, advantages and application for understanding plant processes, sensitivity, verification, calibration and validation; IT application for computation of water and nutrient requirement of crops; Computer-controlled devices (automated systems) for agri-input management; Smartphone mobile apps in agriculture for farm advice, market price, post-harvest management, etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information; Decision support systems, taxonomy, components, framework, classification and applications in agriculture; Agriculture Information/Expert System; Soil Information Systems, etc. for supporting farm decisions; Preparation of contingent crop-planning and crop calendars using IT tools.

Practical

Study of computer components, accessories; Practice of important DOS commands; Introduction of different operating systems such as windows, Unix, Linux; Creating files and folders; File management; Use of MS-WORD and MS Power point for creating, editing and presenting a scientific document; Handling of tabular data; Animation, video tools, art tool, graphics, template and designs; MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros; MS-ACCESS: Creating database, preparing queries and reports, demonstration of agri-information system; Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web; Introduction of programming languages - Visual Basic, Java, Fortran, C, C++, and their components; Hands-on practice on writing small programmes; Hands-on practice on Crop Simulation Models (CSM); DSSAT/Crop-Info/ CropSyst/ Wofost; Preparation of input file for CSM and study of model outputs; Computation of water and nutrient requirements of crop using CSM and IT tools; Use of smart phones and other devices in agro-advisory and dissemination of market information; Introduction of Geospatial Technology; Demonstration of generating information important for agriculture; Hands on practice on preparation of Decision Support System.

Suggested Readings

- Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology.* Kalyani Publishers.
- Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics.* Tata McGraw-Hill Education.
- Kumar A 2015. *Computer Basics with Office Automation.* IK International Publishing House Pvt Ltd.
- Maidasani D. 2016. Learning Computer Fundamentals, MS Office and Internet & Web Technology. 3rd edition, Laxmi Publications.

Compulsory Basic Science Courses

1. Plant Physiology 3(2+1)

Theory

UNIT I

Plant physiology, its scope in agriculture; Osmosis, imbibition, water absorption, water translocation and transpiration; Stomatal mechanisms; Physiological role and deficiency symptoms of major and minor elements, Absorption and translocation of minerals.

UNIT II

Concepts of photosynthesis, photorespiration, respiration and translocation of photoassimilates; Dynamics of growth; Stress physiology; Nitrogen and sulphur metabolism; Plant growth regulators: Their biosynthesis and physiological roles, seed germination & seed dormancy, senescence, vernalization.

Practical

Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis; Ascent of sap, transpiration; Deficiency symptoms of nutrients in crop plants; Plant growth analysis; Quantitative and qualitative estimation of plant pigments; Experiments on photosynthesis and respiration; Effects of plant growth regulators on plant growth and seed germination; Experiments on seed dormancy; Relative water content and plant water potential; Proline estimation.

Suggested Readings

- Bhatia KN & Prashar AN. 1990. *Plant Physiology*. Trueman Book Company.
- Salisbury FB. & Ross CW. 1992. *Plant Physiology*. Wordsworth Publishing Company. Srivastava HN. 2000. *Plant Physiology.* Pradeep Publications.

2. Biomathematics 3(2+1)

Theory

UNIT-I

Rolle's theorem; Lagrange's theorem; Taylor's and Maclaurin's series; Partial differentiation, Euler's theorem on homogeneous function, change of variable; Jacobian, maxima and minima of two or more than two variables eigen values and eigen vectors of a matrix; Reduction formulae, definite integrals and its applications.

UNIT-II

Solution of ordinary differential equation of first degree and first order and their application for determination of volume of blood and drug distribution; Epidemic models, Simultaneous differential equation of first order and their applications to predator models; Linear differential equations of higher order and their applications to simple biological problem; Numerical methods for solving algebraic and transcendental equations.

Practical

Tutorials on Taylor's and Maclaurin's expansions; Partial differentiation; Euler's theorem; Change of variable, total derivative, implicit function, maxima and minima, eigen values and eigen vectors of matrix, reduction formulae, definite integrals and their properties; Epidemic models, predator models; Determination of volume of blood and drug distribution; Ordinary differential equation of first order, linear differential equation of higher older and their applications to biological problems, numerical methods.

Suggested Readings

- Grewal BS. 2013. *Higher Engineering Mathematics.* Khanna Publishers, India.
- Rastogi SK. 2008. *Biomathematics.* Krishna Prakashan Media Pvt. Ltd.
- Srivastava AC & Srivastava PK. 2011. *Engineering Mathematics.* Vol.I . PHI Learning Pvt. Ltd.
- Srivastava AC & Srivastava PK. 2011. *Engineering Mathematics.* Vol.III . PHI Learning Pvt. Ltd.

3. Biophysics 3(2+1)

Theory

UNIT I

Quantum mechanics; Electronic structure of atoms; The wave particle duality, wave length of de-Broglie waves; Phase and group velocity; Some basic concepts of quantum mechanics; Schrodinger's wave equations; Particle in a box; Quantum mechanical tunneling; Ist and IInd law of thermodynamics; Enthalpy; Entropy; Statistical and thermodynamic definition of entropy; Helmholtz free energy, Equilibrium thermodynamic; Near-equilibrium thermodynamic; Gibbs free energy; Chemical potential; Thermodynamic analysis of membrane transport.

UNIT II

Hydration of macromolecules; Role of friction; Diffusion; Sedimentation; The ultracentrifuge; Viscosity; Rotational diffusion; Light scattering, Small angle x-ray scattering; Ultraviolet and visible spectroscopy; Circular dichroism(CD) and optical rotatory dispersion(ORD); Fluorescence spectroscopy; Infrared spectroscopy; Raman spectroscopy; Electron spin resonance; NMR spectroscopy; Light microscopy.

UNIT III

Electron optics; Transmission electron microscope (TEM); Scanning electron microscope(SEM); Preparation of the specimen for electron microscopy; Image reconstruction; Electron diffraction; Tunnelling electron microscope; Atomic force microscope; Crystals and symmetries, crystal systems, point group and space groups; Growth of crystals of biological molecules; X-ray diffraction.

Practical

Refractive index and dispersive power of the prism using spectrometer; Calibration of prism spectrometer; Newton's rings; Polarimeter; Diffraction grating; Resolving power of telescope

and grating; Ostwald viscometer; Planck's constant using photovoltaic cell; Photospectrometer; Photoelectric effect; Stefan's constant; Thermal diffusivity in metals.

Suggested Readings

- Chang R. 2005. *Physical Chemistry for the Biosciences*. University Science Books.
- Glaser. 2012. *Biophysics.* Springer.
- Pattabhi V & Gautam N. 2002. *Biophysics.* Narosa Publishing House.
- Rodney Cotterill. 2002. *Biophysics: An Introduction.* John Wiley & Sons.
- Srivastava PK. 2006. *Elementary Biophysics: An Introduction*. Narosa Publishing House.

4. Basic Statistics 2(1+1)

Theory

UNIT I

Definition of statistics, its use and limitations; Frequency distribution and frequency curve and cumulative frequency curve; Measures of central tendency; Measures of dispersion; Probability: Definition, additive and multiplicative law for two events; Normal distribution and its properties; Introduction to sampling; Sampling techniques.

UNIT II

Tests of significance: Null hypothesis, alternate hypothesis, Type I & II Error, one and two tail tests, level of significance and confidence interval; SND test for means: Single sample and two samples Z-test; Student's t-test for means, single sample, two samples and paired t-test; F-test;

UNIT III

Chi-square test in 2x2 contingency table; Yate's correction for continuity; Correlation: Scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing; Linear regression and its properties; Analysis of variance and its assumptions, Analysis of CRD and RBD; Analysis of Latin Square Design.

Practical

Construction of frequency distribution tables and frequency curves; Computation of Arithmetic: Mean, median, mode; Standard deviation; Variance and coefficient of variation for ungrouped and grouped data; SND test for means; Student's t-test; F-test and Chi-square test; Correlation coefficient 'r' and its testing; Fitting of regression equations; Analysis of CRD, RBD and LSD.

Suggested Readings

- Freud JE & Perles BM. 2006. *Modern Elementary Statistics.* 12th Ed. Pearson India.
- Kapoor VK. 2003. *Problems and Solutions in Statistics.* 7th Edition. Sultan Chand and
- Sons.
- Snedecor GW. & Cochran WG. 1989. *Statistical Methods.* Iowa State University Press.

5. Biostatistics 3(2+1)

Theory

Unit I

Random variables: expected value and its variance; probability distribution of random variables; Conditional probability; Baye's theorem and its applications; Introduction to Uniform, Binomial, Poisson, Normal, Exponential and Gamma probability distributions.

Unit II

Random mating populations, Hardy-Weinberg Law; Introduction to Poisson process and Markov chains: Transition probability matrix, n-step transition probabilities, steady state. Random walk models; Sensitivity and specificity.

Unit III

Chi-square test: testing heterogeneity, use in genetic experiment, detection of linkage, linkage ratios and its estimation; Analysis of variance: One-way and two-way classification with interaction; Analysis of covariance; Incomplete block designs; Estimation and significance of genotypic and phenotypic variation.

Practical

Expected value and variance of discrete and continuous distributions; Uniform, Binomial, Poisson, Normal, Exponential and Gamma Probability distributions; Hardy-Weinberg Law; Construction of transition probability matrix in Markov Chains; Calculation of sensitivity and specificity; Detection and linkage using Chi-square test; One-way and two-way analysis of variance; Analysis of covariance; Incomplete block designs; Testing of heritability.

Suggested Readings

- Biswal PC. 2009. *Probability and Statistics.* PHI Learning Pvt. Ltd.
- Kaps M. & Lamberson W. 2007. *Biostatistics for Animal Science.* CABI Publishing.
- Narayan P, Bhatia VK & Malhotra PK. 1989. *Handbook of Statistical Genetics.* Indian Agricultural Statistics Research Institute, New Delhi, India.
- Pal N. & Sahadeb Sarkar. 2009. *Statistics – Concepts and Applications.* 2nd Ed. PHI Learning Pvt. Ltd.

Core Courses in Biotechnology

1. Cell Biology 2(2+0)

Theory

UNIT I

Origin and evolution of cell; Introduction to microscopy; Sub-cellular structure of prokaryotic and eukaryotic cells; Membrane structure and function: plasma membrane, cell wall and extracellular matrix; Structural organization and function of intracellular organelles and organelle biogenesis: Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles.

UNIT II

Structure and function of cytoskeleton and its role in motility; Cell membrane transport; Introduction to cell signalling; Cell growth, cell cycle and its control; Cell death and cell renewal.

Suggested Readings

- Alberts B, Johnson A, Lewis J, Raff M, Roberts K &Walter P. 2008. *Molecular Biology of the Cell*. 5th Ed. Garland Science/ Taylor and Francis Group.
- Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. *Molecular Cell Biology*. W. H. Freeman.
- Sadava DE. 1993. *Cell Biology: Organelle Structure and Function*. Jones and Bartlett Publishers.

2. Basic Genetics 3(2+1)

Theory

UNIT I

History of Genetics; Mendel's principles and rediscovery; Cell division; Chromosomes structure and function; Chromosome theory of inheritance; Sex-linked, sex-limited and sex-influenced inheritance; Sex determination and sex differentiation.

UNIT II

Multiple allelism; Linkage and crossing-over; Gene-gene interaction; Genetic analysis in prokaryotes and eukaryotes; Extra chromosomal inheritance; Mutations; Hardy-Weinberg law; Quantitative inheritance; Introduction to Human genetics; Genetic basis of evolution.

Practical

Life cycle in model plants and animals; microscopy; Mitosis and meiosis; Monohybrid crosses (segregation); Dihybrid crosses (independent assortment); Probability and use of Chi-square; Sex-linked inheritance; Multiple allelism; Detection and estimation of linkage.

Suggested Readings

- Gupta PK. 2014. *Genetics* 4th ed. Rastogi Publications.
- Inbasekar P. 2009. *Cell Biology and Genetics*. Panima Publications.
- Miglani GS. 2000. *Basic Genetics*. Narosa Publishing house, New Delhi.
- Russell PJ. 2013. *iGenetics: Pearson New International Edition: A Molecular Approach*. Pearson.
- Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Education International.

3. Introduction to Biotechnology 3(2+1)

Theory

UNIT I

History, definitions, concepts, scope and importance of Biotechnology: Plant, microbial, animal, medical, environmental, industrial, Marine, Agricultural and food Biotechnology; Nanobiotechnology.

UNIT II

Introduction to recombinant DNA technology and its applications: Vectors, DNA restriction and modifying enzymes, gene cloning; Introduction to genomics and proteomics: Molecular markers, DNA sequencing; Genetic transformation and transgenic organisms; Bioinformatics. Biosafety guidelines.

Practical

Orientation to the laboratories: glass houses, screen houses, transgenic facilities and field area; General guidelines for working in Biotechnology laboratories; Familiarization with basic equipment's used in biotechnology; Selection of chemicals (different grade), buffer preparation, calculations and scientific notations used in laboratories.

Suggested Readings

- Brown T A. 2002. *Genomes 2*. 2nd ed. New york:Wiley-Liss.
- Prave P, Faust U, Sittig W & Sukatsch DA. 1987. *Basic Biotechnology: A Student's Guide*. VCH Verlagsgesellschaft.
- Prave P, Faust U & Sittig W. 1987. *Fundamentals of Biotechnology.* VCH Verlagsgesellschaft.
- Renneberg R. 2008. *Biotechnology for Beginners*. Academic Press Publishers.

4. Plant Tissue Culture 3(2+1)

Theory

UNIT I

History of plant tissue culture; concept of totipotency; Concept of aseptic culture practices; Components of *in vitro* culture media and role of different macro and micro nutrients, vitamins, plant growth regulators and growth supplements; Sterilization techniques.

UNIT II

Various plant cell, tissue and organ culture techniques and uses; Somatic cell cultures; morphogenesis: organogenesis and somatic embryogenesis; Micropropagation: *In vitro* grafting, meristem culture; Anther, pollen, embryo, ovule, ovary culture; Protoplast culture and somatic hybridization; Somaclonal variation.

Practical

Good laboratory practices;Media preparation and sterilization; Surface sterilization of explants; Establishment of callus/cell suspension cultures; Micropropagation; Embryo culture; Anther and pollen culture; Induction of plant regeneration; Hardening and transfer to soil.

Suggested Readings

- Bhojwani SS & Razdan MK. 1996. *Plant Tissue Culture: Theory and Practice.*Elsevier.
- Bhojwani SS & Dantu PK. 2013. *Plant Tissue Culture: An Introductory Text*. Springer

- Dixon RA & Gonzales RA. 2003. *Plant Cell Culture: A Practical Approach*. Oxford University press.
- Helgason CD & Miller CL. 2005. *Basic Cell Culture Protocols*. 3rd Ed. Humana Press.

5. Molecular Biology 3(2+1)

Theory

UNIT I

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; DNA replication; transcription; Genetic code and translation; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, tryp concept.

UNIT II

Introduction to microbial genetics; conjugation, transformation and transduction; Tools in molecular biology: Role of enzymes in molecular biology; Principles of Polymerase Chain Reaction; Electrophoresis; PCR and hybridization based molecular markers. \

Practical

Preparation of bacterial competent cells and transformation; Isolation and purificationof plant and animal DNA; Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis; DNA amplification using RAPD, microsatellite primers and analysis; CAPS primers; Generation of linkage maps and mapping of qualitative genes; Estimation of genetic similarities and generation of dendrograms.

Suggested Reading

- Allison LA. 2011. *Fundamental Molecular Biology*. Wiley Global Education.
- Carson S, Miller HB & Witherow DS. 2012. *Molecular Biology Techniques A Classroom Laboratory manual*. Elsevier.
- Kreuzer H & Massey A. 2008. *Molecular Biology and Biotechnology: A Guide for Teachers*. ASM Press.
- Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. *Molecular Cell Biology*. W. H. Freeman.
- Sambrook J, Russel D. 2001. *Molecular Cloning: A Laboratory Manual*. 3rd Ed Cold Spring Harbor Laboratory Press.
- Surzycki S. 2000. *Basic Techniques in Molecular Biology*. Springer Berlin Heidelberg
- Voet D, Voet JG & Pratt CM. 2004. *Fundamentals of Biochemistry*. 2nd Ed. New York: Wiley.
- Walker JM & Rapley R. 2000. *Molecular Biology and Biotechnology*. 4th Ed. The Royal Society of Chemistry.
- Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Education International.

6. Recombinant DNA Technology 3(2+1)

Theory

UNIT I

Recombinant DNA technology; Restriction endonucleases: Types and uses; DNA ligases; Vectors: plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, expression vectors, shuttle vectors, binary plant vectors, co-integrating vectors.

UNIT II

Competent cells; Gene isolation and cloning; Genetic transformation of *E. coli*; Gel electrophoresis; Preparation of probes; Southern blotting; Northern blotting; Western blotting; PCR and gene amplification.

Practical

Orientation to recombinant DNA lab; preparation of stock solutions and buffers; Plasmid DNA isolation; Genomic DNA isolation; Quality and quantity determination of DNA; restriction digestion of DNA; Agarose gel electrophoresis, SDS-PAGE; PCR; Genetic transformation of *E. coli*; Screening of recombinant DNA clones in *E. coli*.

Suggested Readings

- Brown TA. 1998. *Genetics: A Molecular Approach*. 3rd Ed. Stanley Thornes.
- Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.
- Winnacker EL. 2003. *From Genes to Clones: Introduction to Gene Technology*. 4th Ed. Panima Publishers.
- Watson JD & Zoller M. *Recombinant DNA*. 3rd Ed. Panima Publishers

7. Introductory Bioinformatics 3(2+1)

Theory

UNIT I

Introduction to bioinformatics; Development and scope of bioinformatics; Applications of computers in bioinformatics: Operating systems, hardware, software, Internet, www resources, FTP.

UNIT II

Primary databases: Nucleotide sequence databases (GenBank, EMBL), protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam;

Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.

UNIT III

Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment, concept of local and global alignment; Algorithms: Dot Matrix method, dynamic

programming methods (Needleman–Wunsch and Smith–Waterman); Tools of MSA: ClustalW, TCoffee; Phylogeny; Introduction to BLAST and FASTA.

Practical

Basic computing: Introduction to UNIX, LINUX; Nucleotide information resource: EMBL, GenBank, DDBJ, Unigene; Protein information resource: SwissProt, TrEMBL, Uniprot; Structure databases: PDB, MMDB; Search Engines: Entrez, ARSA, SRS; Similarity Searching: BLAST and interpreting results; Multiple sequence alignment: ClustalW; Structure visualization of DNA and proteins using Rasmol.

Suggested Readings

- Baxevanis AD. & Ouellette BFF. 2001. Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley and Sons.
- Mount DW. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.
- Xiong J.2006. Essential Bioinformatics. Cambridge University Press.

8. Plant Genetic Transformation 3(2+1)

Theory

UNIT I

History of plant genetic transformation; Generation of gene construct and maintenance; Genetic transformation: *Agrobacterium* mediated, biolistics, electroporation, liposome, Polyethylene glycol, *in planta* methods.

UNIT II

Selection and characterization of transgenic plants using selectable and reportable markers; PCR; qRT-PCR; Southern, Northern, ELISA and Western techniques; Application of genetic transformation: for quality, yield, biotic, and abiotic stresses; Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions, Preparation of competent cells of *Agrobacterium tumefaciens*; Restriction mapping of plasmid, Construction of binary vector and its transfer to an *Agrobacterium* strain; Confirmation of transformed bacterial colonies; *Agrobacterium tumefaciens* mediated and biolistic plant transformation; Colony hybridization.

Suggested Readings

- Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual*. 4th Ed. 3 Vol Sets. Cold Spring Harbor Laboratory Press.
- Grierson D. 2012. *Plant Genetic Engineering*. Springer Netherlands.
- Primose SB & Twyman RM. 2006. *Principles of Gene Manipulation and Genomics*, 7th Ed. Black Well Publishing.
- Sambrook J, Russel D. 2001. *Molecular Cloning: A Laboratory Manual*. 3rd Ed Cold Spring Harbor Laboratory Press.

- Stewart NC Jr. 2008. *Plant Biotechnology and Genetics: Principles, Techniques and Applications*. John Wiley & Sons Inc.

9. Electronics and Instrumentation in Biotechnology 2(1+1)

Theory

UNIT I

Electronics

PN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltage multiplier circuit; Construction and working of bipolar transistor, load line concept, analysis and design of various biasing methods of NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor with common emitter configuration; Concept of generalized instrumentation system; Transducers for the measurement of temperature using thermometer and thermocouple, linear displacement measurement using LVDT; Force measurement using the strain gauge.

UNIT II

Principles and working of laboratory equipments: Table top, refrigerated and ultra centrifuges; Laminar air flow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers; Gel electrophoresis, 2-D gel electrophoresis, gel documentation, gel driers; ELISA readers; Freeze driers/lypholizers; Spectrophotometers; Gene pulser; Particle gun; Plant growth chambers; Thermal cyclers; Realtime PCR; DNA synthesizer; DNA sequencer; Microscopes: Light, stereo, phase contrast and inverted.

Practical

To familiarize laboratory equipment and its equipment working; Forward and reverse VI Characteristics of a PN junction diode; To study half wave, full wave and bride rectifier using diode; Clipper, Clamper and Voltage multiplier circuit; To determine input V-I Characteristics s of bipolar transistor for common emitter configuration; To determine output V-I Characteristics s of bipolar transistor for common emitter configuration; To analyse a biasing circuits for CE transistor; To design and test a biasing circuits for CE transistor; To study the measure of temperature using the available sensor; To measure displacement with the available sensor; To study force with the available sensor.

Suggested Readings

- Edward William Golding & Frederick Charles Widdis. 1969. *Electrical Measurements and Measuring Instruments*. Pitman.
- Gupta JB.2009. *Basic Electronics*. S. K. Kataria & Sons.
- Malvino. 2007. *Electronics Principles*. Tata McGraw-Hill Education.
- Manhas P. & Thakral S. 2010. *Digital Electronics*. S. K. Kataria & Sons.
- Sharma Sanjay. 2012. *Electronics Devices & Circuits*. S. K. Kataria & Sons.

10. Classical and Molecular Cytogenetics 3(2+1)

Theory

UNIT I

Introduction and history; Mitosis and meiosis; Structure of chromatin; Chromosome structure and chromosome landmarks; Specialized chromosomes; Differential staining of the chromosomes- Q-banding, G banding, C banding, R banding; *In situ* hybridization-FISH, GISH.

UNIT II

Changes in chromosome number: aneuploidy- monosomy, trisomy and tetrasomy, haploidy and polyploidy- autopolyploidy and allopolyploidy; Methods of doubled haploid production; Structural aberrations of chromosomes: deletions, duplications, inversions and translocations; Locating genes on chromosomes; Genome analysis.

Practical

Preparation of chromosome stains; Pollen fertility; Preparation of mitotic and meiotic slides of plant/animal cells; Preparation of karyotypes; C/G banding of the chromosomes; Genomic *in situ* hybridization; Microphotography.

Suggested Readings

- Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.
- Carroll M. 1989. *Organelles*. The Guilford Press.
- Charles B. 1993. *Discussions in Cytogenetics.* Prentice Hall.
- Gupta PK. 2007. *Cytogenetics*. Rastogi publications.
- Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.
- Mahabal Ram. 2010. *Fundamentals of cytogenetics and genetics*. PHI Learning Pvt. Ltd.
- Yao-Shan Fan. 2002. *Molecular Cytogenetics: Protocols and Applications*. Humana
- Press.

11. Immunology 3(2+1)

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin structure and functions; Molecular organization of immunoglobulins and classes of antibodies; Antibody diversity; antigens, haptens, antigens antibody interactions; Immuno-regulation and tolerance.

UNIT II

Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques; Immunological application in plant science, monoclonal antibodies and their uses; Molecular diagnostics.

Practical

Preparation of buffers and reagents; Precipitation and agglutination test; HA, HI test; Immunoblotting, immunoelectrophoresis and fluorescent antibody test; Enzyme immunoassays including ELISA variants, western blotting; Raising of antisera in laboratory animals; Collection and preservation of antisera – separation, filtration and aliquoting.

Suggested Readings

- Murphy K. 2012. *Janeway's Immuno Biology*. 8th Ed. Garland Science/ Taylor &Francis Group.
- Owen JA, Punt J, Kuby J & Sharon A. 2013. *Kuby Immunology*. 7th Ed. W.H. Freeman.

12. Molecular Genetics 2(2+0)

Theory

UNIT I

Structures, properties and modification of DNA; Molecular mechanisms of DNA replication, repair, mutation, and recombination; Centromere and telomere sequences and DNA packaging; Synthesis and processing of RNA and proteins; Regulation of gene expression; Mutations and DNA repair.

UNIT II

Repetitive DNA sequences and transposable elements; Promoters and their isolation; Transcription factors – their classification and role in gene expression; Epigenetic control of gene expression; Small RNAs, RNA interference and its applications.

Suggested Readings

- Allison LA. 2011. *Fundamental Molecular Biology*. Wiley Global Education.
- Brown TA. 1998. *Genetics: A Molecular Approach*. 3rd Ed. Stanley Thornes.
- Lewin B. 2009. *Genes 9*. Jones & Bartlett Learning.
- Tropp BE. 2014. *Principles of Molecular Biology*. Jones & Bartlett Learning.
- Tropp BE. 2012. *Molecular Biology Genes to Proteins.* 4th Ed. Jones & Bartlett Learning.

13. Nanobiotechnology 2(2+0)

Theory

UNIT I

Introduction to nanotechnology; Concepts and Terminology; Nano-Bio Interface; Biological based Nanosystems, molecular motors, biosensors and other devices.

UNIT II

Self assembly of molecules for nanotechnology applications; Biomimetics, Biotemplating and *de novo* designed nanostructures and materials; DNA-Nanotechnology; Nanomanipulations, material design, synthesis and their applications.

Suggested Readings

- David E. Reisner. 2009. *Bionanotechnology: Global Prospects*. CRC Press.
- Gabor L. Hornyak, John J. Moore, Tibbals HF., Joydeep Dutta. 2008. *Fundamentals of Nanotechnology*. CRC Press.
- Jesus M. de la Fuente, V. Grazu. 2012. *Nanobiotechnology: Inorganic nanoparticles Vs Organic nanoparticles*. Elsevier.
- Yubing Xie. 2012. *The Nanobiotechnology Handbook*. CRC Press.

14. Animal Biotechnology 4(3+1)

Theory

UNIT-I

History and development of animal biotechnology; Basic techniques in animal cell culture: Introduction to embryo biotechnology: oocyte collection and maturation; Sperm preparation; in vitro fertilization; Cryopreservation of oocyte, sperm and embryos; Embryo transfer technology.

UNIT II

Breeds of livestock and their characteristics; Marker assisted breeding of livestock; Introduction to animal genomics: RFLP, RAPD, SSRs, QTL, SNP, STR, Mitochondrial DNA polymorphism; Rumen and its environment: Rumen microbes-manipulation of rumen microbes for better utilization of feed; Introduction to nutrigenomics; Milk biome; Manipulation of lactation by biotechnological tools; Application of biotechnology in meat and meat products.

UNIT III

Genome and protein based diagnostics of important animal diseases: FMD, brucellosis, PPR, Mastitis, Blue tongue, Newcastle disease; Introduction to vaccinology: live attenuated vaccines, killed vaccines, cell culture based vaccines, recombinant vaccines.

Practical

Basic cell culture techniques; oocyte aspiration from ovaries; sperm preparation; In vitro fertilization; PCR based detection of animal pathogens; PCR-RFLP; Immuno histochemical localization of protein marker in tissues/cells – meat species identification by PCREDIT

Suggested Readings

- Aberle Elton D, Forrest John C, Gerrard David E & Mills Edward W. 2012. *Principles of Meat Science*. 5th Ed. Kendall Hunt Publishing.
- Lawrie & Ledward. Lawrie's. 2006. *Meat Science*. 7th Ed. Woodhead Publishing. Sukumar De. 1997. *Outlines of Dairy Technology*. Oxford University Press-New Delhi.
- Sharma BD. 1999. *Meat and Meat Products Technology: Including Poultry Products Technology*. Jaypee Bros. Medical Publishers.
- Varnam A & Jane P. 1994. *Milk and Milk Products: Technology, Chemistry and Microbiology*. Sutherland Springer Science & Business Media.

15. Molecular Marker Technology 2(2+0)

Theory

UNIT I

Types of molecular markers- RFLP; PCR based markers like RAPD,SCAR, SSR, STS, CAPS, AFLP, SNP and their variants; Uses of molecular markers: Application as a genetic tool for genotyping and gene mapping; Mapping populations: F_2, DH, RILs, NILs; Bulked segregant analysis; Linkage maps; Physical maps.

UNIT II

Application of molecular markers: Assessing genetic diversity, variety protection; Marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits; Human and animal health: Association with genetic-based diseases, Paternity determinations; Forensic studies.

Suggested Readings

- Huges S. & Moody A. 2007. *PCR: Methods Express*. Royal College of General Practitioners.

16. Genomics and Proteomics 3(3+0)

Theory

UNIT I

Introduction to Genomics, Functional Genomics and Proteomics; Structural genomics: Classical ways of genome analysis, BAC and YAC libraries; Physical mapping of genomes; Next generation sequencing; Genome analysis and gene annotation; Genome Projects: *E. coli*, Arabidopsis, Bovine, Human; Comparative Genomics: Orthologous and Paralogous sequences, Synteny, Gene Order, Phylogenetic footprinting.

UNIT II

Functional genomics: Differential gene expression techniques: ESTs, cDNA-AFLP, microarray, Differential display, SAGE, RNAseq, Real time PCREDIT

UNIT III

Introduction to proteomics; Analysis of proteome: Native PAGE, SDS PAGE, 2D PAGE; Edmann Degradation; Chromatographic techniques: HPLC, GC, Mass Spectrometry: MALDI-TOF, LC-MS; Post Translational modifications.

Suggested Readings

- Branden C & Tooze J. l999. *Introduction to Protein Structure*. 2nd Ed. Garland Science.
- Connor DO & Hames BD. 2007. *Proteomics: Methods Express*. Royal College of General Practitioners.
- Pennington S R & Dunn M J. 2001. *Proteomics from protein sequence to function*. BIOS Scientific Publishers Ltd.
- Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.
- Tropp BE. 2012. *Molecular Biology Genes to Proteins*. 4th Ed. Jones & Bartlett Learning

17. IPR, Biosafety and Bioethics 2(2+0)

Theory

UNIT I

Introduction to Intellectual Property, concepts and types; International treaties for protection of IP's; Indian Legislations for the protection of various types of Intellectual Property; Patent search, filing process; Material transfer agreements.

UNIT II

Biodiversity definition, importance and geographical causes for diversity; Species and population biodiversity, maintenance of ecological biodiversity hot spots in India; Convention on biological diversity; Cartagena Protocol of bio-safety, and risk management for GMO's; Bio-safety guidelines, rules and regulations and regulatory frame work for GMOs in India.

Suggested Readings

- Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani Publishers.
- http://patentoffice.nic.in
- www.wipo.org
- www.dbtindia.nic.in
- www.dbtbiosafety.nic.in

18. Computational Biology 2(2+1)

Theory

UNIT I

Introduction to computational biology; Web based servers and software for genome analysis: Ensembl, UCSC genome browser, MUMMER, BLASTZ; Sequence submission.

UNIT II

Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE; Principles of Protein structure prediction; Fold Recognition (threading); Homology modeling; SCOP, CATH, PDB, PROSITE, PFAM; Methods for comparison of 3D structures of proteins.

UNIT III

Phylogenetic analysis: Evolutionary models, tree construction methods, statistical evaluation of tree methods; PHYLIP, dendroscope, MEGA; DNA barcoding database-BOLD.

Practical

Application of Genome browsers in genomic research; Exploring protein-protein interaction databases; Working with protein structural classification databases; SNP and SSR identification tools; PHYLIP.

Suggested Readings

- Creighton TE. 1993. *Proteins: Structures and Molecular Properties* 2nd Edition. W.H Freeman.
- DovStekel. 2003. *Microarray Bioinformatics*. 1st Ed. Cambridge University Press.
- Mount D. 2001. *Bioinformatics: Sequence and Genome Analysis*, 2nd Ed. Cold Spring Harbor Laboratory Press.
- Malcolm Campbell A. & Laurie J. Heyer. 2007. D*iscovering Genomics, Proteomics and Bioinformatics.* 2nd Ed. Benjamin Cummings.
- Setubal Joao & Meidanis Joao. 2004. *Introduction to Computational Molecular Biology*,
- PWS Publishing Company.

19. General Biochemistry 4(3+1)

Theory

UNIT I

Introduction and importance; Cell structure; Bio molecules: Carbohydrates, lipids, proteins and nucleic acids - structure, functions and properties; Enzymes: Classification, factors affecting activity; Structure and role of water in biological system; Acids, bases and buffers of living systems; The pK of biomolecules; Vitamins and hormones.

UNIT II

Bioenergetics; Metabolism - basic concept: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation; General reactions of amino acid degradation; Biosynthesis - carbohydrates, lipids, proteins, nucleic acids.

UNIT III

Secondary metabolites: Terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids; Extraction and characterization of lipids by TLC; Determination of acid , iodine and saponification values of oil; Extraction, quantitative estimation and separation of sugars by paper chromatography; Determination of phenols; Determination of free amino acids and proteins.

Suggested Readings

- Berg JM, Tymoczko JL, & Stryer L. 2002. Biochemistry. 5th Ed. W.H. Freeman & Co.
- Com EE & Stumpf PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.
- Goodwin, TW & Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. Pergaman Press.
- Murray RK, David B., Botham KM & Kennelly PJ. 2012. Harper's Illustrated Biochemistry. 29th Ed. Lange Medical Books/Mc. Graw Hill.
- Nelson DL & Cox MM. 2000. Lehninger Principles of Biochemistry. 5th Ed. C.B.S Publilshers, Prentice Hall.

- Wilson K & Walker J. 1994. Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed. Cambridge University Press.

20. Enzymology and Enzyme Technologies 3(2+1)

Theory

UNIT I

Classification and nomenclature of enzymes; General characteristics of enzymes, active site, cofactors, prosthetic groups; Metalloenzymes; Isolation, purification, characterization and assays of enzyme and international units; Criteria for purity.

UNIT II

Enzyme kinetics: effect of pH, temperature, determination of Km and Vmax; Regulation of enzyme activity; Enzyme inhibition: competitive, non-competitive and uncompetitive; Isoenzymes, schizomers and isoschizomers; Ribozymes; Immobilization of enzymes; Applications of enzymes: biotechnology, industry, environment, agriculture, food and medicine.

Practical

Isolation, purification and assay of enzymes; Determination of optimum pH and optimum t;emperature of enzymes; Thermostability of enzymes; Activators and inhibitors of enzyme catalysis; Determination of kinetic parameters of enzymes; Immobilization of enzymes; Isoenzymes analysis.

Suggested Readings

- Bisswanger H. 2011. *Practical Enzymology*. 2nd Ed. Wiley-Blackwell.
- Cook PF & Cleland WW. 2007. *Enzyme Kinetics and Mechanism.* Garland Publishing Inc.
- Cornish-Bowden A. 2012. *Fundamentals of Enzyme Kinetics.* 4th Ed. Wiley-Blackwell.
- Price NC & Stevens L. 1999. *Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins.* 3rd Ed. Oxford University Press.

21. Biodiversity and its Conservation 2(2+0)

Theory

UNIT I

Concepts of biodiversity, bioresource and wildlife management, conservation strategies: *in situ* and *ex situ* conservation; Wild life conservation projects in India; Protection of biodiversity for its suitable utilization; Threats to biodiversity; WCU Red data book; Biodiversity hotspots in India; National bureaus of genetic resources.

UNIT II

Sustainable development; Diversification of cropping system; Diversity of indigenous livestock; Vulnerability and extinction of flora and fauna; Endangered species in various ecosystems; Germplasm banks; Environmental impact assessment; Bioremediation and biosafety; Introduction to regulatory agencies and legislation.

Suggested Readings

- Das MK & Choudhury BP. 2008. *A Text book on Plant Nomenclature and Biodiversity Conservation.* Kalyani Publishers.
- Hopsetti BB. & Venketashwarlaru M. 2001. *Trends in Wild Life Conservation and*
- *Management.* Vol. 2, Daya Publishing House.
- Singh MP & Singh BS. 2002. *Plant Biodiversity and Taxonomy.* Daya Publishing House, Delhi.

22. Microbiology 3(2+1)

Theory

UNIT I

History of Microbiology-its applied areas; Microorganisms and their role in fermentation; Germ theory of diseases and protection; Introduction to eukaryotic and prokaryotic cell; Major groups of eukaryotes- fungi, algae and protozoa; Major groups of prokaryotes – Actinomycetes, Cyanobacteria, Archaebacteria, Rickettsias and Chlamydia; Preservation of microorganisms; Microbial repositories at national and international level.

UNIT II

Bacterial growth; Metabolism in bacteria- ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation; Viruses: Bacteriophages - structure and properties, lytic and lysogenic cycles; viriods, prions.

UNIT III

Microbial groups in soil; Microbes in biotic and abiotic stressed environments; Microbial transformation of carbon, nitrogen and sulphur; Biological nitrogen fixation; Beneficial microorganisms in agriculture-biofertilizers, microbial pesticides; Plant microbe interaction; Microbes in composting and biodegradation; Microbiology of water and food.

Practical

Microscope and other instruments in a microbiological laboratory; Media preparation, sterilization and aseptic methods for isolation, identification, preservation and storage; Identification of bacteria by staining methods; Enumeration of bacteria by pour plate and spread plate methods; Micrometery.

Suggested Readings

- Brock TD. 1961. *Milestones in Microbiology.* Infinity Books.
- Pelczar MJ, Chan ECS & Kreig NR. 1997. *Microbiology: Concepts and Application.* Tata McGraw Hill.
- Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology.* MacMillan.
- Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology.* Wiley Eastern.

23. Microbial Genetics 3(2+1)

Theory

UNIT I

Microorganisms as tools for genetic studies; Genetic variability in microorganisms; Genetic analysis of representative groups of bacteria, fungi and viruses; Random and tetrad spore analysis; Recombination and chromosomal mapping; Complementation - intergenic and intragenic.

UNIT II

Bacterial plasmids; Structure, life cycle, mode of infection and their role in genetic engineering; Transfer of genetic material in bacteria: Conjugation, transformation and transduction; Genetics of bacteriophage: T4, lambda and M13 - fine structure of gene, life cycle, mode of infection; Mutation: types, mutagens, DNA damage and repair; Transposable elements; Lac operon; Yeast genetics.

UNIT III

Concept and application of recombinant DNA technology; Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

Practical

Conjugation and transformation in bacteria; Spontaneous and auxotrophic mutation; Chemical and UV mutagenesis in fungi and bacteria; Complementation in fungi; Identification of mutants using replica plating technique; Isolation of genomic DNA from *E. coli*; Isolation and curing of plasmid;Identification of plasmid by electrophoresis / antibiotic plates.

Suggested Readings

- Birge EA. 1981. *Bacterial and Bacteriophage Genetics.* Springer Verlag.
- Gardner JE, Simmons MJ & Snustad DP. 1991. *Principles of Genetics.* John Wiley &Sons.
- Lewin B.1999. *Gene.* Vols. VI-IX. John Wiley & Sons.
- Maloy A & Friedfelder D. 1994. *Microbial Genetics.* Narosa.
- Scaife J, Leach D & Galizzi A 1985. *Genetics of Bacteria.* Academic Press.
- William Hayes 1981. *Genetics of Bacteria.* Academic Press.

Student READY programme

Student READY - In-house Skill Development Modules 20(0+20)

Four Modules (Only one to be opted as per chosen elective)

1. Plant Biotechnology
2. Animal Biotechnology
3. Microbial and Environmental Biotechnology
4. Bioinformatics

Evaluation Criteria:

Activity within each Module	Marks Distribution (%)
Attendance	10
Mid-term	25
Practical Assignments	15
Final Exam for Practical Skill Assessment	40
Oral Examination	10

Student READY - Project Formulation, Execution and Presentation 0+10

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Formulation and Implementation	20
Work Performance	30
Regularity, General Conduct and Discipline	10
Initiative and Creativity	10
Final Presentation	15
Final Project Report	15

Student READY - Entrepreneurial Development in Biotechnology 10(0+10)

Micropropagation; DNA fingerprinting; Genetic purity for maintenance breeding; Marker assisted selection; Haploid production; Database Management skills; Molecular Diagnostics; Recombinant protein production; Animal cell culture and maintenance; Fermentation, Biopharma production; Bioprocess enrichment; Bioremediation; Biofules, etc.

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Planning, Writing and Presentation	20
Regularity	10
Monthly Assessment	10
Output Delivery	15
Technical Skill Development	15
Entrepreneurial and Business Networking Skills	10
Report Writing	10
Final Presentation	10

ELECTIVES (Semester VI): 18 Credit hours

Four electives each of 18 credit hours will be offered to B.Tech. Biotechnology students during VI semester of the degree programme. The students will have to choose only one out of the four electives.

ELECTIVE I

PLANT BIOTECHNOLOGY

1. Plant Tissue Culture and its Applications 3(2+1)

Theory

UNIT I

Historical benchmarks of plant cell and tissue culture; Culture media components and modifications; Sterilization techniques; Various types of culture: callus, suspension, nurse, root, meristem; *In vitro* differentiation: Organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *in vitro* culture and regeneration.

UNIT II

Applications: Micropropagation; Anther and microspore culture; Somaclonal variation; *Ivitro* mutagenesis; Production of secondary metabolites; Synthetic seeds; *In vitro* fertilization; Embryo rescue in wide hybridization; Endosperm culture; Protoplast isolation, culture and regeneration; Somatic hybridization: cybrids, asymmetric hybrids; *In vitro* germplasm conservation.

Practical

Establishment of callus/ cell suspension cultures; Induction of plant regeneration; Micropropagation – Explant establishment, shoot multiplication, root induction, Hardening and transfer to soil; Monitoring of growth and differentiation of cells, Seed/Embryo culture; Ovary culture, Anther /pollen culture, Suspension cultures and production of secondary metabolites.

Suggested Readings

- Bhojwani SS & Razdan MK. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier.
- Debergh PC & Zimmerman RH. 1991. *Micropropagation: Technology and Application*. Kluwer Academic.
- Dixon RA & Gonzales RA. 2003. *Plant Cell Culture: A Practical Approach*. Oxford University press.
- George EF, Hall MA & Klerk GJD. 2007. *Plant Propagation by Tissue Culture.* 3rd Ed. Volume 1. Springer Science & Business Media.

2. Principles and Applications of Plant Genetic Transformation 3(2+1)

Theroy

UNIT I

Gene transfer methods: Direct and Indirect; Marker free transformation; *In planta* transformation; Vectors for plant transformation, molecular characterization of transgenicplants

using PCR, real time PCR, Southern, Northern and western analysis; Bioassayswith transgenic plants; Evaluation and selection of transgenic events for target trait.

UNIT II

Genetic engineering of crop plants for useful traits: Over expression, inducible, tissue specific and gene silencing systems; Biosafety concerns and regulatory mechanisms; Commercialization of transgenic products, GMO's, transgenic plants for the production of biopharmaceuticals; Molecular farming of plants for applications in medicine systems, heterologous protein production in transgenic plants; Successful case studies.

Practical

Gene isolation and gene cloning; Gene constructs and their maintenance;*Agrobacterium* mediated genetic transformation; Particle gun mediated genetic transformation. Histochemical GUS assays; PCR screening of putative transgenic plants; Raising transgenic under containment and field conditions.

Suggested Readings

- Bhojwani SS & Dantu PK. 2013. *Plant Tissue Culture: An Introductory Text*. Springer Brown TA. 2007. *Gene Cloning & DNA Analaysis: An Introduction*. 6th Ed. Wiley- Blackwell Publishing.
- Grierson D. 2012. *Plant Genetic Engineering*. Springer Netherlands.Lal R & Lal S. 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.
- Primose SB & Twyman RM. 2006. *Principles of Gene Manipulation and Genomics*. 7th
- Ed. Wiley-Blackwell Publishing.

3. Applications of Genomics and Proteomics 3(2+1)

Theory

UNIT I

Structure of genomes: *Arabidopsis*, rice, tomato, pigeon pea, wheat; DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Site directed mutagenesis; Transposon tagging; Transient gene expression: VIGS and FACS based, targeted genome editing technologies.

UNIT II

Bio-informatics in proteomics: Protein 3D structure modelling (Homology modelling and crystallography); Proteome analysis; Protein- protein interaction: FRET, yeast twohybrid and co-immunoprecipitation. Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and ionomics for elucidating metabolic pathways.

Practical

- SDS-PAGE; 2D Electrophoresis; Protein characterization through HPLC; Specialized crop based genomic resourses: TAIR, Gramene, Graingenes, Maizedb, Phytozome, Cerealdb, Citrusdb; miRbase.

- **Suggested Readings**
- Connor DO & Hames BD. 2007. *Proteomics: Methods Express*. Royal College of General Practitioners.
- Pennington S R, Dunn M J. 2001. *Proteomics from protein sequence to function*. BIOS Scientific Publishers Ltd.
- Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.
- Tropp BE. 2012. *Molecular Biology Genes to Proteins*. 4th Ed. Jones & Bartlett Learning.
- Verma PS & Agarwal VK. 2014. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.* S. Chand & Company Pvt. Ltd.

4. Molecular Breeding in Field Crops 3(2+1)

Theory

UNIT I

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Development of specific mapping populations.

UNIT II

QTL mapping using structured populations; Fine mapping of genes/QTL; Map based gene/ QTL isolation and development of gene based markers.

UNIT III

Marker assisted selection (MAS): Foreground and background selection; MAS for major and minor genes, Marker assisted pyramiding, Marker assisted recurrent selection; Transgenic breeding; MAS for specific traits with examples; Commercial applications of MAS.

Practical

Working on some genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, MapDisto and QTL mapping softwares such as WinQTL cartographer; Use of gene based and closely linked markers for foreground selection for target traits in target crops; Marker assisted detection of the transgene.

Suggested Readings

- Nagat T, Lorz H & Widholm JM. 2008. *Biotechnology in Agriculture and Forestry.* Springer.
- Trivedi PC. 2000. *Plant Biotechnology: Recent Advances*. Panima Publishers.

5. Molecular Breeding of Horticultural Crops and Forest Trees 3(2+1)

Theory

UNIT I

Reproductive biology of major fruit and forest crops; Basic methods of fruit crop improvement; Target traits in major fruit crops; Limitations of fruit crop breeding; Breeding methods of self and cross pollinated vegetable crops; Breeding of commercial flower crops.

UNIT II

Molecular markers for germplasm characterization and genetic diversity analysis; Pseudo test cross mapping strategy in fruit crops; Molecular mapping in vegetable crops; Marker assisted breeding in horticultural crops and forest plants; Micropropagation for variety dissemination; Mutation breeding and characterization of mutants; Genomic resources for marker development; Transgenic approaches with tree crops and utility.

Practical

Modifications in DNA extraction methods for horticultural and forest crops; Agarose gel electrophoresis, and DNA quantification; Map maker; Diversity analysis using UPGMA; Identifying repeat sequences using MISA; Standard Gene cloning methods including construct making with the use of Restriction enzymes; DNA ligases and standard molecular approaches.

Suggested Readings

- J S Bal. 2013. *Fruit Growing*. Kalyani Publishers.
- Kumar N. 2006. B*reeding of Horticultural crops: Principles and Practices*. New India Publishing Aagency.
- K. L. Chada. 2012. *Handbook of Horticulture*. ICAR.
- Kumar J. Prasad. 2010. *Handbook of Fruit Production*. Agrobios.
- Schnell RJ & Priyadarshan PM. 2012. *Genomics of Tree Crops*. Springer.
- Singh Jitender. 2014. *Basic Horticulture*. Kalyani Publishers.
- Singh Ranjit. 2012. *Fruits*. National Book Trust.
- Spangenberg G. 2001. *Molecular Breeding of Forage Crops*. Kluwer Academic
- Publishers.
- Victor Ray Garden, Frederick Charles Bnaford, Herry & Daggett HoDlor Ir. 1992.
- *Fundamentals of Fruit Production*. Mc Graw Book Company.

6. Epigenetics and Gene regulation 3(2+1)

Theory

UNIT I

DNA methylation and histone modifications: DNA methylases, methyl binding proteins and histone modifiers; Epigenetic changes in response to external stimuli leading to changes in gene regulation; Role of DNA methylation in plant development: mutant case studies.

UNIT II

Introduction to small RNAs: History, biogenesis; *In silico* predictions, target gene identification, methylation of heterochromatin by het associated siRNAs; Gene regulation by small RNA Other classes of siRNAs; Role in epigenetics; Jacob Monod model; RNA editing, Genome imprinting.

Practical

In silico study of structural components of histone modifiers and DNA methylases of model plants; *In silico* prediction of siRNAs and miRNAs; Small RNAs electrophoresis using PAGE; Blotting of small RNAs on nylon membrane; miRNA target finding; Detection of small RNAs using

fluorescent labelled probes; Bisulphite sequencing for methylation; qRT-PCR for quantitative analysis of small RNAs in developmental phases.

Suggested Readings

- Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual.* 4th Ed. Vol I, II & III Cold Spring Harbor Laboratory Press.
- Mohanpuria P, Kumar V, Mahajan M, Mohammad H & Yadav SK. 2010. *Gene Silencing: Theory, Techniques and Applications: Genetics-Research and Issues.* Nova Science Publishers.

ELECTIVE II

ANIMAL BIOTECHNOLOGY

1. Principles and Procedures of Animal Cell Culture 3(2+1)

Theory

UNIT I

History, importance and development of animal cell culture techniques; Basic requirements for animal cell culture; Sterilization procedures for cell culture work; Different types of cell culture media, growth supplements, serum free media and other cell culture reagents.

UNIT II

Different cell culture techniques including primary and secondary cultures; continuous cell lines, suspension culture, organ culture etc; Commonly used animal cell lines: CHO, HeLa, BHK-21, VERO, Sf9, C636; Their origin and characteristic, growth kinetics of cells in culture, differentiation of cells; Characterization and maintenance of cell lines; Applications of animal cell cultures.

UNIT III

Cryopreservation and revival of cells; Hybridoma technology; Scaling up methods; bioreactors; Overview of insect cell culture; Stem cell culture and its application; Common cell culture contaminants and their management.

Practical

Basic equipments used in animal cell culture laboratories; Washing, packing and sterilization of glass and plastic wares for cell culture; Preparation of media and reagents for cell culture; Primary culture technique of chicken embryo fibroblast; Culture and sub-culturing of continuous cell lines; Viability assay by trypan blue dye exclusion method; Isolation and cultivation of lymphocytes; Cryopreservation of primary cultures and cell lines; Cytopathic effect of viruses on cultured mammalian cells.

Suggested Readings

- Butler M. 2003. *Animal Cell culture & Technology*. Garland Science.
- Freshney RI. 2011. *Culture of Animal Cells: A manual of basic technique and specialized applications.* 6th Ed. John Wiley & Sons.

2. Animal Genomics 3(2+1)

Theory

UNIT I

Genome organization in eukaryotes; Satellite DNA: VNTRs & families, LINE & SINE; Sex determination: Chomosomal basis of sex determination, Molecular markers for sex determination, environmental sex determination; Chromosomal aberrations: Euploidy, Chromosomal Non-disjunction and Aneuploidy, Polyploidy, Induced Polyploidy, Syndromes, Structural aberrations, Robertsonian Translocations, Position Effect, Chromosomal Mosaics, Chromosomal aberrations and evolution.

UNIT II

Molecular Markers: Markers, Genetic Markers: RAPD, STR, DNA fingerprinting, SSCP, RFLP, SNP, EST; SNP Analysis; karyotyping, Somatic cell hybridization; Radiation hybrid maps; FISH technique; Major Histocompatibility Complex: Concept and its relevance in disease resistance & immune response; Quantitative trait Loci; Marker Assisted Selection: Concept, Linkage Equilibrium, Application in Animal Sciences; Genomic Selection: Concept, Linkage Disequilibrium, Methodologies of economic Selection; Mitochondrial DNA analysis and its application in livestock; Applying DNA markers for breed characterization.

Practical

Extraction of genomic DNA from peripheral blood; Analysis of DNA by agarose or polyacrylamide gel electrophoresis; Checking the quality & quantity of genomic DNA; Restriction digestion & analysis; Sanger Sequencing data analysis; Extraction of mitochondrial DNA; Extraction of RNA from PBMC; Quality checking of total RNA; cDNA synthesis.

Suggested Readings

- Brown TA. 2006. *Genomes*. 5th Ed. Wiley-Blackwell.
- Dale JW, Schantz MV & Plant N. 2012. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.
- Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual.* 4th Ed. Vol I, II & III. Cold Spring.
- Reece RJ. 2004. *Analysis of Genes & Genomes*.Wiley.

3. Embryo Transfer Technologies 3(2+1)

Theory

UNIT I

History, advantages, limitations and scope of embryo transfer technology; Estrus cycle and its detection in animals; Methodology of super ovulation; Ovum pick up (OPU); Preparation of sperm for *in vitro* fertilization (IVF); Embryo grading and culture; Micromanipulation and immuno-modulation for enhancement of fecundity.

UNIT II

Different methods of gene transfer and their limitations; embryo splitting; embryo sexing by different methods; production of transgenic livestock by nuclear transfer and its application; regulatory issues (social, ethical, religious and environmental); Cloning of domestic animals; Conservation of endangered species; Characterization of embryonic stem cells and applications.

Practical

Demonstration of estrus detection methods; Estrus synchronization; Superovulation; Oocyte collection from slaughterhouse ovaries; Grading of oocytes from slaughterhouse ovaries; collection and preparation of semen samples; *In vitro* fertilization; Collection of embryos using non-surgical procedures; Grading and culture of embryos; Embryo sexing by different methods; Embryo splitting; Embryo freezing.

Suggested Readings

- Gordon I. 2004. *Reproductive Technologies in Farm Animals*. CABI.
- Hafez ESE. 2000. *Reproduction in Farm Animals*. Lippincott, Williams & Wilkins.

4. Transgenic Animal Production 3(3+0)

Theroy

UNIT I

History of transgenesis; Isolation of gene, preparation of gene construct; Methods of transgenic animal production: Calcium chloride mediated transfection, lipofection, electroporation, microinjection, nanodelivery.

UNIT II

Production of gene knockouts: cre-lox, zinc finger nucleases; CRISPR; TALENs; Production of chimeric animals; gene silencing by lentivirus system.

UNIT III

Stem cell technology: Isolation and characterization of stem cell lines from different sources: embryo, mesenchymal, induced pluripotent stem cell; Introduction to animal cloning; Application of stem cells in transgenesis and animal cloning.

UNIT IV

Fundamental assays of transgenic products: confirmation of integration of transgene; Validation of transgenic products like isolation of transgenic protein from milk and characterization; Application of transgenics in production of disease resistance models and carcinogenesis. Regulatory issues associated with transgenic animal production.

Suggested Readings

- Ramadass P. 2008. *Animal Biotechnology: Recent Concepts and Developments*. MJP Publishers.
- Ranga MM. 2007. *Animal Biotechnology*. Agrobios.
- Singh BD. 2010. *Biotechnology expanding Horizons*. Kalyani Publishers.
- Singh B. Gautam SK & Chauhan MS. 2014. *Textbook of Animal Biotechnology.* The
- Energy and Resources Institute, TERI.

5. Molecular Diagnostics 3(2+1)

Theory

UNIT I

Principle and applications of molecular diagnostic tests; Nucleic acid based diagnostics for detection of pathogenic organisms: Application of restriction endonuclease analysis for identification of pathogens; Polymerase chain reaction (PCR) and its variants; Reverse transcriptase polymerase chain reaction (RT PCR); isothermal amplification (LAMP); LCR, nucleic acid sequence-based amplification (NASBA); Real-Time PCR; DNA Probes; Southern blotting; Northern blotting; Protein based assays: SDS-PAGE, Western Blot, Dot-blot, ELISA and lateral flow device.

UNIT II

Advantages of Molecular diagnostics over conventional diagnostics; serodiagnostics; DNA array technology; Protein array; tissue array; Biosensors and nanotechnology; Development and validation of diagnostic tests.

Practical

Preparations of buffers and reagents; Collection of clinical and environmental samples for molecular detection of pathogens (bacteria/virus); Extraction of nucleic acids (DNA & RNA) from the clinical specimens; Restriction endonuclease digestion and analysis using agarose gel electrophoresis; Polymerase chain reaction for detection of pathogens in blood and animal tissues; RT-PCR for detection of RNA viruses; PCR based detection of meat adulteration in processed and unprocessed meats; PCR based detection of pathogens in milk, eggs and meat; Lateral flow assay; ELISA.

Suggested Readings

- Debnath M, Prasad GBKS & Bisen PS. 2010. *Molecular Diagnostics: Promises and Possibilities*. Springer Science & Business Media.
- Singh BD. 2010. *Biotechnology expanding Horizons*. Kalyani Publishers.
- Viljoen, GJ, Nel LH & Crowther JR. 2005. *Molecular Diagnostic PCR Handbook*.Springer Science & Business Media.
- Wilson K & Walker J. 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.

6. Molecular Virology and Vaccine Production 3(2+1)

Theory

UNIT I

Properties of viruses; Classification of viruses; Virus replication; Cell transformations, Cultivation of viruses, assay techniques for detection/quantification; Important Animal viruses; Virus-Host interactions; Viral infections; Immune responses to viruses: Interferon and other cytokines; Bio-safety and bio-security principles.

UNIT II

Properties of an ideal vaccine; Classification of vaccines; Methods of inactivation and attenuation of viruses; New generation vaccines: subunit, synthetic, rDNA, marker and edible; Adjuvants and vaccine delivery systems; Novel immunomodulators and vaccine delivery using nanotechnology; Vaccine preparation: Stabilizers, preservatives and vehicles; Quality control and testing of vaccines; Sero-surveillance and sero-monitoring.

Practical

Processing of clinical specimens for isolation of viruses; Cultivation of viruses in cell cultures and embryonated eggs; Harvesting of virus; Study of cytopathic effects; Titration of virus and estimation of $TCID_{50}$;Haemagglutination and Haemagglutination Inhibition test; Detection of virus by SNT, AGID and ELISA.

Suggested Readings

- John Carter J & Saunders V. 2007. *Virology: Principles and Applications.* 2nd Ed. Wiley.
- Morrow WJW, Sheikh NA, Schmidt CS, Davies DH. 2012. *Vaccinology: Principles and Practice*. John Wiley & Sons.
- Sharma S & Adlakha S. 1996. *Textbook of Veterinary Microbiology*. Vikas Publishing House Pvt Ltd.
- Stephenson J & Warnes R. 1998. *Diagnostic Virology Protocols*. Springer Science &Business Media.

ELECTIVE III

MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

1. Microbial Biotechnology 3(2+1)

Theory

UNIT I

Microbial biotechnology, scope and techniques; Industrially important microorganisms; Gene transfer mechanisms in microbes: Transformation, transduction, conjugation and recombination; Genetic variability in microorganisms; Biotechnological tools to improve the microbial strains with respect to industry and agriculture.

UNIT II

Biotransformation and biodegradation of pollutants, biodegradation of lignocelluloses and agricultural residues; Biotechnological treatment of waste water, sewage and sludge; Industrial production of alcohols, ethanol, acids (citric acid, acetic acid), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycine, tetracycline), amino acids (lysine, glutamic acid), single cell proteins; Recombinant and synthetic vaccines.

Practical

Isolation and preservation of industrially important microorganisms; Microbial fermentation, production of proteins and enzymes using bacteria, yeast and fungus; Microbial biomass production, utilization of plant biomass by recombinant microorganisms; Production of secondary metabolites from microbes.

Suggested Readings

- Glaze AN & Nikaido H. 2007. *Microbial Biotechnology: Fundamentals of Applied Microbiology.* 2nd Ed. Cambridge University Press.
- Mohapatra PK. 2006. *Text Book of Environmental Biotechnology*. International Publishing House Pvt. Ltd.

2. Bio-Prospecting of Molecules and Genes 3(3+0)

Theory

UNIT I

Concepts and practices of bioprospecting; Traditional and modern bioprospecting; Gene prospecting; Isolation, synthesis and purification of new bioactive chemicals for laboratory. clinical and field trials; Intellectual property rights, mechanisms and the legal framework; Patenting of new genes and/or bioactive principles with novel antibiotic, insecticidal or anti-tumour properties.

UNIT II

Principles of the Convention on Biological Diversity, biodiversity conservation and biotechnology; Development and management of biological, ecological, taxonomic, and related systematic information on living species and systems.

UNIT III

Bioprospecting of microorganisms and their components; Bioprospecting of biodiversity for new medicines: Identification and collection of material by random and traditional (medicinal) approaches; Screening for particular bio-activities; Elucidation of novel molecular form, process technology; Development of techniques for large scale industrial production of the final bioactive product and its market availability and accessibility to the public.

Suggested Readings

- Mohapatra PK. 2006. *Text Book of Environmental Biotechnology*. International Publishing House Pvt. Ltd.
- Sharma PD. 2012. *Ecology and Environment*. 11th Ed. Rastogi Publications.

3. Molecular Ecology and Evolution 3(3+0)

Theory

UNIT I

Molecular Evolution: Concept, molecular divergence and molecular clocks; Speciation and domestication; Evolution of earth and earlier life forms; Primitive organisms,their metabolic strategies and molecular coding; New approaches to taxonomical classification including ribotypeing, Ribosomal RNA sequencing; Molecular tools in phylogeny, classification and identification.

UNIT II

Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence; Genome evolution, components of genomes, whole genome duplications, chromosome rearrangements and repetitive sequence evolution.

UNIT III

Application of molecular genetics and genomics to ecology and evolution; Assessment of genetic diversity, phylogeny, inbreeding, quantitative traits using molecular tools; Mutations; Regulations of gene expression.

Suggested Readings

- Beebee T & Rowe G. 2008. *An Introduction to Molecular Ecology*. 2nd Ed. Oxford University Press.
- Brown TA. 2007. *Genome 3*. Garlan Science Publishing.
- Carvalho GR. 2002. *Advances in Molecular Ecology*. IOS Press Netherland.

4. Fundamentals of Molecular Pharming and Biopharmaceuticals 3(2+1)

Theory

UNIT I

Concept of molecular pharming and production of biopharmaceuticals; Mammalian cell culture manufacturing and microbial fermentation; Fermentation and cell culture processing; Protein purification and processing; Industrial fermentation: batch and continuous cultures, production of biopharmaceuticals, immobilization techniques.

UNIT II

Biopharmaceutical analytical techniques; Biopharma drug discovery and development; production of specific vaccines and therapeutic proteins.

Practical

Isolation & purification of proteins from microbes and plants; Production of recombinant proteins in prokaryotes; Analysis of proteins by one and two dimensional gel electrophoresis; Affinity chromatography; Immunoblotting; Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

Suggested Readings

- Brown TA. 2010. *Gene Cloning and DNA analysis: An Introduction*. 6th Ed. Wiley-Blackwell Publishing.
- Kirkosyan A & Kaufman PB. 2009. *Recent Advances in Plant Biotechnology*. Springer.
- Primrose SB & Twyman RM. 2013. *Principles of Gene Manipulation and Genomics*.
- John Wiley & Sons.

5. Food Biotechnology 3(2+1)

Theory

UNIT I

Food Biotechnology: Introduction, history and importance; Applications of biotechnology in food processing: Recent developments, risk factors and safety regulations; Food spoilage and preservation process; Food and beverage fermentation: Alcoholic and non alcoholic beverages, food additives and supplements.

UNIT II

Industrial use of micro organisms; Commercially exploited microbes: *Saccharomyces, Lactobacillus, Penecillium, Acetobactor, Bifidobacterium, Lactococcus* and *Streptococcus*; Dairy fermentation and fermented products; Prebiotics and probiotics; Genetic engineering for food quality and shelf life improvement; Bioactive peptides; Labelling of GM foods.

Practical

Isolation, culture and maintenance of biotechnologically important micro-organisms; Use of laboratory and industrial scale shakers; Batch and continuous cultures; Use of fermentors; Detection of pathogens in food and feed; Detection of GM food; Visit to food processing industry.

Suggested Readings

- Hui YH & Khachatourians GG. 1995. *Food Biotechnology: Microorganisms*. Wiley-VCH
- Shetty K, Paliyath G, Pometto A. & Levin RE. 2006. *Food Biotechnology*. 2nd Ed. CRC Press.

6. Green Biotechnology 3(2+1)

Theory

UNIT I

Green biotechnology: Definition, concept and implication; Bio-fertilizers and bio-pesticides; Plant growth promoting rhizobacteria; Production of biofuels, biodiesel and bioethanol; Biomass enhancement through biotechnological interventions; Generation of alternate fuels in plants; Identification and manipulation of micro-organisms for biodegradation of plastics and polymers; GMOs for bioremediation and phytoremediation, their roles; Strategies for detection and control of soil, air and water pollutants.

UNIT II

Carbon sequestration; Methanogenic microbes for methane reduction; Microbes for phytic acid degaradation; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Marker-free transgenic development strategies; Development of disease resistant and pest resistant crops through biotechnological tools.

Practical

Identification and efficiency assays of micro-organisms for biodegradation and bioremediation; Isolation of *Bacillus thurigenesis* and plant growth promoting rhizobacteria; Production of biofertilizers, biopesticides and biofuel; Assays for removal of oil spillage.

Suggested Readings

- Kirkosyan A & Kaufman PB. 2009. *Recent Advances in Plant Biotechnology*. Springer.
- Kumar A. 2004. *Environmental Biotechnology*. Daya Publishing House.
- Murray DC. 2011. *Green Biotechnology*. Dominant Publishers and Distributors.

ELECTIVE IV

BIOINFORMATICS

1. Programming for Bioinformatics 4(2+2)

Theory

UNIT I

Introduction: Operating systems, programming concepts, algorithms, flow chart, programming languages, compiler and interpreter; Computer number format: Decimal, Binary, Octal and Hexadecimal.

UNIT II

C-Language: History, constant, variables and identifiers, character set, logical and relational operators, data input and output concepts; Decision making: if statement, if-else statement, for loop, while loop and do-while loop; Arrays and functions, file handling; Programs related to arithmetic operations, arrays and file handling in C.

Practical

UNIT I

PERL-Language: Introduction, variables, arrays, string, hash, subroutines, file handling, conditional blocks, loops string operators and manipulators, pattern matching and regular expressions in PERL; Sequence handling in PERL demonstrating string, array and hash.

UNIT II

Shell Programming: Concepts and types of UNIX shell, Linux variables, if statements, control and iteration, arithmetic operations, concepts of awk, grep and sed; Sequence manipulations using shell scripting.

Suggested Readings

- Balagurusamy. 2008. *Programming in ANSI C*. Tata McGraw-Hill Education.
- James Tisdall. 2003. *Mastering Perl for Bioinformatics*. O'Reilly Media.
- Tom Christiansen, Brian D Foy, Larry Wall & Jon Orwant. 2012. *Programming Perl*. 4thEd. O'Reilly Media.
- Kanetkar Yashavant. 2013. *Let Us C*. BPB Publications.

2. Bioinformatics Tools and Biological databases 3(2+1)

Theory

UNIT I

Introduction: Biological data types, collection, classification schema of biological databases; Biological databases retrieval systems; Sequence and molecular file formats.

UNIT II

Biological databases: Nucleotide database, protein database, structural database, genome databases, metabolic pathway database, literature database, chemical database, gene expression database, crop database with special reference to BTISNET databases.

UNIT III

Bioinformatics Tools: Concept of alignment, scoring matrices, alignment algorithms, heuristic methods, multiple sequence alignment, phylogenetic analysis, molecular visualization tools.

Practical

NCBI; Expasy: SwissProt; EBI; Search engines: ENTREZ and SRS; Perform local alignment using all BLAST variants; Multilple sequence alignment using ClustalW; T Coffee; phylogenetic analysis by PHYLIP; MEGA.

Suggested Readings

- Baxevanis AD, Ouellette BFF. 2001. *Bioinformatics: A practical guide to the analysis of genes and proteins*. John Wiley and Sons.
- Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.
- Xiong J. 2006. *Essential Bioinformatics.* Cambridge University Press.

3. Structural Bioinformatics 3(2+1)

Theory

UNIT I

Introduction to structural databases of macromolecules, natural and synthetic small molecules; Structure of amino acids; Protein structure classification, Ramachandran plot; Experimental structure determination methods; Motifs, domain, profiles, fingerprint and protein family databases.

UNIT II

Structural features of RNA, RNA secondary structure predictions; RNA folding; Small RNA prediction.

UNIT III

Structure prediction: Basics of protein folding, protein folding problem, molecular chaperons; Secondary structure prediction methods and algorithms: Homology, *ab initio* and folding based tertiary structure prediction; Structure validation tools, energy minimization techniques;

Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov chain and HMM; Structure visualization and comparison methods.

Practical

Protein structural classification databases, 3D-Structural databases searching and retrieval, Ramchandran Plot, Structural visualization tools, Tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISSPDB viewer, CPH, MODELLER, SWISS Model, EasyModeler, Procheck; GROMAC; SANJIVNI; BHAGIRATH.

Suggested Readings

- A.Malcolm Campbell & Laurie J.Heyer. 2007. *Discovering Genomics, Proteomics and Bioinformatics*. Benjamin Cummings.
- Allan Hinchkliffe. 2008. *Modeling for Beginners*. Wiley.
- Creighton TE. 1993. *Proteins: Structures and Molecular Properties*. W.H. Freeman
- Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.
- Setubal Joao & Meidanis Joao. 1997. *Introduction to Computational Molecular Biology.*PWS Publishing Company

4. Pharmacogenomics 3(2+1)

Theory

UNIT I

Basic concepts of pharmacogenomics, clinical application and challenges in pharmacogenomics; Human Genome Project, genetic diseases, personalized medicine and pharmacogenomics necessity in drug designing; Prediction of structural changes among sequence variants and genetic analysis; Microsatellites for studying genetic variations; Drug databanks; Gene therapy.

UNIT II

Drug Design: Study of important drug targets and their variations; Pharmacophore designing, prediction of ADME properties; Computational tool for toxicity prediction; SAR and QSAR techniques in drug designing; Drug receptor interactions; Structural based drug design; Lipinski's rule in drug design.

Practical

Receptor-Ligand interactions, Pharmacophore development; OSDD; DrugBank; PubChem; molecular representation using SMILES; Chemsketch: 2D and 3D structure; Structure analyses using Chimera/VMD; Detection of active site of proteins using various software; bioavailability using Mol inspiration; Docking using HEX and AUTODOCK.

Suggested Readings

- Allan Hinchkliffe. 2008. *Modeling for Beginners*. Wiley- Blackwell Publishing.
- GerdFolkers, Wolfgang Sippl, Didier Rognan & Hans Dieter. 2003. *Molecular Modeling : Basic Principles and applications*. Science.
- Gupta S.P. 1996. *Quantum Biology*. New Age.
- Lisa B. *Combinatorial Library Methods and Protocols*

5. Metabolomics and System Biology 3(2+1)

Theory

UNIT I

Metabolomics overview, major metabolic pathways: Glycolysis, Kreb's cycle, oxidative phosphorylation, amino acid, fatty acid and nucleotide metabolism, their control and integration; Metabolic flux and metabolic profiling; Catalytic mechanisms and enzyme kinetics, Michaelis-Menton kinetics; Conformational change, allosteric regulations, regulation of metabolic pathways; Signal transduction: Inter and intra cellular communications; Receptor ligand interaction; Structural components of signal pathways: G-protein, Jak-stat, receptor tyrosine kinase.

UNIT II

Signal Flow: Pathway to networks, small scale system biology experiments; System analysis of complex diseases, system pharmacology; Assembling large data sets in genomics and proteomics, computational analysis of large data sets, building networks; Mathematical representation of cell biological system, time and space.

Practical

Metabolic pathway databases KEGG, BRENDA, Biosilico, Protein-protein interaction databases, Swiss 2D PAGE, E-PCR; Creating networks using Cytoscape, DAVID, MAS3; in silico functional annotation using GO, AGRIGO, PANTHER, BLAST2GO.

Suggested Readings

- Berg JM, Tymoczko JL & Stryer L. 2002. *Biochemistry*. 5th Ed. W.H. Freeman and Company.
- Fersht A. 1999. *Structure and Mechanism of protein science*. W.H. Freeman and Company.
- Klipp E, Herwig R, Kowald A, Wierling C, Lehrach H. 2006. *Systems Biology in practice. Concepts, implementation and Application*. Wiley VCH.
- Vaidynathan S, Harrigan GG, Royston Goodacre. 2005. *Metabolome analysis: Strategies for system biology*. Springer.
- Voet D & Voet J. 2002. *Biochemistry* 3rd Ed. John Wiley and Sons.

6. Computational Methods for Data Analysis 2(1+1)

Theory

UNIT I

Introduction to UNIX/LINUX operating system; Knowledge discovery and data mining techniques; Machine learning and pattern recognitions, hidden markov models; Artificial neural networks, Support vector machines.

UNIT II

Principal component analysis, ANOVA; AMOVA and different clustering methods; Gene Prediction algorithms and Phylogeny algorithms; Basics of R statistical package.

Practical

Gene prediction: FGENESH; R statistical package installation and configuration, GUI for R: R-commander, R-studio, RKWard; Analysis of gene expression using R; GNU PSPP, Scilab, QtiPlot.

Suggested Readings

- Gareth James, Daniela Witten, Trevor Hastie & Robert Tibshirani. 2013. *An Introduction*
- *to Statistical Learning: with Applications in R.* Springer
- Mathur K Sunil. 2010. *Statistical Bioinformatics with R*. Elsevier.

Agriculture Courses

Courses marked with double asterisk (*) with a total of 12 credit hours will be optional alternative to package of Animal Courses marked with asterisk (**)

1. Crop Production Technology 3(2+1)

Theory

UNIT I

Soil and its components; Soil morphological, physical, chemical and biological properties; Acidic, saline and alkali soils and their reclamation; Essential plant nutrients: Functions and deficiency symptoms; Soil micro-organisms; Rhizosphere and its domain in soil; Organic manures and inorganic fertilizers.

UNIT II

Agriculture; Agronomy and its relation with other sciences; Classification of crops; Tillage and tillage practices, concepts of tillage and objectives; Seed, its characteristics and different sowing methods; Weed management: definition of weed, losses and benefits of weeds, different weed control methods and their suitability under different conditions; Irrigation: Soil water classification, methods of irrigation, approaches for scheduling irrigation.

UNIT III

Soil fertility and productivity; Concept of essentiality of plant nutrients; Fertilizers, manures and their types, methods of fertilizer application; Concepts of crop rotation, multiple cropping and intercropping - their principles, advantages and limitations; Cropping intensity; Production technology of major crops: Rice, maize, cotton, soybean, mung bean, mash, wheat, rapeseed and mustard, gram and Egyptian clover.

Practical

Study of soil profile and its characteristics; Determination of soil particle size distribution, particle density and bulk density; Determination of soil pH, electrical conductivity and organic carbon; Isolation of soil micro-flora (bacteria, fungus and actinomycetes).

Land measurement; Practice in seedbed preparation and seeding methods; Identification of crop seeds, crops, weeds and fertilizers; Identification and use of hand tools and implements; Computation of fertilizer doses and their method of application.

Suggested Readings

- Acquaah G. 2005. *Principles of Crop Production: Theory, Techniques and Technology.* Prenice Hall.
- Alexander M. 1977. *Introduction to Soil Microbiology*, 2nd Edition. John Wiley & Sons.
- Balasubrananiyan P & Palaniappan SP. 2010. *Principles and Practices of Agronomy.* Agrobios.
- Brady NC & Well RR. 2002. *The Nature and Properties of Soils,* Thirteenth Edition. Pearson Prentice Hall.
- Chandrasekaran B, Annadural K & Samasundaram E. 2010. *A Text Book of Agronomy.* New Age International (P) Limited Publishers.
- Das DK. 2011. *Introductory Soil Science.* Third Revised Edition, Kalyani Publishers.
- Reddy SR. 2011. *Principles of Agronomy.* Kalyani Publishers.

2. Production Technologies for Horticultural Crops 3(2+1)

Theory

UNIT I

Importance and scope of fruit cultivation; Classification of fruit crops; Climatic requirement; Selection of site; Fencing and wind break; Lay out and planting systems; Sexual and asexual methods of plant propagation; Production technology of important tropical, sub tropical and temperate fruit crops.

UNIT II

Importance of vegetable cultivation for nutritional security; Production technology of important vegetable crops: potato, brinjal, tomato, chilli, onion, okra, cabbage, cauliflower, musk melon, water melon, cucumber and leafy vegetables.

UNIT III

Status and scope of floriculture in India and abroad; Production technology of commercial flower crops: Rose, chrysanthemum, gladiolus, marigold, gerbera, carnation, lilium, jasmine, anthurium and orchids.

Practical

Identification of different fruit, vegetables, ornamental and flower crops; Lay out and planning for planting orchards; Preparation of seed beds; Raising of seeds, rootstocks, and propagation techniques of major fruit, vegetable and flower crops; Visit to commercial nurseries and orchards.

Suggested Readings

- Arora JS. 2013. *Introductory Ornamental Horticulture. Kalyani Publishers.*
- Bal JS. 2013. *Fruit Growing. Kalyani Publishers.*
- Chadha KL. 2012. *Handbook of Horticulture. ICAR*
- Dhaliwal MS. 2014. *Handbook of Vegetable Crops. Kalyani Publishers*

3. Basics of Plant Breeding 3(2+1)

Theory

UNIT I

History, aims and objectives of Plant breeding; Role of related sciences in plant breeding; Modes of reproduction - sexual, asexual, apomixes: Significance in plant breeding; Modes of pollination, genetic consequences, differences between self- and cross pollinated crops; Germplasm resources and their utilization.

UNIT II

Methods of breeding: Introduction and Acclimatization; Selection: Mass selection, Johannesen's pure-line theory, genetic basis, pure-line selection; Hybridization: Aims and objectives, types of hybridization; Methods of handling segregating generations: Pedigree method, bulk method, back cross method; Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigor, Hardy Weinberg law, selection in cross pollinated crops; Population improvement programmes; Synthetics and composites; Methods of breeding vegetatively propagated crops.

UNIT III

Incompatibility and male sterility and their utilization in crop improvement; Mutation breeding; Ploidy breeding; Wide hybridization and its significance in crop improvement; Procedure for release of new varieties.

Practical

Classification of plants; Botanical description and floral biology of field crops: rice, sorghum, maize, wheat, bajra, sugarcane, brassicas, groundnut, sunflower, sesamum, red gram, bengal gram, green gram, soybean, black gram, cotton; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Hybridization techniques and precautions to be taken; selfing, emasculation and crossing techniques; Study of male sterility and incompatibility.

Suggested Readings

- Allard RW. 1960. *Principles of Plant Breeding.* John Wiley and Sons.
- Chahal GS & Gosal SS. 2002. *Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches.* Narosa Publishers.
- Phundan Singh. 2014. *Essentials of Plant Breeding.* Kalyani Publishers.
- Singh BD. 2009. *Plant Breeding: Principles and Methods.* Kalyani Publishers, India.

4. Breeding of Field Crops 3(2+1)

Theory

Unit I

Application of genetic, cytogenetic and biotechnological techniques in breeding of: Wheat, triticale, rice, maize, bajra, barley, sorghum, cotton, sugarcane, important pulses, oilseeds and forage crops including their origin and germplasm sources.

Unit II

Problems and present status of crop improvement in India with emphasis on the work done in state National and International centres of crop improvement.

Unit III

Classes of seed; seed production and maintenance; seed storage; seed certification.

Practical

Emasculation and hybridization techniques; Handling of segregating generations : pedigree method, bulk method, back cross methods; Field layout of experiments; Field trials, maintenance of records and registers; Estimation of heterosis and inbreeding depression; Estimation of heritability; Parentage of released varieties/hybrids; Study of quality characters; Sources of donors for different characters; seed sampling; seed quality; seed viability; seed vigour; seed health testing; Visit to seed production plots.

Suggested Readings

- Chopra VL 2001. *Breeding Field Crops.* Oxford and IBH Publishing Co.
- Fehr WR. 1987. *Principles of Cultivar Development, Vol. II Crop Species*. MacMillan Publishing Co.
- Sleper DA & Poehlman JM. 2006. *Breeding Field Crops.* Wiley-Blackwell.

5. Fundamentals of Crop Protection 3(2+1)

Theory

UNIT I

Insects - their general body structure; Importance of insects in agriculture; Life cycle of insects; Insects diversity; Feeding stages of insects and kinds (modifications) of mouth parts; Concepts in population build-up of insects – GEP, DB, EIL, ETH and pest status; Causes of insect-pests out break; General symptoms of insects attack; Principles and methods of insect-pests management; Integrated Pest Management concept; Bioecology and management of important pests of major crops and storage products.

UNIT II

Importance and scope of plant pathology; Concept of disease in plants; Nature and classification of plant diseases; Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites; Pathogenesis due to obligate and facultative parasites; Variability in plant pathogens; Conditions necessary for development of disease epidemics; Survival and dispersal of plant pathogens; Management of key diseases and nematodes of major crops.

Practical

Familiarization with generalized insect's body structure and appendages; Life stages; Acquaintance with insect diversity; Identification of important insect-pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms

of damage; Acquaintance with useful insects: predators,parasitoids, pollinators, honey bees and silk worms; Acquaintance with various pesticidal formulations; Principles and working of common plant protection appliances; Calculation for preparing spray material; Acquaintance to plant pathology laboratory equipment; Preparation of culture media for fungi and bacteria; Demonstration of Koch's postulates; Study of different groups of fungicides and antibiotics and methods of their evaluation; Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and their characteristic symptoms.

Suggested Readings

- Agrios, GN. 2010. *Plant Pathology*. Acad. Press.
- Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South-Asia and Their Management.* Kalyani Publishers.
- Dhaliwal GS & Arora R. 1996. *Principles of Insect Pest Management.*National Agriculture Technology Information Centre.
- Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publishers.
- Mehrotra RS & Aggarwal A. 2007. *Plant Pathology.* 7th Ed. Tata Mc Graw Hill Publ.Co. Ltd.
- Singh H. 1984. *House-hold and Kitchen Garden Pests - Principles and Practices.* Kalyani Publishers.
- Singh RS. 2008. *Plant Diseases.* 8th Ed. Oxford & IBH. Pub. Co.
- Singh RS. 2013. *Introduction to Principles of Plant Pathology.* Oxford and IBH Pub. Co.
- Stakman EC & Harrar JG. 1957. *Principles of Plant Pathology*. Ronald Press, USA.
- *Tarr SAJ*. 1964. *The Principles of Plant Pathology*. McMillan, London.
- *Vander Plank, JE.* 1975. *Principles of Plant Infection.* Acad. Press.

Animal Science Courses

Courses marked with asterisk (**) with a total of 12 credit hours will be optional alternative to package of Agriculture Courses marked with double asterisk (*)

1. Anatomy and Physiology of Livestock 3(3+0)

Theory

UNIT I

Definition of terms used in veterinary anatomy, topography, contour, landmarks and functional anatomy of various organs in cow, buffalo, sheep and goat structural and functional classification of muscles.

UNIT II

Structure of animal cell and tissues: study of microscopic structure of organs from digestive, urinary, respiratory, reproductive, nervous, cardiovascular and endocrine systems; Gametogenesis, fertilization, cleavage, gastrulation and the development of fetal membranes in livestock, structure and types of mammalian placenta; Development of the organs of digestive, urogenital, cardiovascular, nervous and endocrine glands.

UNIT III

Introduction to blood physiology; Genetic and endocrine control of reproductive system; maternal recognition of pregnancy; Introduction to physiology of mammary glands: structure and development, hormonal control of mammary growth, lactogenesis and lactation cycle.

Suggested Readings

- Keith Dyce & Wolfgang Sack & Wensing CJG. 2009. *Textbook of Veterinary Anatomy*, 4th Edition. Elsevier Health Sciences.
- Rowen D. Frandson, W. Lee Wilke & Anna Dee Fails. 2009. *Anatomy and Physiology of Farm Animals.* 7th Edition. Wiley–Blackwell.
- William O, Reece. 2004. *Duke's Physiology of Domestic Animals.* 12th Edition. Comstock Publishing Associates.

2. Introduction to Animal Breeding 3(2+1)

Theory

UNIT I

Population and Population Genetics; Hardy- Weinberg Law; Hardy Weinberg Equilibrium; Approaching to Equilibrium for sex linked trait; Linkage Equilibrium; Effect of linkage on HW-equilibrium; Stochastic and Deterministic Forces acting on Population; Mutation; Migration; Selection.

UNIT II

Dissection of Phenotype into its components; Transmitting Ability, Substitution effect of allele; Breeding Value: Definition, concept; Heritability: Definition, Concept, Estimation of heritability from regression of offspring to parents; Repeatability: Definition, Concept and estimation; Correlated traits: Phenotypic and Genetic correlation, Environmental correlation; Selection Index: Basic concept and types; Bases of selection.

UNIT III

Breeding strategies in large ruminants (cattle, buffalo), small ruminants (sheep, goat) and swine; Poultry breeding; Lab animal breeding; Breed improvement programs conducted in India; Molecular breeding: complementation of traditional breeding strategies with molecular genetics.

Practical

Chi-squared test for determining goodness of fit for HW-equilibrium; Estimation of effect of allelic substitution; Estimation of heritability: regression of offspring on parents; Estimation of repeatability; Phenotypic correlation, genetic correlation, environmental correlation; Chi-squared test for determining goodness of fit for HW-equilibrium; Linkage analysis from pedigree data ; Selection index.

Suggested Readings

- Brah GS. 2014. *Animal Genetics: Concepts and Implications.* 2nd Ed. Kalyani Publishers.
- Nicholas FW. 2010. *Introduction to Veterinary Genetics.* 3rd Ed. Wiley-Blackwell Publication.
- Richard M. Bourdon. 1999. *Understanding Animal Breeding.* 2nd Ed. Prentice Hall.

3. Livestock Production and Management 3(2+1)

Theory

UNIT I

Livestock history in India: Vedic, medieval and modern era; Demographic distribution of livestock and role in economy; Introductory animal husbandry; Breeds of livestock; Cattle, Buffalo, Sheep, Goat and Pig; Important traits of livestock; General management and feeding practices of animals; Handling and restraining of animals; Housing systems. Importance of grasslands and fodders in livestock production; Common farm management practices including disinfection, isolation, quarantine and disposal of carcass; Common vices of animals and their prevention; Diseases and parasite control & hygiene care.

UNIT II

History and economic importance of poultry; Poultry breeds; Reproductive system of male and female birds; Formation and structure of eggs; Important economic traits of poultry, Egg production, Egg weight, Egg quality; Fertility and Hatchability, Plumage characteristics and comb types.

Care and management of chicks, grower and layers/broiler; Brooding management; Hatchery practices; Poultry Diseases, control and hygiene care;

Practical

Visit to livestock farms/demonstration centres; Breeds of cattle, buffalo, sheep, goat and Pigs; Familiarization with body parts of animals; Handling and restraining of cattle, buffalo, sheep, goat and swine; Male and female reproductive system and Artificial Insemination; Feeding of livestock; Methods of identification: marking, tattooing, branding, tagging; Milking methods; Record Keeping

Visit to the Poultry farm; Poultry breeds; Body parts of chicken, duck, quail and turkey; Housing, equipment, nesting and brooding requirements; Male and female reproductive system; Methods of identification and sexing; Hatchery layout and equipment; Identification of diseases and control of parasites, Vaccination; Maintenance of farm records;

Suggested Readings

- Banerjee GC. 1989. *Text Book of Animal Husbandry.* Oxford and IBH.
- ICAR. 1962. *Handbook of Animal Husbandry*. ICAR Publication.
- Parsad Jagdish. 2001. *Poultry Production and Management.* Kalyani Publishers.
- Sastry NSR & Thomas CK. 1991. *Dairy Bovine Production.* Kalyani Publishers.
- Singh RA. 1990. *Poultry Production.* Kalyani Publishers.
- Thomas CK & Sastry NSR. 2013. *Livestock Production Management.* Kalyani Publishers.

4. Livestock Product Technology 3(2+1)

Theory

UNIT I

Composition and nutritive value of milk and factors effecting composition of milk; Physiochemical properties of milk; Determination of microbial load in milk and milk products; Milk Processing: Collection, chilling, standardization, pasteurization and homogenization; Toxins and pesticide residues in milk and milk products; Organic milk food products; Bureau of Indian Standards for milk and milk products; Sanitation in milk plant.

UNIT II

Retrospect and prospects of meat industry in India; Structure and composition of muscle (including poultry), nutritive value of meat, Meat adulteration, preservation of meat, Physico – chemical and microbiological quality of meat and meat products. Laws governing national, international trade in meat and meat products, organic meat food products, food products of genetically modified animals.

Practical

Sampling of milk, estimation of fat, solids not fat (SNF) and total solids, Platform tests, cream separation, Microbiological quality of milk, meat and meat products. Chilling/freezing of meat, meat products, preservation of meat and meat products. Visit to modern milk and meat processing units.

Suggested Readings

- Aberle ED, Forrest JC, Gerrard DE & Mills EW. 2012. *Principles of Meat Science.*5th Eds.
- Kendall Hunt Publishing
- Ledward DA & Lawrie RA. 2006.*Lawrie's Meat* Science, 7th Eds. Woodhead Publishing
- Sharma BD.1999. *Meat and Meat Products Technology: Including Poultry Products Technology.* Jaypee Bros. Medical Publishers
- Sukumar De. 2001.*Outlines of Dairy Technology*. Oxford University Press.
- Varnam A & Sutherland JP. 2001.*Milk and Milk Products: Technology, Chemistry and Microbiology.* Springer Science & Business Media

5. Animal Health Care 3(2+1)

Theory

UNIT I

Introduction to animal health; history of disease diagnoses and medicine; classification of diseases; Introduction to fore stomach disorders in ruminants.

UNIT II

Introduction to important diseases of respiratory, urinary, musculoskeletal and cardiovascular system of domestic animals. Introduction to common metabolic, bacterial, viral, parasitic and blood protozoan diseases of domestic animals. Importance of animal health in relation to public health.

Practical

Introduction to veterinary hospital; methods of sample collection; introduction to common disease diagnostic tests in animals; vaccination schedule in domestic animals. Microscopic examination of parasites. Clinical diagnostics: urine, blood, milk, sputum, faeces examination.

Suggested Readings

- Blood DC & Henderson JA. 1968. *Veterinary Medicine.* Bailliere Tindall publishers.
- Bradford P & Smith DVM. 2014. *Large Animal Internal Medicine.* 5th edition. Mosby Publishers.
- Chakrabarti Amalendu. 2007. *Textbook of Clinical Veterinary Medicine.* Kalyani Publishers.
- Stephen J, Ettinger DVM, Edward C & Feldman DVM. 2010. *Textbook of Veterinary Internal Medicine Expert Consult.* 7th edition. Saunders Publishers.

Minimum Standards for Establishing a College of Biotechnology

1. **Degree Nomenclature:** B.Tech. Biotechnology

   The UG degree will have four areas of choice for elective *viz.* Plant Biotechnology, Animal Biotechnology, Microbial & Environmental Biotechnology, and Bioinformatics.

2. **Eligibility Criteria:** 10+2/Intermediate with PCM/PCMB/PCB (P - Physics, C - Chemistry, M - Mathematics and B -Biology) from a recognised Board/university
3. **Medium of Instruction:** English
4. **Minimum Intake:** 50 students per year

   **Maximum number of students in any practical group*: 25
5. **Divisions/Departments /Section: Three Divisions and One Section**
   1) Division of Plant Biotechnology (PB)
   2) Division of Animal Biotechnology (AB)
   3) Division of Microbial and Environmental Biotechnology (MEB)
   4) Bioinformatics Section

6. Faculty Requirements for Divisions/Section

Division/Section	Faculty			Total
	Professor	Associate Professor	Assistant Professor	
Division of Plant Biotechnology	1	2	6	9
Division of Animal Biotechnology	1	2	6	9
Division of Microbial and Environmental Biotechnology	1	2	6	9
Bioinformatics Section	1	2	4	7
Total	4	8	22	34

Note: Services of the existing faculty will be utilised for teaching the supporting courses

7. Administrative and Supporting Staff for Divisions/Section

Division/ Section	Steno/PA/ Computer Operator	Assistant	Attendant/ Messenger	Clerk	Laboratory Assistant/ Attendant	Field Staff
Plant Biotechnology	2	1	2	1	6	3
Animal Biotechnology	2	1	2	1	6	3
Microbial and Environmental Biotechnology	2	1	2	1	6	3
Bioinformatics Section	5	1	2	1	1	-
Total	**11**	**4**	**8**	**4**	**19**	**9**

Note: Security services to be outsourced

8. Faculty Expertise

Division/Section	Faculty Expertise	
	Core	**Associated**
Plant Biotechnology	Plant Molecular Biology, Tissue culture and Genetic Transformation, Genetics, Microbiology, Plant Biochemistry	Plant Breeding, Plant Protection, Plant Physiology, Agronomy, Horticulture, Forestry
Animal Biotechnology	Cell Culture and Genetic Transformation, Molecular Biology, Animal Genetics, Animal Biochemistry, Animal Microbiology, Immunology	Animal Breeding, Animal Physiology, Live Stock Production and Management
Microbial and Environmental Biotechnology	Microbiology, Microbial Genetics, Microbial Engineering, Biochemistry	Plant Physiology, Water and Soil Sciences, Analytical Chemistry, Agrometeorology, Food Science and Technology
Bioinformatics Section	Bioinformatics, Information Technology	Plant and Animal Biotechnology, Statistics/ Biostatistics

9. Central/Division/Section Laboratories (as per requirements of the teaching and research work of the college)

Division/Section	Laboratory
Central Research and Teaching Laboratories	- DNA sequencing, SNP Genotyping and Proteomics Laboratory - High Performance Computing Facility - Cold Rooms: -20°C, 4°C - Liquid Nitrogen Plant - Computer Lab
Plant Biotechnology	- Plant Genomics Laboratory - Functional Genomics Laboratory - Genetic Transformation Laboratory - Molecular Breeding Laboratory - Proteomics and Metabolomics Laboratory
Animal Biotechnology	- Animal Genomics Laboratory - Functional Genomics Laboratory - Arthropod Molecular Biology Laboratory - Animal Cell culture Laboratory - Immunology Laboratory
Microbial and Environmental Biotechnology	- Microbial Genetics and Genomics Laboratory - Environmental and Soil Microbiotechnology Laboratory - Bioremediation Laboratory

Division/Section	Laboratory
Bioinformatics Section	- Sequence Analysis Laboratory - Computational Biology Laboratory

10. Manpower Requirements of Dean's Office

Manpower	Number
Dean	1
A. Establishment	
PA to Dean	1
Administrative Officer	1
Superintendent	1
Steno/Computer operator	4
Assistant	2
Operator (Audio Visual)	1
Attendants/Messengers	4
Clerk (LDC)	4
Electrician	1
Store Keeper	1
Driver	6
Security, Sanitation and Landscaping	To be outsourced
B. Central Research and Teaching Laboratories (Four Laboratories)	
Assistant Professor (Genomics)	1
Assistant Professor (Computer Engineering)	1
Computer Assistant	1
Laboratory Technicians	2
Laboratory Assistant	1
Laboratory Attendant	3
C. Library Staff	
Assistant Librarian	1
Library Assistant	1
Clerk	1
Shelf Assistant	2
D. Students Welfare	
To be provided by the Institute as the Central Facility	
E. Hostel Staff for two Hostels	
Wardens	1+1

Manpower	Number
Assistant Wardens	1+1
Clerk (LDC)	2
Attendants	8
Security, Sanitation and Landscaping	To be outsourced

11. Land Requirements

Main building and hostels	:	4 ha
Field area	:	10 ha
Play grounds	:	From common facility of the institute
Total	:	**14 ha**

12. Floor Space Requirement

A) Central Facilities

S. No.	Details	Number of Rooms	Dimensions
1	Dean office	1	20' x 24'
2	PA room	1	20' x 12'
3	Committee room with video conferencing facility	1	20' x 48'
4	Administrative officer room	1	20' x 12'
5	Admin. staff rooms	3	20' x 36' each
6	Examination cell	1	20' x 12'
7	Evaluation room	1	20' x 36'
8	Faculty room	1	20' x 12' each
9	Placement cell	1	20' x 48'
10	Smart Lecture rooms	5	Seating capacity - 70
11	Auditorium (optional)	1	Seating capacity - 300
12	Library/Book bank	1	30' x 72'
13	Examination hall (optional)	1	Seating capacity - 300
14	Multipurpose room	1	20' x 36'
15	Laboratories	4	30' x 48' each
16	Hostels	2	One each for Boys & Girls
17	Generator shed	1	20' x 36'
18	Liquid Nitrogen plant	1	20' x 24'
19	Toxic chemical waste storage/ disposal Unit	1	20' x 24'
20	Canteen	1	20' x 12' (kitchen) & 20 x 36' (sitting)

S. No.	Details	Number of Rooms	Dimensions
21	Toilets	-	2 sets for each floor
22	Parking space	As per requirement (APR)	For college and hostels
23	Vehicles: Office car Staff car/Jeep Bus Pick-up van	 1 3 1 1	

B) Division/Section

S. No.	Detail	Number of rooms	Dimensions
1	Office of Head of the Division	3 (one for every Division)	20' x 24' each
2	Administrative Staff	4 (one for every Division)	20' x 36' each
3	Faculty room	21 (as per faculty strength)	20' x 24' (3 rooms) 20' x 12' (18 rooms)
4	Rooms for Research Scholars	4 (one for every Division)	20' x 24' each
5	Committee room cum library	4 (one for every Division)	20' x 36' each
6	Smart Lecture cum seminar room	4 (one for every Division)	Seating capacity - 50 each
7	Laboratories (no. of laboratories as per requirement and include UG and PG teaching laboratories)		
	Plant Biotechnology	5	20' x 60' (one) 20' x 36' (four)
	Animal Biotechnology	5	20' x 60' (one) 20' x 36' (four)
	Microbial and Environmental Biotechnology	4	20' x 60' (one) 20' x 36' (three)
	Bioinformatics Section	2	20' x 48' each
8	Screen houses, glass houses, transgenic green house	APR	

13. Equipment Required

(A)Central Teaching and Research Laboratories

S. No.	Name of the Equipment	Number
1	Sequencer - ABI 3730xl	1
2	Illumina Sequencing Platform	1
3	Cold room -20^{0}C	1
4	Cold room 4^{0}C	1
5	SNP Genotyping Platform	1

S. No.	Name of the Equipment	Number
6	HPTLC	1
7	High Performance Computing Grid	1
8	Liquid Nitrogen Plant	1
9	Inductively Coupled Plasma (ICP-OES) Central laboratory	1
10	High Speed Centrifuge	4
11	Water Purification Unit	As per requirement

(B) Equipment in the Divisional Laboratories (additional specialised equipment may be required depending on the mandate of the institute)

S. No.	Name of the Equipment	Number of units x Divisions	Total number	Divisions#
1	-20°C Freezer	2x3	6	PB, AB, MEB
2	-80°C Freezer	1x3	3	PB, AB, MEB
3	Autoclaves	2x3	6	PB, AB, MEB
4	Automated Capillary Electrophoresis System	1x3	3	PB, AB, MEB
5	Auto pipetting System	1x2	2	PB, AB
6	Biolistic Particle Gun	1x1	1	PB, AB
7	Bio photometer	1x3	3	PB, AB, MEB
8	Biosafety Cabinet	4x3	12	PB, AB, MEB
9	Centrifuge	8x3	24	PB, AB, MEB
10	Cryo-cans	5x3	15	PB, AB, MEB
11	Dry Baths	APR	-	PB, AB, MEB
12	Electrophoresis Systems and Power Packs	10x3	30	PB, AB, MEB
13	Electroporator	1x3	3	PB, AB, MEB
14	Environmental Chamber	1x3	3	PB, MEB
15	Fermenter	2x1	2	MEB
16	Fluorescent Microscope	1x2	2	PB, AB
17	Gel Documentation System	2x3	6	PB, AB, MEB
18	Gel Dryers	1x3	3	PB, AB, MEB
19	Growth Rooms	2x1	2	PB
20	Hot Plates, Magnetic stirrers, Vortex etc.	APR	-	PB, AB, MEB
21	Hybridization Ovens	1x2	2	PB, AB
22	Ice Making Machines	1x3	3	PB, AB, MEB
23	Incubator Shakers	4x3	12	PB, AB, MEB
24	Incubator	APR	-	PB, AB, MEB

S. No.	Name of the Equipment	Number of units x Divisions	Total number	Divisions#
25	Laminar Flow	3x3	9	PB, AB, MEB
26	Lypholyser	1x3	3	PB, AB, MEB
27	Microcentrifuge	10x3	30	PB, AB, MEB
28	Microplate Washer	1x2	2	PB, AB
29	Microscope	1x3	3	PB, AB, MEB
30	Microscopes (for teaching)	10x2	20	PB, AB
31	Microplate Readers	1x2	2	PB, AB
32	Microwave Digestion Oven	1x1	1	MEB
33	Multiflow Dispenser	2x3	6	PB, AB, MEB
34	Nanodrop for DNA Quantification	1x3	3	PB, AB, MEB
35	Precision Ovens	APR	-	PB, AB, MEB
36	Plant Imager	1x2	2	PB, MEB
37	Plate Centrifuges	2x3	6	PB, AB, MEB
38	Real Time PCR	2x3	6	PB, AB, MEB
39	Refrigerator 4°C	4x3	12	PB, AB, MEB
40	Semi Dry Blotter	1x3	3	PB, AB, MEB
41	Shakers (Table Top)	3x3	9	PB, AB, MEB
42	Spectrophotometer	1x3	3	PB, AB, MEB
43	Thermocycler	10x3	30	PB, AB, MEB
44	Thermomixer	4x3	12	PB, AB, MEB
45	Tissue lyser	2x3	6	PB, AB, MEB
46	Ultracentrifuge	1x3	3	PB, AB, MEB
47	Ultrasound Sonicator	2x3	6	PB, AB, MEB
48	UV Transilluminator	2x3	6	PB, AB, MEB
49	UV Stratalinker	1x2	2	PB, AB
50	Vacuum Concentrator	1x3	3	PB, AB, MEB
51	Water Bath - Shaking	2x3	6	PB, AB, MEB
52	Computers	-	50	PB, AB, MEB
53	Computer for Bioinformatics Section	40	40	Bioinformatics
54	Major Softwares-CLC Genomics and other relevant softwares	APR	APR	Bioinformatics
55	Internet Facility	-	-	Central facility

DAIRY TECHNOLOGY

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i). UG Degree: B.Tech (Dairy Technology)

ii). PG Degrees: M.Tech, M.Sc. and Ph.D.

P.G. with specializations in following disciplines:

S. No.	Specialization in M.Tech/ M.Sc. / Ph.D.
1	M.Tech (Dairy Technology)
2	M.Tech (Dairy Engineering)
3	M.Tech/M.Sc.(Dairy Chemistry)
4	M.Tech/M.Sc.(Dairy Microbiology)
5	M.Sc.(Dairy Extension)
6	M.Sc.(Dairy Economics)
7	Ph.D (Dairy Technology)
8	Ph.D (Dairy Engineering)
9	Ph.D (Dairy Chemistry)
10	Ph.D (Dairy Microbiology)

Restructuring of UG Progaramme for increased practical/practice content

DEPARTMENT-WISE COURSES

Dairy Technology

S.N	Discipline and Title of the Course	Credit Hours
1	Market Milk	4 (3+1)
2	Traditional Indian Dairy Products	3 (2+1)
3	Fat Rich Dairy Products	3 (2+1)
4	Condensed & Dried Milks	4 (3+1)
5	Cheese Technology	5 (3+2)
6	Ice-cream & Frozen Deserts	3 (2+1)
7	By Products Technology	3 (2+1)

S.N	Discipline and Title of the Course	Credit Hours
8	Packaging of Dairy Products	3 (2+1)
9	Sensory Evaluation of Dairy Products	3 (2+1)
10	Food Technology - I	3(2+1)
11	Dairy Plant Management	2 (1+1)
12	Waste Disposal & Pollution Abatement	2 (1+1)
13	Food Technology -II	3 (2+1)
	Total	**41 (27+14)**

Dairy Engineering

S.N	Discipline and Title of the Course	Credit Hours
1	Workshop Practice	2 (1+1)
2	Fluid Mechanics	3 (2+1)
3	Engineering Drawing	1 (0+1)
4	Thermodynamics	2 (1+1)
5	Heat & Mass Transfer	3 (2+1)
6	Boilers and Steam Generation	2 (1+1)
7	Basic Electrical Engineering	3 (2+1)
8	Refrigeration & Air-conditioning	3 (2+1)
9	Dairy Engineering	3 (2+1)
10	Dairy Process Engineering	3 (2+1)
11	Instrumentation and Process Control	3 (2+1)
12	Food Engineering	3 (2+1)
13	Material Strength & Dairy Machine Design	3 (2+1)
14	Dairy Plant Design and Layout	2(1+1)
15	Energy Conservation and Management	2(1+1)
	Total	**38 (23+15)**

Dairy Chemistry

S.N	Discipline and Title of the Course	Credit Hours
1	Physical Chemistry of Milk	3 (2+1)
2	Biochemistry	2 (1+1)
3	Human Nutrition	2 (1+1)
4	Chemistry of Milk	3 (2+1)
5	Chemistry of Dairy Products	3 (2+1)
6	Chemical Quality Assurance	2 (1+1)
7	Food Chemistry	3 (2+1)
	Total	**18 (11+7)**

Dairy Microbiology

S.N	Discipline and Title of the Course	CreditHours
1	Fundamentals of Microbiology	3 (2+1)
2	Microbiology of fluid milk	2 (1+1)
3	Microbiology of Dairy Products	2 (1+1)
4	Starter Cultures and Fermented Milk Products	3 (2+1)
5	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
6	Food and Industrial Microbiology	3 (2+1)
	Total	**16 (10+6)**

Dairy Business Management

S.N	Discipline and Title of the Course	Credit Hours
1	Milk Production Management and Dairy Development	3 (2+1)
2	Computer and Application Software Packages	2 (1+1)
3	Economic Analysis	2 (2+0)
4	Environmental Studies	2 (1+1)
5	ICT in Dairy Industry and Operation Research	4(2+2)
6	Fundamentals of Dairy Extension	3 (2+1)
7	Marketing Management & International Trade	2 (2+0)
8	Communication Skills	2 (1+1)
9	Industrial Statistics	2 (1+1)
10	Entrepreneurship Development and Industrial Consultancy	2 (2+0)
11	Financial Management and Cost Accounting	3 (2+1)
	Total	**27 (19+8)**

Semester Wise Distribution of Courses

Semester – I

S.N.	Discipline	Title of the Course	Credit Hours
1	DE	Workshop Practice	2 (1+1)
2	DE	Fluid Mechanics	3 (2+1)
3	DE	Engineering Drawing	1 (0+1)
4	DM	Fundamentals of Microbiology	3 (2+1)
5	DBM	Milk Production Management and Dairy Development	3 (2+1)
6	DBM	Communication Skills	2 (1+1)
7	DBM	Computer and Application Software Packages	2 (1+1)
8	DC	Biochemistry	2 (1+1)
9	DBM	Environmental Studies	2 (1+1)
		Total	**20 (11+9)**

Semester – II

S.N	Discipline	Title of the Course	Credit hours
1	DE	Thermodynamics	2 (1+1)
2	DC	Physical Chemistry of Milk	3 (2+1)
3	DE	Heat & Mass Transfer	3 (2+1)
4	DE	Boilers and Steam Generation	2 (1+1)
5	DE	Basic Electrical Engineering	3 (2+1)
6	DM	Microbiology of fluid milk	2 (1+1)
7	DBM	Economic Analysis	2 (2+0)
8	DC	Chemistry of Milk	3 (2+1)
		Total	**20 (13+7)**
		Student READY Rural Dairy Work Experience Programme-I (Summer Break)	**5 (0+5)**

Semester – III

S.N	Discipline	Title of the Course	Credit Hours
1	DT	Market Milk	4 (3+1)
2	DT	Traditional Indian Dairy Products	3 (2+1)
3	DE	Refrigeration & Air-conditioning	3 (2+1)
4	DE	Dairy Engineering	3 (2+1)
5	DT	Fat Rich Dairy Products	3 (2+1)
6	DT	Condensed & Dried Milks	4 (3+1)
7	DC	Human Nutrition	2 (1+1)
		Total	22 (15+7)

Semester – IV

S.N	Discipline	Title of the Course	Credit Hours
1	DE	Dairy Process Engineering	3 (2+1)
2	DM	Starter Cultures and Fermented Milk Products	3 (2+1)
3	DM	Microbiology of Dairy Products	2 (1+1)
4	DT	Cheese Technology	5 (3+2)
5	DT	Ice-cream & Frozen Deserts	3 (2+1)
6	DC	Chemistry of Dairy Products	3 (2+1)
7	DBM	Fundamentals of Dairy Extension	3 (2+1)
		Total	**22 (14+8)**
		Student READY Rural Dairy Work Experience Programme-II (Summer Break)	**5 (0+5)**

Semester – V

S.N.	Discipline	Title of the Course	Credit Hours
1	DE	Instrumentation and Process Control	3 (2+1)
2	DM	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
3	DT	By Products Technology	3 (2+1)
4	DT	Packaging of Dairy Products	3 (2+1)
5	DC	Chemical Quality Assurance	2 (1+1)
6	DBM	ICT in Dairy Industry and Operation Research	4(2+2)
7	DBM	Marketing Management and International Trade	2 (2+0)
		Total	**20(13+7)**

Semester – VI

S.N.	Discipline	Title of the Course	Credit Hours
1	DE	Food Engineering	3 (2+1)
2	DE	Material Strength & Dairy Machine Design	3 (2+1)
3	DE	Dairy Plant Design and Layout	2 (1+1)
4	DM	Food and Industrial Microbiology	3 (2+1)
5	DT	Sensory Evaluation of Dairy Products	3 (2+1)
6	DT	Food Technology - I	3 (2+1)
7	DC	Food Chemistry	3 (2+1)
8	DE	Energy Conservation and Management	2(1+1)
		Total	**22 (14+8)**

Semester – VII

S.N.	Discipline	Title of the Course	Credit Hours
1	DT	Student READY In- Plant Training	20 (0+20)
		Total	**20 (0+20)**

Semester – VIII

S.N.	Discipline	Title of the Course	CreditHours
1	DT	Dairy Plant Management	2(1+1)
2	DT	Waste Disposal and Pollution Abatement	2 (1+1)
3	DT	Food Technology -II	3 (2+1)
4	DBM	Entrepreneurship Development and Industrial Consultancy	2 (2+0)
5	DBM	Financial Management & Cost Accounting	3 (2+1)

S.N.	Discipline	Title of the Course	CreditHours
6	DBM	Industrial Statistics	2 (1+1)
7	DT	Student READY Experiential Learning Module	10 (0+10)
		Total	**24(10+14)**

* Students will register for any of the 3 elective courses (one each in semester I, II & V).

* Total credit hours: 90+90=180 (including student ready) +6/7 elective credit hours)

Student READY Program

- In plant Training of six months duration (One semester): 20 (0+20) credit hours
- Rural Dairy Work Experience programme of 10 weeks (0+10) (total 10 credit hours) during summer vacation (spread over 2 or 3 Semester breaks) to be introduced starting from first year. The areas of internship maybe:
  - First year: On Milk Production & Procurement to be taken up in State Dairy Federations/ Dairy Development Departments/Private Dairies/Animal Husbandry Department/Cattle farm/Progressive dairy farmers
  - Second Year: On Preliminary Dairy Operations to be taken up in Experimental Dairy/ Referral lab/Dairy Plants
  - Third year: Exposure to Product manufacturing operations in Dairy & Food Industry or
  - Plant visits in each Dairy Technology course to have Industrial exposure in specialized products like Ice cream, Milk Powders, Cheese, By-products etc. should be made compulsory
- Experiential Learning Module of 10 (5+5) credit hours to run concurrently in the final semester along with the regular courses. This shall include development of Detailed Project Report on setting up of enterprise in the selected areas of product manufacture and Evaluation of the Module.

SYLLABUS

I. DAIRY TECHNOLOGY

1. Market Milk 4(3+1)

Theory

Market milk industry in India and abroad: Distinctive features of tropical dairying as compared to those of the tropical climate of developed countries. Collection and transportation of milk; a) Organization of milk collection routes b) Practices for collection of milk, preservation at farm, refrigeration, natural microbial inhibitors, lactoperoxidase system. Reception and treatment (pre-processing steps) of milk in the dairy plant: a) Reception, chilling, clarification and storage: General practices. b) Homogenisation: Definition, pretreatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) c) Effect of homogenization on physical properties of milk. d) Bactofugation: Theory and microbiology. Thermal processing of milk: a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve,

Arrhenius equation, D value, Z value, F value, Q_{10} value. b) Factors affecting thermal destruction of microorganisms. c) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing. d) Product control in market milk plant. e) Defects in market milk. f) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized, vitaminised and sweet acidophilus milk. g) Manufacture of sterilized milk. h) Distribution systems for market milk. UHT processing of milk**:** a) Relevance of UHT processing in the tropical climate b) UHT plants: Description. Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants. c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems. d) Technical control in the UHT plant. e) Shelf life of UHT milk and tests for UHT milk. Nutritive value of milk. Effect of heat processing on nutritive value. Cleaning and sanitization of dairy equipment.

Practical

Familiarization with equipments for reception of milk in plant. Pretreatments: Chilling, clarification, filtration. Standardization and numericals relating to it. Cream separation: parts of separator and the process. Operation of LTLT, HTST pasteurizer, laboratory steriliser. Preparation of special milks; toned, double toned, standardised, flavoured, sterilised. Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP. Detection of adulterants and preservatives in milk. Assessment of homogenisation efficiency in milk. Strength of common detergents and sanitizers used in market milk plant.

2. Traditional Indian Dairy Products 3(2+1)

Theory

Status and significance of traditional Indian milk products in India. *Khoa:* Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. *Khoa based sweets:* Burfi, Peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. *Rabri and Basundi:* Product identification, process description, factors affecting yield, physico-chemical changes during manufacture. *Channa:* Product description, standards method of manufacture, packaging and preservation. *Chhana-based sweets:* Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. *Paneer:* Product description, standards, method of manufacture, packaging and preservation**.** Mechanization of Paneer manufacturing/packaging process. *Chakka/Maska and Shrikhand:* Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. Misti *Dahi:* Product description method of manufacture and packaging process. *Kheer and Payasam:* Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk. Preparation of Burfi, Peda,

Kalakand, Milkcake and Gulabjamun. Preparation of Paneer from cow, buffalo and mixed milk. Preparation of Chhana from cow and buffalo milk and mixed milk. Preparation of Sandesh and Rasogolla. Preparation of kheer. Preparation of Rabri, Misti Dahi, Chhaka and Shrikhand. Visit to industry.

3. Fat-Rich Dairy Products 3(2+1)

Theory

Status of fat-rich dairy products in India and abroad. *Cream:* a) Definition & Legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream. b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT processing of cream. d) factors affecting quality of cream; ripening of cream e) Packaging, storage and distribution, defects (non-microbial) in cream and their prevention. *Butter:* a) Introduction to the butter making process; theory of churning, Legal standards. b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat loses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine. Special butters and related products: a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter/fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. b) Manufacture, packaging, storage and characteristics of margarine of different types. *Ghee and butter oil:* a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. b) Ghee: Composition and changes during manufacture fat constants. C) Butteroil: Manufacture of butteroil, packaging and storage.

Practical

Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant.

4. Condensed and Dried Milk 4(3+1)

Theory

Condensed Milks: History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk, manufacturing techniques; a) Manufacture of evaporated milk including pilot sterilization test, b) Manufacture of sweetened condensed milk, c) Recombined sweetened condensed milk. Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention.

Recent advances with reference to freeze concentration and membrane concentration. *Dried Milks:* History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders, Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk, Manufacture of infant foods, malted milk foods and other formulated dried products, Cheese spread powder, ice cream powder, cream powder, butter powder, whey powder, Management of condensed and dried milk industry.

Practical

Manufacture of plain skim concentrated milk. Manufacture of Sweetened Condensed Milk. Manufacture of Evaporated Milk. Concentration of milk by membrane processing. Manufacturing of Skim Milk Powder by spray drying/roller drying. Manufacture of instant milk powder.

5. Cheese Technology 5(3+2)

Theory

Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese. Milk quality in relation to cheese making. Pre-treatment of milk; Physical and chemical. Additives and preservatives for cheese making. Rennet preparation and properties, rennet substitutes. Action of rennet on milk in relation to cheese making. Manufacture of different varieties of cheese: Cheddar, Gouda, Swiss, Mozzarella, Cottage. Enzyme modified cheese (EMC), flavourings, Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Practical

Familiarization with equipments, accessories and standardization numericals. Study of factors affecting rennet action. Manufacture of Cheddar cheese. Manufacture of Gouda cheese. Manufacture of Mozzarella cheese. Manufacture of Swiss cheese. Manufacture of Cottage cheese. Manufacture of Processed cheese. Manufacture of Processed cheese spread. Manufacture of processed cheese food

6. Ice-Cream and Frozen Desserts 3(2+1)

Theory

History, development and status of ice cream industry, History, development and status of ice

cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts, Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant, Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice

cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention, Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes.Manufacture of plain and fruit flavoured ice-cream. Manufacture of chololcate, fruit and nut ice cream. Preparation of sherbets/ices. Preparation of soft served and filled ice-cream. Manufacture of kulfi. Study of continuous and batch type freezers. Manufacture of ice-cream by continuous process. Determination of overrun in ice cream. Factory visit.

7. By Product Technology 3(2+1)

Theory

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems, Physico-chemical characteristics of whey, butter milk and ghee residue, *By-products from skim milk: Casein:* types of commercial casein, their specifications, manufacturing processes with basic principles involved. b) Industrial and food uses of caseins c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications d) Manufacture of casein hydrolysates and its industrial application e) *Cooprecipitates:* types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications. *Whey processing:*a) Fermented products from whey, b) Beverages from whey c) Deproteinized and demineralized whey d) Condensed whey e) Dried whey, types and their specification, manufacturing techniques. F) Utilization of whey products. Application of membrane processing for whey processing. *Whey proteinconcentrates:* a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates b) Functional properties and food applications of WPC. *Lactose:* methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: a) Condensed butter milk b) Dried butter milk c) Utilization of butter milk products. *Ghee residue*: Composition, processing and utilization. Nutritional characteristics of by products.

Practical

Manufacture of edible casein from cow and buffalo milk. Manufacture of rennet casein. Manufacture of sodium caseinate. Manufacture of calcium caseinate. Manufacture of co-preceinate. Isolation of whey proteins by cold precipitation technique. Manufacture of whey proteins, concentration by ultra filtration process. Manufacture of whey drinks. Manufacture of dried whey. Manufacture of lactose. Incorporation of whey protein concentrates in processed cheese foods. Manufacture of coffee whitener.

8. Packaging of Dairy Products 3(2+1)

Theory

Introduction, Importance of Packaging, History of Package Development, Packaging

materials, a) Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product informatio. Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeades, concentrated and dried milks including baby foods. Packaging of functional dairy/food products. Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food

Practical

Identification of packaging materials, Flame Hot wire test, Testing of papers/ paperboards:Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength. Testing of glass bottle – resistance to thermal shock.Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance. Packaging of different dairy products by using prepak and vacuum packaging machines.

9. Sensory Evaluation of Dairy Products 3(2+1)

Theory

Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects. Terminology related to sensory evaluation. Design and requirements of a sensory evaluation laboratory. Basic principles: senses and sensory perception. Physiology of sensory organs. Classification of tastes and odours, threshold value. Factors affecting senses, visual, auditory, tactile and other responses. Fundamental rules for scoring and grading of milk and milk products. Procedure and types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, hedonic scale and descriptive tests. Panel selection, screening and training of judges. Requirements of sensory evaluation, sampling procedures. Factors influencing sensory measurements. Milk: score card and its use. Judging and grading of milk, defects associated with milk. Cream: desirable attributes and defects in cream, Score card for cream, sensory evaluation of different types of cream. Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter. Ghee: grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee. Fermented milks: desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, srikhand, lassi and other fermented drinks. Frozen dairy products: desirable and undesirable characteristics of frozen dairy products. Sensory evaluation of ice cream, kulfi and milk sherbets. Cheese: sensory Quality attributes of some common cheese varieties and their defects, score card for cheese. Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses. Dried dairy products: desirable and undesirable characteristic of dried milks. Sensory evaluation and grading of dry milk products. Concentrated milks: desirable attributes and defects.

Sensory evaluation and grading of evaporated and condensed milk. Heat desiccated Indian milk products: desirable and undesirable characteristics. Sensory evaluation of khoa and khoa based sweets. Acid coagulated Indian milk products: desirable arid undesirable characteristics. Sensory evaluation of paneer, chhana and chhana based sweets. Consumer acceptance studies: Objectives, methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and consumers studies, limitations. Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests.

Practical

Determination of threshold value for basic tastes. Determination of threshold valuefor various odours. Selection of sensory evaluation panel. Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests. Sensory evaluation of milk and cream. Sensory evaluation of butter and ghee. Sensory evaluation of condensed and evaporated milk. Sensory evaluation of milk powders. Sensory evaluation of cheese and related products. Sensory evaluation of frozen products. Sensory evaluation of khoa and khoa-based sweets. Sensory evaluation of chhana and chhana based sweets. Sensory evaluation of dahi and fermented dairy products. Preparation of milk and milk products with defects, techniques for simulation. Novel techniques of sensory evaluation.

10. Food Technology-I 3(2+1)

Theory

Status of food processing industries in India and abroad, magnitude and inter- dependence of dairy and food industry, prospects for future growth in India. Harvesting, transportation and storage of fruits and vegetables. *Post harvest processing of fruits and vegetables:* Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables. *Juice processing*: General steps in juice processing, role of enzymes in fruit. Juice extraction, equipments and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders. Fruit juice processing; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices. *Manufacture of Jam, Jelly and Marmalade*: Role played by pectin, sugar and acid in jellied fruit products. Fruits and vegetable preserves, Glazed, Crystallized fruits. Tomato based products: Juice, puree, paste, sauce, ketchup. Pickles: Principle of pickling, technology of pickles. *Beverages:* Classification, scope, carbonated non-alcoholic beverages and their manufacture. Fruit beverages and drinks, additives for fruit based beverages. *Coffee:* Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee. *Tea:* Tea leaf processing, green, red, yellow, instant tea. *Technology of confectionery foods:* Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products. *Chocolate products:* Cocoa bean processing, chocolate liquor, Standards of confectionery products. *Functional foods:* Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

Practical

Manufacture of toffees and caramels, Testing the efficacy of blanching process, Drying of fruits and vegetables, Preparation of fruit based drinks and beverages: Ready-to-serve drink,

Nectar, Squash, Whey-fruit based beverages. Manufacture of fruit jam. Manufacture of fruit jelly. Manufacture of chocolate confections. Manufacture of tomato ketchup/tomato sauce. Manufacture of soups. Manufacture of fruit preserve. Manufacture of candied fruits. Manufacture of fruit bar; Manufacture of pickles

11. Food Technology-II 3(2+1)

Theory

Cereal grains, legumes and oilseeds: Structure and composition of cereals, legumes and oilseeds, Milling of paddy, quality factors of rice grains, processing of rice bran oil, Instant rice, quick cooking rice, canned rice, Milling technology of wheat, Criteria of wheat flour quality, improvers for wheat flour, Types of wheat flour, Milling technology of maize, wet milling of corn, Milling technology of barley, malting of barley and its utilization in manufacture of value added food products including malted milk foods, Dehulling and processing technology of important pulses, Dehulling and extraction of oil in major oilseed crops like soy bean, mustard, sunflower, ground nut, Vegetable protein concentrates/isolates, Utilization of oil cake in food formulation. *Bakery and Snack technology:* Technology of bread, biscuits, crackers and cakes, Technology of manufacturing process of Pasta foods- Macaroni, Noodles and Spaghetti, Technology of breakfast cereals: corn flakes, puffed, extruded snacks, Potato chips. *Meat, fish and egg technology:* Development of meat, poultry, egg and fish industry in India, Pre-slaughter care, handling and ante-mortem inspection of animal, Stunning and slaughtering techniques, Postmortem inspection, rigor mortis and conversion of muscle to meat Slaughterhouse sanitation, meat hygiene and zoonotic diseases, Processing of poultry meat, Egg and egg products – quality assessment of egg, Types, handling, transportation and marketing of fish, Preservation of fish., Manufacturing process of dehydrated fish and fish pickles. Cleaning and sanitation, Waste management of food processing plants.

Practical

Manufacture of barley malt. Determination of cooking quality of rice. Manufacture of bread and bun. Manufacture of biscuits. Preparation of noodles. Preparation of cake. Manufacture of potato chips. Preparation of malt based food products. Manufacture of malted milk foods, Manufacture of soy beverage and tofu, Preparation of salami. Preparation of chicken soup. Manufacture of chicken pickle.

12. Dairy Plant Management 2(1+1)

Theory

Production Management: Definition, Function and structure of Production Management, Production planning & Control, Work study and measurement motion and time study. *Efficiency of plant operation:* product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency. *Plant Operations:* Energy conservation and Auditing, Product and process control, Control charts, Process Sigma, Efficiency factors losses, Financial and Managerial efficiency. Provision for Industrial Legislation in India, particularly in dairy industry, Factory Act & Regulations. *Human Resource Management:* Personnel Management, Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions. *Safety hazards:* hazards prevention,

security for plant machinery and the employees, Plant Maintenance. *Prevention & Break-down maintenance:* Spare parts inventory, tools & lubricants, etc. *Food hygiene:* personnel hygiene, plant hygiene, water quality, etc.

Practical

Flow process charts of different milk products. Identification of steps of material losses on dairy plants. Identification of hazardous processes and equipments, safety and precautions. Identification and uses of common lubricants.

13. Waste Disposal and Pollution Abatement 2(1+1)

Theory

Wastes discharged from dairy plants: An overview. Wastewater discharged from a) Milk reception dock b) Liquid milk processing section, c) Butter and ghee manufacturing, d) Ice-cream and condensed milk manufacturing, e) Milk powder manufacturing, f) Cheese and paneer manufacturing. Packaging wastes. *Environmental issues in effluent discharge:* a) Effects on waterways, b) Effects on land c) Effects on the atmosphere d) Solid waste. *Waste treatment process in a dairy processing plant*: Wastewater treatment options for A Dairy Processing Plant. Calculation of wastes discharged and the economics thereof.

Practical

Waste Utilization processes. Various treatments in waste disposal. Analysis of cleaning agents and sanitizers. Reports and records maintenance of dairy plant. Operational precautions. CIP cleaning.

II. DAIRY ENGINEERING

1. Workshop Practice 2(1+1)

Theory

Introduction: workshop practice, safety, care and precautions in workshop. *Wood working* tools and their use, Carpentry. *Heat treatment process:* Hardening, tempering, annealing and normalizing etc. *Metal work:* Metal cutting. Soldering, Brazing. *Welding:* Electric arc and Gas welding. *Smithy and forging operations*: tools and equipments. *Bench work:* The bench, flat surface filing, chipping, scrapping, marking out, drilling and screwing. *Introduction to following tool machines:* (a) Lathe Machine (b) Milling Machine (C) Shaper and Planner (d) Drilling and Boring machines (e) Grinder (f) CNC Machines etc.

Practical

To study different types of measuring tools used in metrology and determine least counts of vernier calipers, micrometers and vernier height gauges. Job work on filing and chipping. To study different types of fitting tools and marking tools used in fitting practice. To study various types of carpentry tools and prepare simple types of at least two wooden joints. Job work on hand hack and power hack saw. Job work on metal sheet working. Job work on butt and lap welding. To study different types of machine tools (lathe, milling, drilling machines etc). To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making, threading etc.

2. Fluid Mechanics 3(2+1)

Theory

Units and dimensions, Properties of fluids. *Static pressure of liquids:* Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular surfaces. Compressible and non compressible fluids. Surface tension, capillarity. Pressure measuring devices, simple, differential, micro, inclined manometer, mechanical gauges, Piezometer. *Fluidflow:* Classification, steady uniform and non uniform flow, Laminar and turbulent, continuity equation, Bernolli's theorem and its applications. *Flow through pipes:*Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge. *Dimensional analysis:*Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude. *Pumps:*Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Pump selection and sizing.

Practical

Study of various types of pipes and pipe fittings. Study of different types of valves. Study of reciprocating pump. Study of rotary gear pump. Study of piezometer. Study of U tube Manometer. Study of inclined tube Manometer. Study of Venturimeter. Determination of frictional coefficient of given pipe. Determination of minor head loss. Study of Pitot tube. Study the construction and working principle of centrifugal pump. Study of Reciprocating pump. Study and measurement of flow of liquid by V- notch.

3. Engineering Drawing 1(0+1)

Practical

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale. Drawing of projections; Orthographic projections, methods of projections. Drawing of screw threads; Types of threads and terminologies used in lit. Screw fastening: Types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt. Drawing of rivets and riveted joints forms of vivet heads, types of riveted; joints, failure of riveted joints. Drawing of welded joints: Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings

4. Thermodynamics 2(1+1)

Theory

Importance and applications of thermodynamics in Dairy/Food processing. **Basic concepts:** Thermodynamic systems, properties, state, processes, cycles, energy, The Zeroth Law of

Thermodynamics. *Ideal gases:* Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. Analysis of non-flow and flow processes. *The second Law of Thermodynamics:* Thermodynamic temperature scale, Carnot cycle, heat engine, entropy, reversibility, availability. *Air Cycles:* Otto, Diesel, dual cycles and their efficiencies, Plotting the air cycles on p-V, T-S, p-h diagram etc. *I.C. Engines:* Concepts, Classification, Working of two stroke and four stroke cycle S.I. engines and C.I. engines. Parts of I.C. engine, Performance of IC engines.

Practical

A visit to dairy/ food processing plant showing the thermodynamics applications/ devices. Study of 2-stroke and 4-strokes IC engines working. Study of S.I. and C.I. engines working Study of modern fuel injection systems of I.C. engines. Study of diesel fuel supply system (pump and fuel injector) of I.C. engine. Study of fuel supply system of a petrol engine. Study of cooling system of an I.C. engine (air cooling and water cooling). Study of lubrication system of I.C. engine. Study of Solar water heater and biogas plants and appliances

5. Heat & Mass Transfer 3(2+1)

Theory

Basic heat transfer process: thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature. *One-dimensional steady state conduction:* Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian coordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines. *Steady-state heatconduction with heat dissipation to environment:* Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction. *Convection:* Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, Some important empirical relations used for determination of heat transfer coefficient. *Heat Exchangers:* General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry. *Mass transfer:* Fick's Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolal diffusion. Mass transfer co-efficient and problems on mass transfer.

Practical

Determination of thermal conductivity: milk, solid dairy & food products. Determination of overall heat transfer co-efficient of: Shell and tube, plate heat exchangers and Jacketted kettle used in Dairy & Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteuriser. Design problems on heat

exchangers. Study of various types of heat exchangers. Design problems on Mass Transfer Heat transfer in tubular heat exchanger: co current/ counter flow Heat transfer through composite wall. Heat transfer through legged pipes. Heat transfer through natural and forced convection

6. Boilers and Steam Generation 2(1+1)

Theory

Fuels: Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. *Renewable energy sources:* Concepts, classification, Types and description of of renewable energy sources. *Properties of steam:* Properties of wet, dry saturated, superheated steam, Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption. *Steam generators:* Definition, classification, fire tube boilers, water tube boilers, Boiler performance parameters, Boiler mountings and Boiler accessories. Layout of steam pipe-line and expansion joints. Introduction to Indian Boiler Regulation Act. *Boiler Draught:* Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, Draught analysis. *Air Compressors:* Definition, classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis.

Practical

To study different types of boilers with the help of Lab models. To study Boiler mountings and steam-line layout and steam traps. Industrial exposure visit to plant with steam utilization. Study of Fire tube low pressure boiler installed in a dairy processing plant. Study of water softening plant installed with boiler in a dairy processing plant. Study the construction and working of Cochran boiler. Study of Babcok & Wilcox boiler. Study of different Boiler accessories.

7. Basic Electrical Engineering 3(2+1)

Theory

Alternating current fundamentals: Generation of alternating current or voltage, magnitude of induced E.M.F. Alternating current, R.M.S value and average value of an alternating current. Phase relation and vector representation. Cycle, Time period, Frequency, Amplitude, Phase and Phase Difference, Root – Mean Square Value, Average value, Form Factor, Crest or Amplitude Factor. *Poly-phase Circuit:* - Generation of Poly-phase Voltage, Phase Sequence, Interconnection of Three Phases such as Star Connection and Delta Connection and their respective value of current and voltages, Energy Measurement by using Single and Two Watt-meters. *Transformers:* - Working Principle of Transformer, Construction features of Core and Shell type transformer, Elementary theory of an Ideal Transformer, E.M.F. Equation of a Transformer, Vector diagram of transformer with and without load, Transformer losses, voltage regulation and efficiency of transformer, Construction and working on an Single Auto-transformer, Different parts of a 11/0.4 KV, Distribution Transformer. *Three Phase Induction Motor:* - Fundamental working principles, Production of rotating magnetic fields, construction, Different types of Rotor such as Squirrel Cage and Phase wound rotors, Starting of induction motors using Direct on Line (DOL) and Star-Delta Starter. Soft starter and variable frequency drives. *Single Phase Induction Motors:* - Introduction, Different types of single phase induction motors such as Split Phase, Capacitor type, Shaded Pole type, Universal or AC series motors, Repulsion start induction run motor, Repulsion – induction

motor. *DC Machine:* - Construction and operation of DC generator, types of generators and their various characteristics. DC motors: Torque speed characteristics of DC motors, Starting and speed control of DC motors by using 3-point DC Starter. *Alternators:*- Elementary working principles, Different parts of an Alternators, Relation between Speed and Frequency, E.M.F. equation in an Alternators. Different types of Circuit Breaker and its use. Introduction to DG set system. *Electric Power Economics:* - Economics of Generation of electrical energy and related important terms such as, load curve, connected load, Maximum Demand, Demand Factor, Average load or demand, Load Factor, Diversity factor and its significance, Capacity Factor or Plant factor, Utilization Factor, Plant Operating Factor and Selection of Units and related numerical, Various types of Tariff used for calculation of electricity bill. *Lighting system:* Introduction to industrial lighting system. *Energy Management and Power Factor Corrections:* - Types of energy, Energy Management, Concept of Energy Audit. Concept of Power Factor, Disadvantages of low power factor, Causes of low power factor, Various methods of improving low power factor, Location of power factor correction equipment, Advantages of power factor improvement.

Practical

Introduction to various basic circuits of parallel wiring, stair case wiring, fluorescent light fitting. Study of voltage and current relationship in case of Star connected load. Study of voltage and current relationship in case of Delta connected load. Measurement of power in 3-phase circuit; for a balanced load, using watt meters. Measurement of power in 3-phase circuit; for a unbalanced load, using watt meters. Measurement of iron losses of Single Phase transformer by conducting open circuit test. Measurement of Copper losses of Single Phase transformer by conducting short circuit test. Starting and reversing the speed of a single phase induction motor. Starting and reversing the speed of a three phase induction motor using Direct on Line (DOL) Starter. Starting and reversing the speed of a three phase induction motor using manual Star Delta Starter. Starting and reversing the speed of a DC shunt motor using 3-point DC Starter. Starting of slip-ring induction motor by manual and automatic Slip-ring Induction Motor Starter. To determine the relation between induced armature voltage and speed of separately /self excited DC Shunt Generator.

8. Refrigeration and Air-Conditioning 3(2+1)

Theory

*Basic refrigeration cycles and concepts:*Standard rating refrigerating machines; Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors; Theoretical vapour compression cycle; Departure from theoretical vapour compression cycle, representation on *T-S* and p-h diagrams; Mathematical analysis of vapour compression refrigeration system. *Refrigerants:*Primary and secondary refrigerants; common refrigerants (Ammonia, Freon, *HFC, HCFC etc*); Brine, their properties and comparison.*Multi-Pressure Refrigeration Systems:*Applications; Multi-evaporators with single stage and multi-stage compression and expansion systems; Working, Control and mathematical analysis of above systems. *Refrigeration Equipments and Controls:*Introduction to the types, construction, operation and maintenance of Refrigeration Components, Controls and Safety Devices as used in different refrigeration applications. Capacity control methods, Refrigeration Piping**:** Purpose, Types,Materials, Fittings

and Insulation. *Design and Balancing of Refrigeration System:*Basic elements of design of individual components and a complete refrigeration system. Input and Output design parameters, Balancing of components of refrigeration system for optimum performance. *Absorption Refrigeration Systems:*Simple vapour absorption refrigeration systems, Actual Vapour absorption refrigeration system, Refrigerant absorbent pairs, Absorption cycle analysis.*Cryogenic Freezing:*Cryogenics, cryogens, properties, applications, cryogenic freezers. *Psychrometry:*Definition, properties of moist air, psychrometric charts, psychrometric processes; Cooling/ Heating coils, humidifiers and dehumidifiers, Temperature and humidity measurements and controls. *Air-conditioning Systems:*Types of cooling loads and their calculation, Design conditions for Human and Industrial air conditioning systems, Analysis of different air-conditioning systems with the help of psychrometric chart. *Cold Storage:*Types of cold storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.

Practical

Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools. Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler. Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant. Estimation of installed cooling capacity with the help of observed working pressures. Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT). Study of specifications, components, operation, control and maintenance of a Cold Storage. Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air-Washer or Room air-cooler etc. Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications. Study of different types of capacity control devices used with compressors in a refrigeration plant. Experimental study of a simple refrigeration system on refrigeration tutor or an experimental set-up. (comparison of actual and theoretical performance). Experimental study of an year-round air-conditioning system on an air-conditioning tutor or an experimental set-up. Determination of SHF and By-pass factor etc. Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor. Measurement of psychrometric properties using psychrometric meters/gadgets Industrial exposure visit to refrigeration/air-conditioning plant.

9. Dairy Engineering 3(2+1)

Theory

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and

designing of system. *Mechanical Separation:* Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers. *Homogenization:* Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers**.** *Pasteurization:*Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.

Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers. *Packaging machines:*Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance. *Mixing and agitation:* Theory and purpose of mixing. Equipments used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

Practical

Study of S. S. pipes, fitting and gaskets. Study and selection of pump. Study of different types of milk filter. Study of equipments at raw milk reception dock. Constructional details, operation and maintenance of straight through can washer. Constructional details, operation and maintenance of C.I.P. system. Constructional details, operation and maintenance of homogenizers. Constructional details, operation and maintenance of batch pasteurizer. Constructional details, operation and maintenance of HTST pasteurizer. Comparison of conventional and modern pasteurizer. Constructional details, operation and maintenance of cream separators. Constructional details, operation and maintenance of sterilization systems. Constructional details, operation and maintenance of pouch filling machine. Constructional details, operation and maintenance of different types of agitators. Constructional details, operation and maintenance of bottle filling and capping machine. Visit to a dairy processing plant.

10. Dairy Process Engineering 3(2+1)

Theory

Evaporation: Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators. *Drying:* Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers. *Fluidization:* Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed

Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers. *Processing equipments:* Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. *Packaging equipments:* Packaging machines for milk & milk products. *Membrane Processing:* Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

Practical

Constructional details, operation and maintenance of Vacuum pan. Constructional details, operation and maintenance of multiple effect evaporator. Constructional details, operation and maintenance of spray drier. Constructional details, operation and maintenance of butter making equipment. Constructional details, operation and maintenance of equipment related to ghee production. Constructional details, operation and maintenance of ice-cream making equipment. Constructional details, operation and maintenance of cheese making equipment. Constructional details, operation and maintenance of reverse osmosis and ultra filtration system. Design problems on double effect evaporator and vacuum pan. Visit to a milk product plant

11. Instrumentation and Process Control 3(2+1)

Theory

Instrumentation scheme & characteristics: Measurands. Some basic discussion about electric field, potential, capacitance, resistance etc. Definition, Application and types of measurements, instrument classification, Functional elements of an instrument, standards, calibration, introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems. *Introduction to various typesof sensors:*Definition, principle of sensing & transduction, classification, selection and applications of Sensors., Measurement of parameter : Measurement of length ,angle, area , temperature , pressure flow , speed, force , torque, vibration , level , concentration (conductivity and ph) measurement . Flow measurement using magnetic flow measurement. Piezoelectric transducer. *Micro-sensors and smart sensors:*Construction, characteristics and applications. *Electronic Instruments:*Role and importance of general purpose test instruments, Electronic Millimeter, Cathode Ray Oscilloscope, Measurement of amplitude, frequency and phase using CRO Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator. Display devices and recorders like X-Y & X-T recorders.

Automation: Introduction to plant automation, automation hierarchy, PLC, SCADA

Practical

Strain gauge characteristics and weight measurement. Measurement of pressure using bellows and diaphragm. Preparation and calibration of thermocouple. Study the construction and working of Bourden pressure gauge. Test and calibration of pressure gauges using dead weight tester. Study the mechanism of pH meter and its electrodes. Study a Proximity sensor. Study the different parts and working of pressure switch. Study the different parts of an indicating instrument. Study of RTD and Thermister. Study of different speed measurement sensor/ instruments. Study of LVDT. Study of level/flow controller. Study of PLC.Visit to a automatic controlled dairy plant.

12. Food Engineering 3(2+1)

Theory

Rheology: Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of solids foods, Viscoelastic models. Measurement of food texture. *Food Freezing:* Thermal properties of frozen foods. Predication of freezing rates. Plank's equation, Design of food freezing equipment, Air blast freezers, Plate freezers, spiral freezers, and immersion freezers, IQF, storage of frozen foods. Freeze concentration. *Food dehydration:* Estimation of drying time for food products, constant rate period and falling rate period dehydration. Diffusion controlled falling rate period. Use of heat and mass balanced in analysis of continuous dryers, Classification of driers, tray, vacuum, vacuum band, tunnel, bin, solar, drying, freeze drying, spin flash. *Freeze dehydration:* Heat and mass transfer, Calculation of drying time, Industrial freeze drying. *Other food processing operations and equipments:* Equipment for pulping, fruit juice extraction, blanching, dehulling, size reduction, milling, extrusion and distillation.

Practical

To determine physical properties of food product. To determine viscosity of food product. To study food freezers. To study freeze drier. To determine drying characteristics of food product. To compare various dying methods. To determination juice yield. To compare hot water and steam blanching. To study construction and working of distillation system. To study various size reduction equipments. Visit to cold storage. Visit to food processing plant.

13. Material Strength & Dairy Machine Design 3(2+1)

Theory

*Strength of Materials:*Basic concepts in Statics and Dynamics. Force Systems. Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem. Dynamics: Equation of motion. Translation and rotation of a Rigid body, work and mechanics of materials: Stress-Axial Load classification Strain-Hooke's law, stress-strain diagram, Poisson's Ratio: Shearing Stresses. Torsion, Torsion formula, Angle to Twist of circular members. Power transmission shear force and bending moments, Shear in Beams, Bending Moment in beams. Pure bending of beams, Flexural stress shearing stresses in beams relations between centre, Torsional and flexural loads. *Dairy Machine Design:*Procedures, Specification, strength, design factor, factor of safety selection of factor of safety. Materials and properties. Static strength, ductility, hardness, fatigue, designing for fatigue conditions. Theories of failure, Stresses in elementary machine parts, Design of a drive system. Design of length and thickness of belt. *Bearing:* Journal and Anti-friction bearings. Selection of ball, tapered roller and thrust bearing. Springs, helical and leaf springs. Energy stored in springs. Design and selection of springs.

13. Practical

Design problems on applications of engineering statics and dynamics. Design problems on applications of work and energy. Design problems on applications of linear and angular momentum. Design problems on stress-strain diagram evaluation of elastic constants. Study on shear force and bending moment diagrams and its applications. Design problems on applications

of flexural stresses. Design problems on applications of shearing stresses in beams. Study on system of limits, fits and tolerances and their applications. Design stresses in elementary machine parts. Design features and applications of shafts. Design features and applications of axles. Design features and applications of keys. Design features and applications of couplings. Design problems on various types of power transmission systems. Design features and applications of bearings. Design features and applications of springs. Design problems on agitator/stirrer. Design features of milk silo.

14. Dairy Plant Design And Layout 2(1+1)

Theory

Introduction of Dairy Plant design and layout: Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site. Hygienic design considerations for dairy processing plants. *Planning:* Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout. Space requirements for dairy plants, estimation of service requirements including peak load consideration. *Dairy plant design aspects:* General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design. Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop. Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility. Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout. *Building construction materials:* Floors, general requirement of dairy floor finishes, floors for different section of dairy. Foundations, walls doors and windows. *Other design aspects:* Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants. *Computer aided Design:*Introduction to CAD software.

Practical

Building symbols and convention. Symbols for equipments. Study of process schedule. To draw layout of collection/chilling centre. Visit to dairy processing plant for understanding of layout of different sections. To draw layout of small dairy plant. To draw layout of small dairy plant using CAD. To draw layout of medium dairy plant. To draw layout of large dairy plant. To draw layout of cheese plant. To draw layout of ice-cream plant. To draw layout of butter manufacturing unit. To draw layout of ghee plant. To draw layout of composite dairy plant

15. Energy Conservation and Management 2(1+1)

Theory

Introduction: Potential and opportunities of industrial energy conservation in dairy and food processing. Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE). Electricity Act 2003, Integrated energy policy. Energy management & audit: Definition, energy audit, need, types of energy audit. Energy audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Energy balances and computation of efficiencies of equipment. Role of Energy inspectors and

Auditors in energy management. Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques. Quality of power, Power factor and its improvement. Transformers, losses in transformers. Energy savings in transformers. Electric motor-selection and application, Energy efficient motors. Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy. Bureau of Energy Efficiency (BEE): Power saving guide with "Star Ratings" of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters. Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls.

Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities. Energy conservation in steam distribution systems, efficient piping layouts, protective & insulation coverings in utility pipes. Steamconservation opportunities. Upkeep and maintenance of steam auxiliaries and fittings. Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors. Maintenance and upkeep of Vacuum lines and Compressed air pipe lines. Conservation and reuse of water, water auditing. Energy conservation opportunities in Wastewater treatment.

Processing equipments: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying & Freezing. Role of steam traps in energy saving. Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator.

Energy conservation in buildings: Concepts of "Green Buildings". Waste-heat recovery and thermal energy storage in food processing facilities. Condensate recovery and reuse. Application of recuparator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc. Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects. Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits. Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries. Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practicals

Study of Energy Conservation Act 2001. Study of schemes of BEE. Study of concepts of Energy Balance in Unit Operations and System boundaries. Solving examples on energy balances. Solving problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve. Determination of Load factor of an installation. Study of use of power factor meter and determination of true power and wattles power using pf meters,Watt meter, Ammeter and Volt meter. Study of performances of a general type of induction motor and an energy efficient induction motor. Study of use of VSD. Study of various types of electrical appliances classified under different BEE Star Ratings. Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency. Exercise on energy audit of Students Experimental Dairy Plant (SEDP-DSc College, Hebbal).

III. DAIRY CHEMISTRY

1. Physical Chemistry of Milk 3(2+1)

Theory

Constituents and gross composition of milk of different species and breeds of milch animals, *Colloidal State:* Distinction between true and colloidal solution, lypophilie & lypophobic solution, properties of colloidal system. Properties of colloidal systems, Gels-their formation and properties. Milk as a colloidal system and its stability. Elementary idea about emulsion. Density : Density and specific gravity, pyknometer method, hydrometer lactometer. Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk. *Liquid State:* Surface tension, surface energy interfacial tension. Surface tension of mixtures. Surface tension of milk and the factors affecting it. Viscosity- Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Refractive index. Colligative Properties of Dilute Solution: Vapour pressure, Raoults Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk. Osmosis and Osmotic pressure. Inter-relation of colligative properties. Aqueous solution of Electrolytes: Electrolytes; non-electrolytes, ionic mobility, electrical conductance, Ostwald Dilution Law, Kohlrawsch Law, Electrical conductance of milk. Ionic Equilibria: Dissociation of water, ionic product of water, concept of pH and pOH and their scale. Acids and bases: Bronsted Lewis concepts of acids and bases, dissociation constants of acids and bases. Salt-their hydrolysis. Buffer solutions. Derivation of Henderson – Hasselbach equation and it application, buffer capacity and buffer index, milk as a buffer system. Equilibrium of electrolytes. pH indicators. Oxidation- Reduction: Redox potential, Nernst equation, electrochemical cells. Hydrogen, glass and calomel electrodes. Redox system of milk. Nuclear Chemistry: The nature of isotopes, radio isotopes. Half life period of radio isotopes. Some of the important radio isotopes. Occurrence of radio nuclide in milk & milk products. Molecular Spectroscopy: The spectrum of electro magnetic radiation, the laws of Lambert and Beer, visible, and ultra-violet Spectroscope. Mention of mass, NMR spectroscopy.

Practical

Determination of density and specific gravity of milk using pyknometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer. Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically. Determination of acidity of milk electrometrically. Determination of electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

2. Biochemistry 2(1+1)

Theory

Bio-Molecules: General structures, classification and functions of bio molecules-Amino acids, Protein Structure, Carbohydrates, Fats, Lipids, DNA and RNA. *Enzymes:* Activation energy / Transition state & Enzyme Classification, Coenzymes/Co-factors & Enzyme kinetics, Mechanism of enzyme action, Factors effecting enzyme activity, Enzyme inhibition, isozymes & Regulatory Enzymes, Immobilization of enzyme, Ribozymes & Zymogens. *Metabolism* :Glycolysis, Gluconeogenesis, TCA cycle, Glycogen synthesis and degradation, Pentose phosphate pathway, Fatty acid oxidation, Urea cycle and transaminase reactions, ATP and Electron transport chain.

Practical

Estimation of alkaline phosphatase by conversion of a non-chromogenic substrate to a chromogenic substrate. Effect of temperature, pH and enzyme inhibitors on the activity of the enzyme. Estimation of catalase by spectrophotometric method. Determination of the Michaelis Menten constant of an enzyme. Estimation of RNA by colorimetric method. Estimation of DNA by colorimetric method. Measurement of proteolysis and lipolysis. Estimation of Vitamin A in Ghee. Estimation of Ascorbic acid in plasma.

3. Human Nutrition 2(1+1)

Theory

Fundamentals of human nutrition, concept of balanced diet, nutrient requirements of different age groups. Methods of evaluation of nutritive value of food and nutritional value of cow, buffalo and human milk, biochemical composition and energy value of foods with special reference to milk and dairy products. Nutrition, digestion and absorption, Vitamins (structure and function), Hormones (structure and function), Milk intolerance and hypersensitivity, Safety aspects of food additives, toxic elements, antibiotics, radionuclides in milk and milk products. Nutraceutical, antioxidants, food toxins, anti-nutritional factors, probiotics and cultured dairy products. Biochemical aspect of post-harvest storage specifically food spoilage.

Practical

Estimation of serum Protein (Biuret method /Lowry method). Estimation of Blood Glucose (Folin Wu method). Estimation of Serum inorganic phosphorus (Fiske and Subba Row method). Estimation of blood creatinine, triglyceride and cholesterol levels. Estimation of calorific value of food items. Diet and nutrition surveys: (a) Identification of vulnerable and risk groups. (b) Diet survey for breast-feeding and weaning practices of specific groups. (c) Use of anthropometric measurement in children. Preparation of visual aids for nutritional disorders. Field visit to (a) Observe the working of nutrition and health oriented programmes (survey based result). (b) Hospitals to observe nutritional deficiencies. Identification of Mono, Di and Polysaccharides. Identification of Proteins (albumin, gelatin, peptone). Planning and preparation of high protein, low fat and specialized diets. Detection of antibiotic/toxin in food products.

4. Chemistry of Milk 3(2+1)

Theory

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins, Casein: Isolation, fractionation and chemical composition, physico-chemical properties of casein, Whey proteins: Preparation of total whey proteins: a-Lactalbumin and b-Lactoglobuline. Properties of a-Lactalbumin and b-lactoglobulin, Immmunoglobulin and other minor milk proteins and non proteins nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins, Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphates, proteases and lactoperoxidase, Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re arrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose, Definition, general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins, Milk Salts: Mineral in milk (a) major mineral (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

Practical

Sampling techniques of chemical examination of milk. Determination of pH and titratable acidity of milk. Determination of fat in milk by different methods. Determination of total solids and solids not fat in milk. Determination of total milk proteins by Kjeldahal method. Determination of casein, whey proteins and NPN in milk. Estimation of alkaline phosphatase and lipase in milk. Determination of lactose in milk. Determination of ash in milk. Determination of phosphorus and calcium in milk. Determination of chloride in milk. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

5. Chemistry of Dairy Products 3(2+1)

Theory

Chemical composition and legal standards of milk products. Chemistry of creaming and factors affecting the same. Ripening and neutralization of cream. Theories of churning and factors affecting the same. Butter colour. Ghee: Physico-chemical changes during manufacture. Hydrolytic and oxidative deterioration, their causes, prevention and role of antioxidants. Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa, Paneer, Dahi, Channa, Lassi, Chakka, Shrikhand. Chemistry of cheese: milk clotting enzymes, enzymatic coagulation of milk, biochemical changes during ripening. Physico-chemical changes during preparation and storage of concentrated and dried milk products. Physico-chemical changes during processing and storage of ice cream and frozen desserts. Role and mechanism of stabilizers and emulsifiers in ice cream.

Practical

Cream: estimation of fat and acidity. Butter: estimation of fat, moisture, curd and salt content. Ghee: estimation of moisture, acid value, Butyro refractive reading and Reichert Meissl value / Polanske value. Determination of lactose and sucrose in sweetened condensed milk. Milk powder: moisture, fat, ash, solubility, acidity and bulk density. Ice cream: estimation of fat and total solids. Estimation of moisture, fat and salt content in cheese. Khoa/paneer: estimation of moisture and fat. Estimation of protein content in milk products and protein rich dairy products using Kjeldahl method.

6. Chemical Quality Assurance 2(1+1)

Theory

Importance of chemical quality control, quality assurance and total quality management in dairy industry. Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc., Application of food safety management system (ISO: 22000). Hazard analysis and critical control points (HACCP) system and its application in dairy industry with respect to chemical quality. Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories. Preparation and standardization of reagents required in the analysis of milk and milk products. Sampling procedures; labeling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis. Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer. Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products. Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products and their chemical testing methods. Importance of milk contact surfaces, metallic contamination in dairy industry. Chemical quality of water in dairy industry. Prediction of shelf life behavior of milk and milk products.

Practical

Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, Fehlings, EDTA solutions etc. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Detection of vegetable oils and animal body fat adulteration in ghee. Analysis of market samples of milk and milk products. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

7. Food Chemistry 3(2+1)

Theory

Water: Water binding and chemical reaction mediated by water. *Food proteins:* Classification and physico-chemical and structural properties. *Lipids:* Definition, classification of lipids, Unsaponifiable matter contents in various fats and oils, classification and chemical composition. *Carbohydrates:* Classification of carbohydrates, polysaccharides, viz. linear, branched and modified. Properties and utilization of common polysaccharides, viz. cellulose, glycogen, hemicelluloses, pectin. *Food Enzymes:* Hydrolases and lipases, utilization in food chemistry. *Minerals in foods:* Main elements, trace elements in eggs, cereals and cereal products, vegetables and fruits. *Aroma compounds in foods:* Threshold value, off-flavours. *Food additives:* Vitamins and Amino acids, Minerals, Aroma Substances/flavour enhancers- Monosodium glutamate, 5-nucleotides sugar substitutes, sorbitol sweeteners- saccharin, and cyclamate, Food colours and food preservatives. *Antinutritional factors and Food contaminants:* Toxic trace elements, radio nucleotides. Cereal and cereal products: Individual constituents like proteins, lipids, carbohydrates and vitamins in cereals flour and their relationship in dough making, influence of additives /minor ingredients on baking properties: physico-chemical changes during baking. *Legumes:* Classification, general composition and physico-chemical properties. *Vegetables and Fruits:* Classification, general composition, chemical changes during ripening and storage. Jams, *Jellies and Pickles:* Classification, composition and preservation. Preservation of foods, general principles of food preservation.

Practical

Determination of the order of hydrolysis of an ester/carbohydrate and measurement of activation energy; determination of the progress curve obtained during the hydrolysis of P-nitrophenyl phosphate by milk alkaline phosphatase; determination of the Michaelis constant for the digestion of casein by trypsin; Measurement of pH and buffering capacity of different types of milk; To study the gel formation and gel stability of milk proteins; preparation of a Tris/phosphate/citrate buffer of a given molarity/ionic strength and pH; determination of pH of the buffer; measuring the stability of an oil-in-water emulsion stabilised by milk proteins; foaming capacity and foam stability of caseins/whey proteins; drawing of an adsorption isotherm of water on casein

IV. DAIRY MICROBIOLOGY

1. Fundamentals of Microbiology 3(2+1)

Theory

Overview of history and scope of microbiology: Discovery of Microorganisms and Microscopy (types, working principles and applications); Theories of Biogenesis and abiogenesis; Contributions of Leeuwenhoek,Pasteur, Tyndal, Joseph Lister, Robert Koch, Edward Jenner and Alexander Fleming; Scope and application of microbiology in fields like Dairy, Food, Pharmaceutical, Industrial, Medical and agriculture. *Classification of Microbes:* Microbial classification systems, numerical taxonomy, General properties and principles of microbial classification, Whittaker's five kingdom and Carl Woese's three domain classification system; Systematics of bacteria and Bergey's manual of systematic bacteriology, Phylogenetic tree. *Procaryotic and Eucaryotic microorganisms:*

Structure and functions of prokaryotic cells; Differences between prokaryotes and eukaryotes; Differences between cell wall of Gram positive and Gram negative bacteria; Structure of Archeal cell wall. *Microbial growth and nutrition*: Bacterial growth curve; factors affecting growth of bacteria, direct and indirect methods of measurement of bacterial growth; Bacteriostatic and bactericidal agents; Common nutrient requirements and nutritional types of microorganisms. *Diversity of Microorganisms:*Viruses: Structure and Classification; Bacteriophages; Differences between viruses and bacteria; Fungi: Classification of Fungi; Reproduction in Fungi; Protozoa and algae.*Microbial Ecology and Environmental Microbiology:*Microflora of air, soil and water and Microbes of Extreme environment like Archea.*Basics of Microbial Genetics and Host-Microbe interactions:*DNA as the genetic material, Structure of DNA/ RNA, DNA replication, transcription and translation; Basic concepts of immunology; Role of immune system in governing host-microbe interactions, Microbial Commensalism, Colonization, Infection, Disease and Vaccines

Practical

General instruction for microbiological laboratory. Microscope- simple and compound; Microbiological equipments; autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Simple staining- methylene blue; crystal violet; negative staining. Differential staining (Gram, spore, acid fast). Motility of microorganisms - hanging drop technique. Measurement of size of microorganisms by micrometry (ocular and stage). Preparation of commonly used growth media liquid and solid: simple and differential media. Isolation techniques for microorganisms – Streak, spreadand pour plate.Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN). Visit to Microbiology Laboratory of Dairy/Food Industry.

2. Microbiology of Fluid Milk 2(1+1)

Theory

*Microbes associated with raw milk:*Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermoduric and thermophillic bacteria - their morphological and biochemical characteristics and classification. Microbial contaminants in raw milk, their sources during various stages of production - milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms; Microbiological changes in bulk refrigerated raw milk. *Sources of contamination and microbial spoilage of raw milk:* Microbial contaminants of raw milk supplies,their sources during various stages of production i.e. milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms and preventive measures. Types of microbial spoilage - souring, curdling, bitty cream, proteolysis, lipolysis, abnormal flavors and discolouration. Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health. *Concept of clean milk production:*Hygienic milk production system; Cleaning and sanitation of udder, animal, utensils, equipments and dairy farm environment; Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world; Microflora of aseptically drawn milk and its natural antimicrobial systems - immunoglobulins, lactoferrin, lysozyme and lactoproxidase (LP) system. *Microbiological aspects of fluid milk:*Pasteurization, boiling, sterilization, ultra high temperature (UHT), non thermal

(pulsed field) micro-filteration, bactofugation, standardization and homogenization. Significance of heat resistant and post processing contaminants in fluid milk with special reference to proteases and lipase enzymes and their role in spoilage of processed milk.Bio-film formation during processing and their control measures. *Public health aspects of fluid milk:*Microbial zoonotic diseases transmitted through fluid milk; Milk borne diseases -food infection, intoxication and toxi- infection caused *E. coli, Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes, Shigella species, Campylobacter* etc. Microbiological grading and legal standards of raw and processed milk.

Practical

Morphological examination of common dairy microorganisms (size and shape, arrangement and sporulation). Estimation of microbial load in raw milk by standard plate count (SPC) and dye reduction tests (MBRT, RRT). Grading of processed/ market milk by total viable count, coliform and methylene blue reduction time. Enumeration of psychrotrophic, thermophillic, thermoduric and spore forming bacteria in raw and market milk. Detection of sources of contamination: Air, water, utensils, equipment and personnel, line testing. Spoilage of milk caused by microorganisms: souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discolouration. Detection of mastitis milks: pH, SLST, somatic cell count, chloride content, Hotis test and CAMP test. Detection and estimation of coliforms: presumptive, rapid coliform and IMViC Test.

3. Microbiology of Dairy Products 2(1+1)

Theory

Microbiology of Cream and Butter - Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in cream and butter; Microbiological aspects including defects in pasteurized (ripened/unripened cream), sterilized and UHT cream; Factors influencing the microbial growth during batch/continuous butter making process; Microbial Defects in butter - Bacterial/mold discoloration, enzymatic deterioration and their control measures; Regulatory microbiological standards. *Microbiology of Condensed, Evaporated andDried products:* Type of microorganisms associated with condensed, evaporated and dried products, their growth/ survival during manufacture and storage; Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavor in evaporated milk; pre-heating/DSI temperature and their impact on microflora of dried products; Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards

Microbiology of Ice Cream and Frozen desserts: Microenvironment in ice cream, microbiological quality of ingredients, critical process factors and their impact on entry of pathogens in ice cream and frozen desserts, their survival during storage, food poisoning out breaks and legal standards. *Microbiology of Indigenous Milk Products:* Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfietc.; Factors affecting the microbiological quality in reference to production, processing, storage and distribution; Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards; Active packaging concepts and role in bio-preservation.

Practical

Microbiological examination of raw, pasteurized, sterilized and UHT cream for Standard plate count (SPC) as well as lipolytic and coliform counts, direct microscopic count (DMC), dye reduction tests and sterility test. Microbiological examination of salted and unsalted butter for SPC, psychrotrophic, lipolytic, coliforms and yeast and mold count; K.Q test. Microbiological examination of concentrated milk for SPC, coliforms, spores, yeast and mold, thermoduric and thermophilic counts. Microbiological examination of dried milks for SPC, coliforms, *Staph. aureus*, *B. cereus, E. coli, Salmonella*, Sulphite reducing clostridia and Staphylococcal enterotoxins. Microbiological examination of ice-cream and other frozen desserts for SPC, coliforms and Staphylococcal counts; Detection of *Salmonella* spp./*E. coli*. Microbiological examination of khoa for SPC, coliforms and staphylococcal counts besides yeast and mold counts. Microbiological examination of paneer and shrikhand for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts. Microbiological examination of packaging materials for SPC, Spores and Yeast and mold counts.

4. Starter Cultures and Fermented Milk Products 3(2+1)

Theory

Types, metabolism and propagation of starter cultures: History, classification and importance of starter Cultures in dairy industry; Single, multiple, defined and mixed strain starters; Probiotics and Special cultures like exopolysaccharide production; Propagation of starter cultures-concentrates - direct bulk and direct vat starter cultures, factors affecting propagation; Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits.

*Activity, Purity, Preservation of Starters and Starter Failure:*Quality and activity tests for dairy starters and their preservation- methods (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures), merits and demerits; factors affecting the survival of cultures during preservation; Defects in starters and their control; Starter failures-effect of antibiotic residues, sanitizers and bacteriophages. Phages-life cycle, sources, prevention, chemical and mechanically protected systems. *Role of Starters in fermented milks:*Role of starters in the preparation of various fermented milks; Types of fermented milks - dahi, yoghurt, acidophilus milk; different types of dahi and yoghurt; preparation; defects and their control. Kefir and koumiss : origin and characteristics; microbiology of kefir grains; Other fermented milks such as Bulgarian milk, cultured buttermilk, Leben, Villi and Yakult; Microbiology of fermented milk products; their nutritional and therapeutic significance. *Chesse Starters:*Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; Rennet: rennet substitutes, microbial rennet and recombinant chymosin

Practical

Testing purity of starter cultures by gram's staining, catalase test; creatine test. Testing starter activity by dye reduction tests, Horrall-Elliker, White Head& Cox test. Preparation of single and mixed starter cultures. Evaluation of homo-fermentation and hetero-fermentation separately

and in combination. Preservation of starter cultures by freeze-drying techniques. Preparation of concentrated starter (DVS). Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters. Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms. Effect of presence of antibiotic residues in milk on starter activity. Evaluation of associative growth of Starter cultures in milk. Detection of Bacteriophages in cheese whey by plaque assay method. Preparation and microbial examination of dahi, yoghurt, cultured butter milk, acidophilus milk and kefir. Analysis of cheese for total spore and anaerobic spore count. Microbiological analysis of cheddar cheese at different stages of manufacture of (storage and ripening).

5. Quality and Safety Monitoring in Dairy Industry 3(2+1)

Theory

Consumer Awareness about Microbiological Quality and Safety of Dairy Foods: Changing scenario; Concepts of quality control, quality assurance and food safety; Global quality and food safety standards, Integrated food law, its main features and functions. *Introduction to FoodSafety Management System:* Concepts of Quality Management System (QMS)–ISO: 9000:2000; Principles of QMS; Standard requirements for QMS; HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools and techniques. *Microbiological RiskAnalysis Concepts:*Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria and two and three class sampling plan / guidelines; Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant. *Rapid Enumeration Techniques:* Enumeration principles and procedure for rapid detection of predominant hygiene indicator organisms and pathogens like *E. coli* (*E. coli* 0157:H7), *Salmonella, Shigella, Staphylococcus aureus, Bacillus cereus* and *Listeria monocytogenes*. *Role of Biosensors for monitoring hygiene and safety of dairy foods:* Detection of antibiotic residues in milk –Delvo SP, MDR test, penzyme test, charm assay, lateral flow assay (ROSA test) etc. Detection of aflatoxins, pesticides other inhibitors etc. and their public health importance in dairy foods. *Plant and equipment hygiene:*Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of waste water and effluents.

Practical

Rapid detection of total plate count, yeast and mold counts, Coliform, *E. coli*, Enterococci, Enterobacteriacae count using D- count and 3M Petrifilm kits. Rapid detection of pathogenic bacteria based on antigen antibody principle: *Staphylococcal enterotoxins, E. coli* O157:H7, *Listeria monocytogenes and Salmonella* using VIDAS system. Rapid detection of antibiotic residues in milk usingDelvo SP, MDR test, Charm assay, Lateral flow assay (ROSA test). Rapid detection of aflatoxin M1/ pesticides residues in milk usingCharm Assay, Lateral Flow Assay (ROSA test) / Enzyme Inhibition Assay using Luminometer. Evaluation of common sanitizing agents used in dairy plants by a) suspension b) capacity test. Microbiological tests for assessing Environmental, equipment and personnel hygiene by swab and rinse methods. Determination of BOD in dairy waste water. Quality evaluation by HACCP in the preparation of dairy products.

6. Food and Industrial Microbiology 3(2+1)

Theory

Scope of food microbiology: Basic aspects, history and scope of food microbiology. Intrinsic and extrinsic factors that affect microbial growth in different foods.

Microbial Spoilage of foods: Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; Sources of contamination; Control of spoilage. *Food preservation:* Principles of food preservation : physical methods viz. low temperature and high temperature preservation (D, Z and F Values); Drying Methods; Chemical preservatives, Natural antimicrobial compounds and bio- preservation; Mode of action of various preservation methods on microbes. *Fermentation processes:* Fermentation processes : Historical development, the range, components and types (i.e. submerged, surface and solid state fermentation); criteria for selection of industrially important microorganisms; preservation and improvement of industrially important micro-organisms using metabolic engineering/genetic engineering; media for industrial process; upstream and downstream processing. *Types of fermenters:* Fermenters: types (batch, fed batch and continuous), functions, design and control; sterilization; growth rate analysis, estimation of biomass; difference in chemostat and turbidostat. *Microbial production of industrial products:* Immobilization of enzymes/cells; Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine; organic acids (citric and lactic), enzymes (protease, lipase and rennet), vitamin (B_{12}), antibiotics and bacteriocins; and fermented whey beverages.

Practical

Microbiological examination of: 1) fresh and canned fruits, vegetables and juices; 2) flour and bread; and 3) eggs and meat. Isolation of psychrophilic, salt and sugar tolerant microorganisms from foods. Isolation of industrially important microorganisms from environment. Determination of Z, D and F values. Production and assaying of microbial enzymes (protease/ lipase). Production of lactic acid from whey. Production of nisin and assaying the antimicrobial activity of the culture. Design and control of a table-top and 10 liter lab fermenter (Demonstration). Production of ethyl alcohol from molasses and whey by yeasts. Production of fermented whey beverages. Educational tour to food processing/ fermentation industries.

V. DAIRY BUSINESS MANAGEMENT

1. Milk Production Management and Dairy Development 3(2+1)

Theory

Introduction to Animal Husbandry. Distinguishing characteristics of India and exotic breeds of dairy animals and their performance. Systems of breeding and methods of selection of dairy animals. General dairy farm practices - Identification, dehorning, castration, exercising, grooming, weighing. Care of animals at calving and management of neonates. Management of lactating and dry cows and buffaloes.

Methods of milking, milking procedure and practices for quality milk production. Dairy farm records and their maintenance. Systems of housing dairy animals and maintenance of hygiene and sanitation at dairy farm premises. Common disease problems in dairy animals, their prevention and control. Feed nutrients required by animal body. Feed resources for milk production and their nutritive values. Digestive system of ruminants and measures of feed energy. Nutrients requirements for growth and milk production. Feeding standards, Structure and function of mammary system. Milk secretion and milk let-down. Male and female reproductive system. Estrus and reproductive cycle, Ovulation, fertilization, gestation, parturition, pregnancy diagnosis. Artificial insemination and embryo transfer and their role in animal improvement introduction to biotechniques in dairy animal production.

Practical

Handling and restraining of dairy animals. External body parts and judging of cows and buffaloes. Feeding and management practices of claves. Identification of common feeds and fodders. Preparation of rations for adult animals. Milking of dairy animals and cleaning and sanitation of milking equipments. Identification of reproductive and digestive organs. Demonstration of semen collection, processing and artificial insemination.

2. Computer and Application Software Packages 2(1+1)

Theory

History, features, classification and organization and I/O peripheral devices for computers; Features of modern operating systems; number systems and coding schemes; Basics of networking and communications; Internet, email concepts and application, Word-processing and desktop publishing, Electronic spreadsheet basics and operations, Database management system basics and operations; Fundamental of presentation-graphic packages. Recent strides in computing.

Practical

Windows Operating System, Word Processing software operations, Presentation Graphics software operations, Internet Surfing/Email usage, RDBMS software package basic operations, Spreadsheet software package basic operations.

3. Economic Analysis 2(2+0)

Theory

Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behaviour-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors. Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus. Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns. Concepts of costs-fixed and variable costs, short run and long run costs,

average and marginal costs, economics and diseconomies of scale. Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition. National income – GDP, GNP, NNP, disposable personal Income, per capita income, inflation.

4. Environmental Studies 2(1+1)

Theory

Environmental Science: An introduction, Ecosystem: kinds, structure, characteristics, functioning, Biochemical cycles, Natural resources and their managements, Environmental pollution, Air pollution, Water pollution, Solid waste pollution, Noise pollution, Soil pollution, Radio active pollution, Food processing industry waste and its management, Management of urban waste water, Recycling of organic waste, Recycling of factory effluent, Control of environmental pollution through low, Composting of biological waste and Sewage, uses of water disposal effluent treatment, microbial examination.

Practical

Environment and its analysis, Water quality parameters, collection of sample for pollution study, Determination of pH/acidity/alkalinity from sample, Estimation of dissolved oxygen, Estimation of BOD, Estimation of COD, Estimation of nitrates, Estimation of phosphates, Estimation of pollutant elements, Estimation of heavy/toxic elements, Estimation of lead/ mercury, Visit to industrial sewage disposal unit.

5. ICT in Dairy Industry and Introduction to Operations Research 4(2+2)

Theory

Introduction–Elementary concepts, objectives of operations research, Applications of OR in decision-making. Modeling in Operation Research. Linear Programming: Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems. Inventory Control – Introduction and general notations, Economic lot size models with known demand. Replacement – Introduction, Replacement of items whose efficiency deteriorates with time. Queuing – Introduction and general notions, Classification of queues and their problems, Probability distribution of queues. Various models in the queuing system. Sequencing – Statement of the problem, notations and assumptions, Problems with 'n' jobs and two machines. Generalization to 'm' machines. Transportation model – Definition and application of transportation model, Formulation of transportation problems and their solutions. Assignment problems and their solutions. Framework of PERT and CPM, Activities, events and network, PERT and activity time estimates, probability of project completion Critical path analysis.

Practical

LP problems, Inventory Control problems, Replacement model problems, problems on queuing theory, sequencing, transportation, assignment, PERT/CPM.

6. Fundamentals of Dairy Extension 3(2+1)

Theory

History, need, definition, philosophy, principles, approaches and objectives of extension education. Present status of dairy and animal husbandry development programme launched in pre and post-independence era. Teaching and learning process, Extension Teaching Methods, classification and selection of teaching methods. Importance of Audio-Visual-Aids. Identification of rural leaders, their characteristics, role and function in rural development, training of rural leaders. Principle of working with group and their mobilisation. Need, principle and step of programme planning. Evaluation of extension programmes. Diffusion of innovations and categories of farmers. Problems of different stake holders, Conceptual orientation about different terms, like- RRA, PRA, IVLP/TAR, ATMA, ATIC, PTD, etc.

Practical

Acquiring skill in use of audio-visual and other aids: Hands-on training on use of LCD projector, PA system, camera. Skills in preparation of documents including script writing, Preparation and use of audio-visual aids including animation for dairy stakeholders Group discussion technique, Hands on learning of field problems in dairy and animal husbandry.

7. Marketing Management and International Trade 2(2+0)

Theory

Concept of marketing; Functions of marketing; concepts of marketing management; scope of marketing management; marketing management. Process; concepts of marketing- mix, elements of marketing- mix. Market Structure and Consumer Buying Behaviour: Concept of market structure, marketing environment, micro and macro environments. Consumers buying behaviour, consumerism. Marketing Opportunities Analysis: Marketing research and marketing information systems; Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning. Allocation and marketing resources. Marketing Planning Process. Product policy and planning: Product-mix; product line; product life cycle. New product development process. Product brand, packaging, services decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing Decisions. Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising; How advertising works; Deciding advertising objectives, advertising budget and advertising message; Media Planning; Personal Selling, Publicity; Sales Promotion. Food and Dairy Products Marketing. International Marketing and International Trade. Salient features of International Marketing. Composition & direction of Indian exports; Trends ion International Dairy Trade, International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO)

8. Communication Skills 2(1+1)

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Précis writing / Abstracting/Summarizing; Style of technical communication Curriculum vitaé/resumé writing; Innovative methods to enhance vocabulary, analogy questions. *Structural and Functional Grammar:* Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults;

Practical

Listening and note taking; Writing skills, précis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

9. Industrial Statistics 2(1+1)

Theory

Definition and scope; sources of animal husbandry and dairy statistics. Measures of central tendency, Measures of dispersion, Moments, skewness and kurtosis. Elementary notions of probability, Laws of addition and multiplication probability. Theoretical frequency distributions: Binomial, Poisson and Normal distribution and their application. Concepts of sampling methods, Introduction to testing of hypotheses, Tests of significance-Z, t, F tests, and their application in the field of dairying. Analysis of variance- One-Way and two-way classification. Simple correlation coefficient and its test of significance, Linear regression, rank correlation. Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

Practical

Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis Fitting of binomial and Poisson distribution. Application of 'Z' test for one and two sample problems. Application of 't' test for one and two sample problems. Application of Chi-square test and F-test. Correlation and regression. Rank correlation coefficient. Control chart for variables & attributes

10. Entrepreneurship Development and Industrial Consultancy 2(2+0)

Theory

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business/ entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs)/SSIs. Export and Import. Policies relevant to dairy sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of dairy inputs industry. Characteristics of Indian dairy processing and export industry. Social Responsibility of Business. *Industrial Consultancy:* Dairy plant management system- milk procurement from the rural milk producer, milk processing and products manufacturing. Pricing and marketing of milk and milk products. Survey on milk production potential and marketed surplus of milk for setting up of milk plants. Recruitment and training of manpower, Estimation of costs of product manufacture and energy utilization in food processing plants. Sources of finance for setting up of dairy farms and processing plants/ units. Guidelines for obtaining ISO/HACCP certification for dairy plants.Assessment of entrepreneurial skills and characteristics for successful entrepreneur. Consumer opinion surveys. Pricing of milk and milk products. Preparation of feasibility reports for setting of dairy farms, composite milk plants, collection centers, chilling units and processing units.

11. Financial Management and Cost Accounting 3(2+1)

Theory

Introduction: Definition, scope and objectives of financial management. Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting. Doubles entry system of Book-Keeping. Preparation of Accounting Records: Journal, Purchases and Sales Book and Posting in Ledger, Cash Book. Preparation of Final Accounts and adjustments at the end of trading period. Preparation of Trial Balance Banking Transactions and Bank reconciliation statements. Statements of Financial Information: Accounting system: A source of financial statements, Classification of capital and revenue expenditure, Balance Sheet, Profit and Loss Account, Statement of changes in the financial position, funds flow statements, cash flow statement, uses of funds flow and cash flow statements in financial decision making. *Financial Analysis:* Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis. Cost Volume – Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis. Capital Structure: C.S Planning, risk return trade off, financial leverage. Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity share capital & retained earning, overall cost of capital. *Investment decision:* Time value of money, Net present value, Investment evaluation criteria, NPV method, Internal rate of return method, Profitability index method, Pay back period method, Accounting rate of return method. Capital budgeting: Complex Investment Decisions:

Investment timing & duration Investment decisions under inflation, Investment decisions under capital rationing. *Project Report;* Feasibility Report Valuation. Working capital management-Concept & determinants of working capital, Estimating working capital needs. Depreciation – Concept and method. Introduction, Definition, Objectives, Common terms. *Costing:* Essentials of sound costing system. Different methods of costing, elements of cost: Labour- recording of time, idle time, methods of remunerating labour, Premium & Bonus Plans, Materials, Overheads. *Cost classification:* Direct and Indirect expenses, fixed and variable costs. Various methods of apportioning indirect expenses. Inventory Management: Planning, control and costing. Stores & storekeeping, scope & importance, purchase procedure, types of purchase, location of stores & materials, procedure for the movement of stores, different methods of pricing materials, store records. Cost Sheets-Different methods, Statement of cost and statement of profit estimates, Tenders or Quotations. Contract or Terminal costing. Process Costing: Process losses and inter-process profits, joint products and by products costing. Ascertainment of cost of milk production. Preparation of Cost Account Information for managerial decisions.

Practical

Preparation of Profit and Loss account. Preparation of Balance Sheet. Preparation of Cash flow statements. Preparation of Funds flow statements. Problems on Ratio analysis. Problems on Break-Even Analysis. Problems on Profit analysis. Problems on Operating Analysis. Problems on Financial leverage. Problems on Cost of Capital. Problems on Investment decisions. Problems on Capital budgeting

ELECTIVES / NON CREDIT COURSES

(Each student to register for any three elective courses)

1. Organic Chemistry 3(2+1)

Theory

Hydrogen bonding: Concepts of hydrogen bonding inter and intra molecular hydrogen bonding in alcohol, carboxylic acids and other molecule. Hydrophobic interactions: Elementary idea of hydrophobicity and its importance in the structure of proteins. *Alcohols:* Important properties of mono, di and trihydric alcohols (Glycol and Glycerol). *Aldehydes and Ketone:* Reactions of aldehydes and ketones. Importance of carbonyl compounds in food flavors. *Carboxylic acids:* Ionization constant and strength of carboxylic acids. Important reactions of carboxylic acid, Derivatives: Esters, Amides, Lactones their preparation and reactions. *Amines:* Basic character of amines, important reactions. *Phenols:* Acidic character of phenols and effect of nuclear subsituents on it. Reactions in phenols. *Substituted carboxylic acid:* important reactions of halogen substituted, Keto and Hydroxy acids. Zwilter-ion forms, its properties viz. melting point and volatility. *Amino Acids and Peptides:* Synthetic and natural amino acids General properties of amino acids. Definition and classification of proteins. Primary, secondary, tertiary and quaternary structure of Proteins. *Carbohydrates:* Definition, Classification and isomerism. Derivation of structure of Glucose, open chain and ring structure, evidences for ring structure stereochemistry and stability of anomers. Reactions of monosaccharides. *Fatty acids and Lipids:* Definition and classification. Important reaction of fatty acids (saturated and unsaturated) Structure and properties of Neutral lipids, phospholipids and cholesterol.

Practical

Systematic identification of Organic Compounds: Aliphatic and Aromatic character, Instauration, Detection of elements (Nitrogen, Sulpher and Halogens), Detection of functional groups (Alcoholic, Phenolic, Carboxylic, Carbonyl, Aldehyde, Ketonic esters, Amino, Amide, Nitro etc.). Preparation of derivatives: Dinitrophenylhydrazone, Oxime and Osazone. Qualitative test for Amino Acids and Proteins: Biuret test, Million's test, Nitroprusside Test, Ninhydrin test, Xantho proteic test, Hopkin's cole reaction. Detection of Carbohydrates (reducing & non reducing sugars) by: Molisch/Orcinol/ Resoreinol/ Silvermirror test. Detection of lipids and phospholipids.

2. Nutraceuticals and Functional Foods 2(2+0)

Theory

Introduction The definition of Functional Foods will be outlined. Students will explore both the industry and the consumer roles involved in this growing field. Antioxidants Students will learn the chemical makeup, free radicals and biochemical functions of antioxidants. Foods explored in this unit will include cranberries, tomatoes, garlic, pomegranate and different iced teas. Dietary Fiber Students will learn about soluble and insoluble fiber, resistant starch, and how important these are to human health. The biochemical functions of dietary fiber will be explored, and oats and oats products will be the main example used in the classroom. Prebiotics and Probiotics Students will learn the definition of both pre-and probiotics, and their biological functions. How to develop prebiotics and probiotics. Pre- and probiotics will be used together as symbiotics. Lipids and health Students will learn the structure and function of essential fatty acids. Chemistry and health benefits of W-3 fatty acids, phytosterols, and CLA , Olive oil. Functions and sources of vitamins and minerals with proposed functional claims.Sports Drink - functional qualities of sports drinks. Electrolytes and sugar level will be a large part of the discussion. . Infant Formula - ingredients and formulation techniques of infant formula, and all aspects of the product that make it a functional food. Consumer trends surrounding infant formula will also be outlined.

3. Food Safety Regulations 2(2+0)

Theory

Food Laws and Regulations, Introduction to food acts laws and standards, National food safety and standard act. International standards, regulatory agencies Consumer protection act. Food Quality Management ,Characteristics of quality, Introduction to Food Safety and Hygiene , Food hygiene Factors affecting food safety· Food spoilage, Food handling, Special requirements for high-risk foods,Safe food cooking temperature and storage techniques. Cleaning and disinfection Personal hygiene, Pest control , Waste disposal

4. Technology Management 2(2+0)

Theory

Introduction to Technology Management: Concept and Meaning of Technology and Technology Management- Technology; Technology management, Evolution and Growth of Technology, Role and Significance of Technology Management, Impact of Technology on Society and Business- Technology and competition; Key issues in managing technological innovation, Forms of Technology- Process technology; Product technology. Technology Forecasting Process, Need and Role of Technology Forecasting, Forecasting Methods and Techniques, Planning and Forecasting. Technology Adoption, Technology Diffusion- of technology diffusion; Perspectives of innovation diffusion process; Activities necessary for diffusion process, Technology Absorption- Role of technology absorption; Benefits of technology absorption; Constraints in technology absorption. Integration of People and Technology, Factors Considered in Technology Management- Organisational factors; Psychological factors, Organizational Structure and Technology

5. Emerging Dairy Processing Technologies 2(2+0)

Theroy

High Pressure Processing: Principles of high pressure processing, use of high pressure to improve food safety and stability. Effects of high pressure on food quality: Pressure effects on microorganisms, enzyme, texture and nutrients of food. Modelling HP processes. Other applications of high pressure processing. Pulsed electric fields processing: Historical background, PEF treatment systems, main processing parameters. Mechanisms of action: mechanisms of microbial and enzyme inactivation. PEF for processing of liquid foods and beverages, PEF Processing for solid foods. Food safety aspects of pulsed electric fields. Pulsed electric field and high pressure processing.

A thermal membrane concentration of liquid foods and colours: osmotic membrane distillation, direct osmosis, membrane modules, Applications of membrane concentration. Processing by radio frequency electric fields: radio frequency electric fields equipments, RFEF non-thermal inactivation of yeasts, bacteria and spores, electrical costs. Ultrasound processing: fundamentals of ultrasound, ultrasound as a food preservation and processing aid, effects of ultrasound on food properties. Alternate thermal processing: Microwave heating: dielectric properties of foods, heat and mass transfer in microwave processing, application of microwave processing for foods; Radio frequency processing: dielectric heating, material properties, radio-frequency heating and drying applications; Ohmic heating: Fundamentals of ohmic heating, electrical conductivity, modeling, treatment of products. Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes, equipment for microwave vacuum drying, product quality degradation during dehydration.

Minimum Standards for Establishing a College/ Institute of Dairy Technology

1. **Degree nomenclature:** B.Tech (Dairy Technology)
2. **Eligibility Criteria:**10+2/Intermediate with PCM (P- Physics, C - Chemistry, M - Mathematics) from a recognised Board/university
3. **Medium of Instruction:** English
4. **Minimum Intake:** 40 students per year
5. **Divisions/Section: Five Divisions and One Section**
   1) Dairy Technology
   2) Dairy Engineering
   3) Dairy Chemistry
   4) Dairy Microbiology
   5) Dairy Trade and Dairy Business Management
   6) Pilot Dairy Unit cum Business Process Development Centre

6. Faculty Requirements for the Departments

Division/Section	Professor	Assoc. Prof	Asst. Prof.	Total
Dairy Technology	1	2	6	9
Dairy Engineering	1	2	6	9
Dairy Chemistry	1	2	3	6
Dairy Microbiology	1	2	3	6
Dairy Business Management	1	2	2*	5
Total	5	10	20	35

*One each in Dairy Economics and Dairy extension, supporting subjects will be taught by other faculty in the university

7. Faculty Expertise

Division/Section	Faculty	Associated
Dairy Technology	Dairy Processing Food Technology	Cheese and Fermented Dairy Products Traditional Dairy Products Packaging Sensory Science Rheology
Dairy Engineering	Dairy Engineering	Food Process Engineering Thermodynamics Civil Engineering Mechanical Engineering
Dairy Chemistry	Dairy Chemistry	Analytical Techniques
Dairy Microbiology	Dairy Microbiology	Microbial Techniques
Dairy Business Management	Dairy Economics Dairy Extension	Business Management

8. Administrative and Supporting Staff for Divisions/Section

Sr. No	Division/Section	Steno/PA/ Computer Operator (9300-34800 +GP 4200)	Assistant (5200-20200+GP 2800)	Attendant/ Messenger (5200-20200+GP 4200)	Clerk (9300-34800+GP 4200)	Laboratory Assistant/ Attendant (5200-20200+GP 2800)
1	Dairy Technology	2	1	2	1	2
2	Dairy Engineering	2	1	2	1	2
3	Dairy Chemistry	2	1	2	1	2
4	Dairy Microbiology	2	1	2	1	2
5	Dairy Business Management	2	1	2	1	2
	Total	**10**	**5**	**10**	**5**	**10**

9. Manpower Requirements of Dean's Office

Designation	No. of Position
Dean	1
Establishment	
PA to Dean	1
Administrative Officer	1
Administrative Comptroller/Assistant Accounts Officer	1
Superintendent	1
Steno/Computer operator	4
Assistant	1
Operator (Audio Visual)	1
Attendants/Messengers	4
Clerk (LDC)	4
Electrician	1
Store Keeper	1
Driver	4
B. Dairy Plant and Business Incubation Centre, Laboratories,	
Manager, Pilot plant/Business Incubation Centre	01
Laboratory Technician for the college	06
Plant Supervisors/ Technical Assistants (Dairy Processing-10, Refrigeration-2, Electrical-2)	14
Plant Operators (Processing-6, Boiler-2 Refrigeration-2)	10
Mechanical Draftsman	01
Jr. Mechanic/wireman	01
Fitter	01
Steno/PA	01

Designation	No. of Position
Assistant	01
Computer operator	02
LDC	01
Attendants	02
C. Library	
Assistant Librarian	01
Library Assistants	01
Clerks	01
Shelf Assistants	01
D. Students Welfare	**To be provided by the University as Central Facility**
E. Hostel Staff for Two Hostels	
Warden	1+1
Hostel Superintendents	2
Clerks	2
Attendants	8
Security, Sanitation and Landscaping	To be outsourced

10. Central/Division/Section Laboratories (as per requirements of the teaching and research work of the college)

Division/Section	Laboratory
Dairy Technology	Product Development Laboratory Product Characterization and Rheology Packaging Laboratory Sensory Evaluation Laboratory Central Instruments Laboratory Food Technology Laboratory
Dairy Engineering	Bioprocess Engineering Laboratory Fluid Mechanics Laboratory Heat Transfer Laboratory Refrigeration and Air Conditioning Food Engineering Laboratory Thermodynamics Laboratory Electrical Laboratory Instrumentation and Control Laboratory Dairy Engineering Workshop
Dairy Chemistry	Dairy Food Analysis Laboratory
Dairy Microbiology	Dairy Food Quality and Safety Laboratory
Dairy Business Management	Computer Laboratory Audio-Visual Laboratory Language Laboratory

11. Land Requirements

- Main building and hostels**:** 4 ha
- Field area: 10 ha
- Play grounds: From common facility of the institute
- **Total: 14 ha**

12. Floor Space Requirements

A) Central Facilities

S. No.	Details	Number of Rooms	Dimensions (ft)
1	Dean office	1	20x 24
2	PA room	1	20x 12
3	Committee room will video conferencing facility	1	20x 48
4	Administrative officer room	1	20 x 12
5	Admin. Staff rooms	3	20x36 each
6	Examination hall	1	20 x 12
7	Evaluation room	1	20 x 36
8	Faculty room	1	20 x 12 each
9	Placement cell	1	20 x 48
10	Smart Lecture rooms	5	Seating capacity - 50
11	Auditorium (Optional)	1	Seating capacity-300
12	Library/Book bank	1	30x72
13	Examination hall (optional)	1	Seating capacity - 300
14	Multipurpose room	1	20x36
15	Laboratories	4	30 x 48 each
16	Hostels	2	Boys and Girls
17	Generator Shed	1	20 x 36
18	Toxic chemical storage and waste unit	1	20 x 24
19	Canteen	1	20 x 12 (kitchen) & 20 x 36 (sitting)
20	Toilets	-	2sets for each floor
21	Parking Space	As per requirement	Office and Hostels
22	Vehicles: Officer car Staff car/Jeep Bus Pick-up van	 1 3 1 1	-

B. Division/ Section

Sr. No.	Details	No. of Rooms	Dimensions (ft)
1	Office of the Head of Division (05)	05 (One for each division)	20 x 24 each
2	Administrative staff	05 (One for each division)	20 x 36 each
3	Faculty room	26	20 x 24 (05 rooms) 20 x 12 (21 rooms)
4	Room for research scholar	04 (one for every Division)	20 x 24 each
5	Committee room cum library	05 (One for each division)	20 x 36 each
6	Smart lecture cum seminar room	05 (One for each division)	Seating capacity - 50 Each

C. Laboratories (UG & PG teaching)

Sr. No.	Details	No. of Laboratories	Dimensions (ft)
1	Dairy Technology	05	20 x 60 (one) 20 x 36 (four)
2	Dairy Engineering	09	20 x 60 (two) 20 x 36 (seven)
3	Dairy Chemistry	04	20 x 60 (one) 20 x 36 (three)
4	Dairy Microbiology	03	20 x 60 (one) 20 x 36 (two)
5	Dairy Business Management	04	20 x 60 (two) 20 x 36 (two)

D. Dairy Plant and Business Incubation Centre

Details	Dimensions
Raw Milk receiving Dock, Milk storage tank room, Milk Processing Hall, Cheese Room, Milk Condensing & Drying Plant room, Cheese Drying & Curing room, Milk Cold Store, Ice Cream Hardening Room,Dispatch Dock, Milk Bottling / Pouch Filling Room, Food processing section (Vegetable/cereal/meat processing) Boiler House, Refrigeration& Ice Bank, System room, Store room – Products, Store room, chemicals & accessories, Sales Counter, Office of the Head of the Department, Offices for the Teaching Staff - Assistant professor, Associate Professor, Offices for the Technical Staff – Boiler Attendant, Refrigeration Attendant, Fitter, Office for the Ministerial Staff & Driver, Wash rooms– Staff & Students (both for Male & Female)	200 x 72

13. Equipment required

A) Central Instrument Facility:

Sr. No.	Name	Number
1	High pressure Liquid Chromatography	01
2	Atomic absorption spectrophotometer	01
3	Hunter LAB Colorimeter	01

Sr. No.	Name	Number
4	Instron Texture Analyzer	01
5	IR Moisture analyser	01
6	Water activity meter	01
7	Flame photometer	01
8	Rheomat	01
9	Viscoamylograph	01
10	Bench-top Microfluidizer	01
11	Rotary evaporator	01
12	Differential Scanning Calorimeter	01
13	Refrigerator	01
14	Deep freezer	01
15	Kjeltec	01
16	Fibretec unit	01
17	Rancimat	01
18	Millipore water purifier	01
19	Low temperature bath	01

B) Pilot Plant cum Business Incubation Centre for Dairy and Food Processing

Sr. No.	Name	Number
1	Milk reception section	01
2	Liquid milk processing unit	01
3	Cream processing , butter and ghee Section	01
4	Powder reconstitution & milk poly pack section	01
5	Paneer section	01
6	Curd/Lassi/Chhach Section	01
7	Ice cream section	01

C. Dairy Trade and Business Management Division:

Sr. No.	Name	Number
1	Desktop computer with LAN facility and Internet connection	20
2	Photocopier	03
3	Laser Printer	06
4	Colour Laser Printer	01
5	Softwares: SPSS/Metlab/Design expert	01 each with multiuse license
6	Indian patent database	01

D. UG/PG Laboratories

Sr. No.	Name	Number
1.	UV-Vis Spectrophotometer	02
2.	Analytical balances	04
3.	Electronic balances	04
4.	Muffle furnace	02
5.	Automatic titrator	01
6.	Soxhlet instrument	01
7.	Gerber centrifuge	02
8.	pH meter	04
9.	Autoclave	02
10.	Laminar flow/Biosafety cabinet	02
11.	BOD Incubator	02
12.	Simple microscope	01
13.	Simple oil immersion microscope	01
14.	Hot air oven	04
15.	Hot water batch	04
16.	Serological bath	02
17.	Centrifuge	01
18.	Low temperature centrifuge	01
19.	Pipette washer	02
20.	Rotary shaker	01
21.	Gas supply and burners	01
22.	Standard assembly for titrimetric analysis with indicator solutions & buffer tablets; Magnetic stirrer; Cyclomix (vortex mixer)	All items: 02 each

E. Packaging Laboratory:

Sr. No.	Name	Number
1	Weighing balance (Accuracy 0.001 g)	02
2	Micrometre	04
3	Mullen Bursting strength tester	01
4	Mechanical drop tester	01
5	Compression strength tester	01
6	Smoothness or porosity tester	01
7	Cobb tester	01
8	Elmendorf tear tester	01
9	Water absorption tester	01

Sr. No.	Name	Number
10	Head space analyser	01
11	Universal testing machine	01
	Barrier testing instruments	
12	Oxygen	01
13	Carbon dioxide	01
14	water vapour transmission tester	01

F. Pilot Plant cum Business Incubation Centre for Dairy and Food Processing

Sr. No.	Name	Number
1	Milk reception section	01
2	Liquid milk processing unit	01
3	Cream processing , butter and ghee Section	01
4	Powder reconstitution & milk poly pack section	01
5	Paneer section	01
6	Curd/Lassi/Chhach Section	01
7	Ice cream section	01

The total production line to be developed for the Dairy Unit (10,000 LPD) is illustrated in the table below:

Sr. No.	Product to be manufactured	Quantity of Milk
1	Liquid milk (Different qualities) of milk such asfull cream, Standardized milk, Toned milk, double toned, milk as per the requirement by PDP	2,500 litres
2	Paneer/Cheese/Shrikhand/Chhana (Production and Chhaina based sweets packaging)	1000 litres
3	Curd/Lassi/Chhach/Yoghurt	1000 litres
4	Ice-cream (1000 litres mix)	1000 litres mix
5	By-Products: casein,caseinates, whey products, etc.	500 litters (only for practical purpose)
6	Heat desiccated products (Khoa, Khoa based sweets like Gulabjamun, Peda, Phirni, Rabri, Kurchan, Kheer, etc.)	500litres(for practical purpose & also for marketing as per demand)
6	Fat rich products Butter, Ghee, etc	Regular production from cream obtained from market milk industry

G. Major Common Pilot Plant Equipment:

S. No.	Item	Numbers	Capacity
1	Milk Weighing Scale	1	0-100 kg
2	Bulk Cooling Tank	1	1000 L
3	Can Washer	1	5 cans/hr

S. No.	Item	Numbers	Capacity
4	HTST Plate Heat Exchanger	1	500 L/hr
5	Batch Pasteurizer	1	500 L
6	Homogenizer	1	500 L/hr
7	Milk Storage Tank	2	1000 each
8	Milk Bottling Plant	1	10 bottle/ min
9	Butter Churn	1	1kg
10	Ghee Boiling Vat	1	100 kg
11	Ice cream Freezer - Batch	1	20kg/batch
12	Cheese Vat	3	200 L each
13	Cheese Cutting Frame	3	1x3ft size
14	Cheese Press	1	6 block
15	Milk Condensing Unit	1	40 kg water evaporation/hr
16	Spray Drying Unit	1	5-10 kg water evaporation/hr
17	Refrigeration Plant	1	10 ton
18	Portable Weighing Scale	2	5 kg
19	Curd Mill	1	-
20	Cheese Hoop	6	20 kg size
21	Milk Cans	50	40 kg each
22	Auto Clave	1	-
23	Ice Water Plant	1	5 ton
24	Cheese Block Cutter	1	-
25	Sieve for Shrikhand	2	-
26	Planetary Mixer	1	10 kg
27	Hand Bottle Filler	1	-
28	Can Scrubber Tank	1	-
29	Pouch Filling Machine	1	100 pouch/hr
30	Cream Separator	1	500 L/hr
31	Butter Trolley	1	50 kg
32	Wet Casein Grinder	1	5 kg
33	Casein Shredder	1	5 kg
34	Casein Dryer	1	5kg /batch
35	Bottle Sterilizer	1	40 bottles/batch
36	Khoa Kettle	1	10 kg/batch
37	Colloidal Mill	1	1 kg/min
38	Crown Capping Machine	1	Manual
39	Sugar Grinder	1	5 kg

S. No.	Item	Numbers	Capacity
40	Tin Seamer	1	Manual
41	UF Cum RO Unit	1	50 kg/hr
42	Crates For Milk Bottles	100	10 kg each
43	Deep Freezer	4	-
44	Gerber Centrifuge	2	24 tubes
45	BOD Incubator	2	-
46	Hot Air Oven	2	-
47	Hot Plate	1	-
48	Magnetic Stirrer	1	-
49	Colony Counter	1	-
50	Weight Box	1 set	100 gm
51	Paraffin Bath	1	50kg
52	Vacuum Packaging Machine	1	5kg/batch
53	Milk Analyser	1	-
54	Ice Cream Freezer - Continuous Type	1	50 L/hr
55	Cooling Unit For Cheese Curing Room	1	2 tonnes
56	Candy Making Machine	1	50 candy/batch
57	Candy Moulds	10	24x100 ml
58	Vacuum Tray Dryer	1	-
59	Extruder	1	-
60	Ice Cream Cup Filling Machine	1	100 cups/hr
61	UHT Milk Sterilization Unit with Aseptic Packaging	1	100 L/hr
62	Tray sealing machine	1	-
63	Colloid Mill	1	-
64	Hammer mill	1	-
65	Planetary mixer	1	-
66	Pin mill	1	-
67	Homogenizer	1	-
68	Steam Jacketed Kettle	3	-
69	Refrigeration System For Ice Cream Hardening Room	1	2 tonnes
70	Processed Cheese Kettle	1	5kg
71	Steam Boiler	2	500-1000 kg steam/hr
72	Diesel power generator	1	125 KWA
73	Effluent Treatment Plant	1	-

H. Equipment for Fruit and Vegetable Processing

Sr. No.	Name	Number
1.	Fruit pulper	01
2.	Screw juice extractor	01
3.	Bottle filling machine	01
4.	Mechanical peeler	01
5.	Peeling knives	Complete set
6.	Slicing knives	Complete set
7.	Mechanical slicer	01
8.	Basket press	01
9.	Plunger press	01
10.	Autoclave	01
11.	Can sealer	01

I. Equipment for Processing of Cereals, Pulses and Oilseeds:

Sr. No.	Name	Number
1.	Dehuller	01
2.	Screw expeller	01
3.	Paddy sheller	01
4.	Corn degermer	01
5.	Popping unit	01
6.	Flaking roller	01
7.	Mini flour mill	01
8.	Pasta making machine	01
9.	Deep fat fryer	01

J. Equipment for Bakery and Confectionary Products:

Sr. No.	Name	Number
1	Moulding unit	01
2	Baking oven	01
3	Sugar grinder	01
4	Biscuit baking unit	01
5	Proofing unit	01
6	Slicing unit	01
7	Chocolate moulder	01

K. Equipment for Meat and Fish processing (Optional):

Sr. No.	Name	Number
1	Bowl chopper	01
2	Meat mincer	01
3	Sausage filler	01
4	Ice flaking machine	01
5	Chopping table	01
6	Combo microwave	01
7	Tumblers	01
8	Molds for hams	01
9	Heating kettle	01

L. Equipment for Dairy Engineering Division:

Sr. No.	Name	Number
1	Orifice and Mouthpiece apparatus	02
2	Pipe friction apparatus	01
3	Minor head loss apparatus	01
4	Flow through channel apparatus	01
5	Computerized centrifugal pump test rig	01
6	Rotameter	02
7	Water flow meters	02
8	Reynolds apparatus	01
9	Bernoulli's apparatus	01
10	Various types of pipe fittings and valves	02 set
11	Self priming pump	02
12	Monoblock pump set	02
13	Submersible pump	01
14	Powder conductivity meter	01
15	Computerized counter and parallel flow apparatus	01
16	Plate Heat Exchanger	01
17	Steam Jacketed kettle	01
18	Stefan Boltzmann Apparatus	01
19	Jacketed vats	02
20	Heat Transfer through composite wall	01
21	Heat Transfer through Natural Convention	01
22	Critical Heat Flux Apparatus	01

Sr. No.	Name	Number
23	Heat Transfer through lagged pipe	01
24	Digital temperature indicators with probes	05 set
25	Multi-channel temperature indicator	02
26	Solar water heating system	01
27	Computerized refrigeration tutor	01
28	Computerized air conditioning tutor	01
29	Water cooler	01
30	Window AC	02
31	Split AC	02
32	Refrigerator	01
33	Models of sealed and open type compressor	01 set
34	Refrigeration plant controls such as thermostat, pressure switches, solenoid valves, expansion valves	01 set
35	Dessert cooler	02
36	Dehumidifier	01
37	Food Processor	01
38	Texture Analyzer	01
39	Laboratory scale freeze dryer	01
40	Try dryer	01
41	Texturometer	01
42	Juice extractors	01
43	Extruders	01
44	Sulfuring chamber	01
45	Blanching equipment	01
46	Clinching equipments	01
47	Jacketed kettle	01
48	Bomb calorimeter	01
49	Flue gas analyzer	01
50	Bucket calorimeter	01
51	Baby boiler	01
52	Models of boiler mountings and accessories.	01 set
53	IC Engine test rig	01
54	Steam flow meter	02
55	Water flow meter	02
56	Models of two stroke and four stroke engine	01 each
57	Different types of steam traps	02 set

Sr. No.	Name	Number
58	Pipes and pipe fittings	As per the requirements
59	Oil and gas burners	01 each
60	Water softening plant	01
61	Boiler feed water pump	01
62	Digital clip-on-meters	02
63	Digital Energy analyzer	01
64	Power measuring instruments such as volt meter, ampere meter, energy meter, meger	05 set
65	Inverter	01
66	Induction Motors with starters	02
67	Variable Frequency Drive	02
68	Single phase Transformer, 2 kVA	02
69	Digital three phase Energy meter	02
70	Different types of starters such as direct on line starter, Star delta starter, Auto- transformer starter ect.	02 set
71	Experimental set up for experiment in parallel & series connection, stair case wiring, tube light wiring, motor connection, speed measurement, demonstration of winding etc with necessary power, voltage, and current measuring devices.	02 set
72	Hand tachometer	02
73	Non contact type tachometer	02
74	Soft starter	02
75	Air anemometer	01
76	Magnetic flow meter	02
77	Digital pocket type thermometers with different types of probes	05
78	Multi channel data logger	01
79	Various tutors/transducers such as Strain gauge, pressure, LVDT, Inductive, Photo cell, piezometer, etc.	01 set
80	Water Level controller	01
81	Pneumatic controller	01
82	PID controller temperature controller system	01
83	Digital Tachometer	01
84	Lux meter	01
85	Solar lighting system	02
86	Lathe Machine	01
87	CNC lathe	01
88	Grinding machine	01

Sr. No.	Name	Number
89	Power saw	01
90	Drilling machine	01
91	Pipe bending machine	01
92	Electric welding machine	01
93	Portable welding machine	01
94	Gas welding set	01
95	Shear cutting machine	01
96	Threading machine	01
97	Universal wood working machine	01
98	Bench vice	20
99	Portable grinding machine	02
100	Shaping machine	01

M. Dairy Trade and Business Management Division:

Sr. No.	Name	Number
1	Desk top computers with LAN facility and Internet connection	20
2	Photocopier	03
3	Laser Printer	06
4	Colour Laser Printer	01
5	Softwares: SPSS/Metlab/Design expert	01 each with multiuse license
6	Indian patent database	01

FISHERIES

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i). UG Degree: B.F. Sc.

ii). PG Degrees: M.F.Sc. and Ph.D. (Fisheries)

P.G. with specialization with specializations in following disciplines:

S. No.	Specialization in M.Tech/ M.Sc. / Ph.D.
1	Aquaculture
2	Fisheries Resource Management
3	Fish Processing Technology
4	Aquatic Environment Management
5	Fish Genetics and Breeding
6	Fish Biotechnology
7	Fish Physiology and Biochemistry
8	Fish Health Management
9	Fish Nutrition and Feed Technology
10	Fisheries Extension
11	Fisheries Economics

Restructuring of UG programmes for increased practical /practice contents

Department wise distribution of proposed courses

1. Department of Aquaculture

Sl. No	Course title	Credit load
1.	Principles of Aquaculture	2(1+1)
2.	Fresh Water Aquaculture	3(2+1)
3.	Ornamental Fish Production and Management	2(1+1)
4.	Coastal Aquaculture and Mariculture	3(2+1)
5.	Finfish Hatchery Management	3(2+1)
6.	Shellfish Hatchery Management	2(1+1)

Sl. No	Course title	Credit load
7	Aquaculture in Reservoirs	2(1+1)
8	Fish Nutrition and Feed Technology	3(2+1)
9	Fish Food Organisms	2(1+1)
10	Introduction to Biotechnology & Bioinformatics	2(1+1)
11	Genetics and Breeding	2(1+1)
12	Fundamentals of Biochemistry	3(2+1)
	Total	**29(17+12)**

2. Department of Fisheries Resource Management

Sl. No.	Course title	Credit load
1.	Taxonomy of Finfish	3(1+2)
2.	Taxonomy of Shellfish	2(1+1)
3.	Anatomy and Biology of Finfish	3(2+1)
4.	Anatomy and Biology of Shellfish	2(1+1)
5.	Physiology of Finfish and Shellfish	3(2+1)
6.	Inland Fisheries	3(2+1)
7.	Marine Fisheries	3(2+1)
8.	Fish Population Dynamics and Stock Assessment	3(2+1)
9.	Aquatic Mammals, Reptiles and Amphibians	1(1+0)
	Total	**23(14+9)**

3. Department of Aquatic Animal Health Management

Sl. No.	Course title	Credit load
1.	Fish and Shellfish Pathology	3(2+1)
2.	Microbial and Parasitic Diseases of Fish and Shellfish	3(2+1)
3.	Pharmacology	3(2+1)
4.	Therapeutics in Aquaculture	2(1+1)
5.	Fish Toxicology	2(1+1)
6.	Fish Immunology	2(1+1)
7.	Fundamentals of Microbiology	3(2+1)
	Total	**18(11+7)**

4. Department of Aquatic Environment Management

Sl. No.	Course title	Credit load
1.	Meteorology, Climatology and Geography	2(1+1)
2.	Soil and Water Chemistry	3(2+1)
3.	Limnology	3(2+1)

Sl. No.	Course title	Credit load
4.	Fishery Oceanography	2(1+1)
5.	Marine Biology	3(2+1)
6.	Aquatic Ecology, Biodiversity and Disaster Management	3(2+1)
7.	Aquatic Pollution	2(1+1)
8.	Coastal Zone Management	2(1+1)
	Total	**20(12+8)**

5. Department of Fish Processing Technology

Sl. No.	Course title	Credit load
1.	Fish in Nutrition	1(1+0)
2.	Food Chemistry	3(2+1)
3.	Freezing Technology	2(1+1)
4.	Fish Canning Technology	2(1+1)
5.	Fish Packaging Technology	2(1+1)
6.	Fish Products and Value Addition	3(2+1)
7.	Fish By-Products and Waste Utilization	2(1+1)
8.	Microbiology of Fish and Fishery Products	3(2+1)
9.	Quality Assurance of Fish and Fishery Products	3(2+1)
	Total	**21(13+8)**

6. Department of Fisheries Engineering

Sl. No	Course title	Credit load
1.	Aquaculture Engineering	3(2+1)
2.	Refrigeration and Equipment Engineering	3(2+1)
3.	Fishing Craft Technology	2(1+1)
4.	Navigation and Seamanship	2(1+1)
5.	Fishing Gear Technology	2(1+1)
6.	Fishing Technology	2(1+1)
	Total	**14(8+6)**

7. Department of Fisheries Extension, Economics and Statistics

Sl. No	Course title	Credit load
1.	Statistical Methods	3(2+1)
2.	Fisheries Economics	3(2+1)
3.	Fisheries Policy and Law	1(1+0)
4.	Fisheries Co-operatives and Marketing	2(1+1)
5.	Fisheries Business Management and Entrepreneurship Development	1(1+0)

Sl. No	Course title	Credit load
6.	Information and Communication Technology	2(1+1)
7.	Fisheries Extension Education	2(1+1)
8.	Communication Skills and personality development	1(0+1)
	Total	**15(9+6)**

Compulsory Non-Credit Courses. At least one class per week

1. Swimming 1 (0+1)
2. Physical Education, First Aid & Yoga Practice 1 (0+1)

Summary

Sl. No.	Department	No. of courses	Credit load
1	Aquaculture	12	**29(17+12)**
2	Fisheries Resource Management	9	**23(14+9)**
3	Department of Aquatic Animal Health Management	7	**18(11+7)**
4	Aquatic Environmental Management	8	**20(12+8)**
5	Fish Processing Technology	9	**21(13+8)**
6	Fisheries Engineering	6	**14(8+6)**
7	Fisheries Extension, Economics and Statistics	8	**15(9+6)**
8	Comp. Non-credit courses (Swimming & Phy. Edn)	2	-
	Sub total	**61**	**140(84+56)**
	Student READY In-Plant Attachment Programme	1	**10(0+10)**
	Student READY Rural Fisheries Work Experience Programme	1	**8(0+8)**
	Study Tour (in and outside State)	1	**2(0+2)**
	Student READY Experiential Module	1	**17(0+17)**
	Project Work	1	**2(0+2)**
	Seminar	1	**1(0+1)**
	Total	**06**	**40(0+40)**
	Grand Total	**67**	**180(84+96)**

SEMESTER WISE DISTRIBUTION OF COURSES

I Semester

Sl. No.	Course Title	Credit hour
1	Principles of Aquaculture	2 (1+1)
2	Taxonomy of Finfish	3(1+2)
3	Taxonomy of Shellfish	2(1+1)
4	Meteorology, Climatology and Geography	2(1+1)

Sl. No.	Course Title	Credit hour
5	Statistical Methods	3(2+1)
6	Fundamentals of Biochemistry	3(2+1)
7	Fundamentals of Microbiology	3(2+1)
8	Soil and Water Chemistry	3(2+1)
9	Fish in Nutrition	1(1+0)
10	Swimming	1(0+1)**CNC***
	Total	**22(13+9)**

*CNC= Compulsory non-credit course.

II Semester

Sl. No.	Course Title	Credit hour
1	Fresh Water Aquaculture	3 (2+1)
2	Anatomy and Biology of Finfish	3(2+1)
3	Limnology	3(2+1)
4	Marine Biology	3(2+1)
5	Inland Fisheries	3(2+1)
6	Food Chemistry	3(2+1)
7	Information and Communication Technology	2(1+1)
8	Aquaculture in Reservoirs	2(1+1)
9	Physical Education, First Aid & Yoga Practices	1(0+1)**CNC***
	Total	**22(14+8)**

*CNC= Compulsory non-credit course.

III Semester

Sl. No.	Course Title	Credit hour
1	Physiology of Finfish and Shellfish	3(2+1)
2	Fish Food Organisms	2(1+1)
3	Aquatic Ecology, Biodiversity and Disaster Management	3(2+1)
4	Fishery Oceanography	2(1+1)
5	Ornamental Fish Production and Management	2(1+1)
6	Freezing Technology	2(1+1)
7	Genetics and Breeding	2(1+1)
8	Fish Immunology	2(1+1)
9	Fisheries Economics	3(2+1)
10	Aquatic Mammals, Reptiles and Amphibians	1(1+0)
	Total	**22(13+9)**

IV Semester

Sl. No.	Course Title	Credit hour
1	Coastal Aquaculture and Mariculture	3(2+1)
2	Therapeutics in Aquaculture	2(1+1)
3	Fish Nutrition and Feed Technology	3(2+1)
4	Fish Canning Technology	2(1+1)
5	Fish Packaging Technology	2(1+1)
6	Fish and Shellfish Pathology	3(2+1)
7	Fishing Craft Technology	2(1+1)
8	Fisheries Extension Education	2(1+1)
9	Shellfish Hatchery Management	2(1+1)
10	Communication Skills and Personality Development	1(0+1)
	Total	**22(12+10)**

V Semester

Sl. No.	Course Title	Credit hour
1	Finfish Hatchery Management	3 (2+1)
2	Anatomy and Biology of Shellfish	2 (1+1)
3	Pharmacology	3 (2+1)
4	Fish Toxicology	2 (1+1)
5	Marine Fisheries	3(2+1)
6	Fisheries Co-operatives and Marketing	2(1+1)
7	Fishing Gear Technology	2(1+1)
8	Fish Population Dynamics and Stock Assessment	3(2+1)
9	Coastal Zone Management	2(1+1)
	Total	**22(13+9)**

VI Semester

Sl. No.	Course Title	Credit hour
1	Introduction to Biotechnology and Bioinformatics	2(1+1)
2	Refrigeration and Equipment Engineering	3(2+1)
3	Fisheries Policy and Law	1(1+0)
4	Aquatic Pollution	2(1+1)
5	Fishing Technology	2(1+1)
6	Fish Products and Value Addition	3(2+1)
7	Microbiology of Fish and Fishery Products	3(2+1)
8	Navigation and Seamanship	2(1+1)
9	Fish By-Products and Waste Utilization	2(1+1)

Sl. No.	Course Title	Credit hour
10	Fisheries Business Management and Entrepreneurship Development	1(1+0)
	Total	**21(13+8)**

VII Semester

Sl. No.	Course Title	Credit hour
1	Student READY Programme In-plant attachment (for 8 weeks) Rural Fisheries Work Experience Prog. (for 8 weeks) Study Tour (in and outside State) (for 4 weeks)	 10 (0+10) 8(0+8) 2(0+2)
	Total	**20(0+20)**

VIII Semester

Sl. No.	Course Title	Credit hour
1	Aquaculture Engineering	3 (2+1)
2	Microbial and Parasitic Diseases of Fish and Shellfish	3 (2+1)
3	Quality assurance of Fish and Fishery Products	3(2+1)
4	Student READY Experiential Module (concurrent with the semester) This will include capacity building and skill development of the students in planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency. Skill Development (for one week) Experiential Learning Programme	 5(0+5) 12(0+12)
5	Project Work	2(0+2)
6	Seminar	1(0+1)
	Total	**29(6+23)**

Total Credit Hours 180 (84+96)+2 Compulsory Non-Credit Course

* Student READY Programme

Student READY Experiential Module:

a) **Skill Development (for one week) :** Aquarium fabrication, Analysis of soil and water quality parameters, Preparation of Fish products or in any appropriate applied aspect of fisheries

b) **Experiential Learning Programme:**

A minimum of two areas should be decided by each university. Areas of specialization for Experiential Learning Programme are 1. Ornamental fish culture 2.Seed Production 3. Trade and export management 4. Aquaclinic 5. Post Harvest technology 6. Aqua farming.

A total of 12 credits are allotted for Experiential Learning Programme and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college.

c) **Project work:** Student will select relevant or interested area of specialization such as

Fish pathology, Fish diagnosis, Fish pharmacology, Fish Toxicology, Fish nutrition, Fish immunology, Fish genetics and breeding, Ornamental fish production, Genomics in Aquaculture, Fish stock assessment, Aquatic pollution, Fish value addition, Fish in nutrition, Fish processing waste management, Quality control and quality assurance, Fish products and by-products etc.. He/she will prepare a research project plan and it will be presented in-front of committee appointed by the Dean of the respective college. Also, for each student, one advisor will be provided, who will guide the student in completion of proposed research plan.

A total of 2 credits are allotted for project work and 1 credit for (completed project work presentation) seminar. The evaluation for the same will be conducted by the committee appointed by the Dean of the respective college.

Overall changes effected in the course curriculum and syllabus by the V Deans Committee recommendations

- New courses for 9 credit hrs on Pharmacology, Chemotherapy, Toxicology and Immunology have been added to address health of both fish and the consumer. Also a new course on Aquatic mammals, reptiles and amphibians included.
- A new Department on Aquatic Animal Health Management created in view of its importance in the rapidly growing aquaculture industry. Furthermore, Department of Fishery Engineering has been carved out of Dept. of Post Harvest Technology.
- Student Ready Programme has been strengthened with 40 credit hrs without diluting curriculum of theory courses. The programme has RAWE 8 credits hrs, Inplant training 10 credit hrs, Experiential learning 17 credit hrs and other Skill development, Educational Tour and Seminar- total 8 credit hrs.
- Only two compulsory non-credit courses with one class per week on 1) swimming 2) physical Education, First aid and Yoga are included.Solid Body
- Course syllabus was reviewed for including latest content and avoiding repetition.

Department wise distribution of proposed syllabus

I. AQUACULTURE

1. Principles of Aquaculture 2(1+1)

Theory

Basics of aquaculture, definition and scope. History of aquaculture: Present global and national scenario. Aquaculture vs Agriculture. Systems of aquaculture - pond culture, pen culture, cage culture, running water culture and zero water exchange system,. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water. Principles of organic aquaculture. Pre-stocking and post stocking pond management. Carrying capacity of pond, factors influencing carrying capacity. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integrated culture systems. Water and soil quality in relation to fish production. Physical, chemical and biological factors affecting productivity of ponds.

Practicals

Aquaculture production statistics- world and India. Aquaculture resources of world and India. Components of Aquaculture farms. Estimation of carrying capacity. Practices on pre-stocking and post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH_3, Organic matter, CO_2). Analysis of manure.

2. Fresh Water Aquaculture 3(2+1)

Theory

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc. Nursery, rearing and grow-out ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods-Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture. Composite fish culture system of Indian and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfish and murrels.

Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

Practicals

Preparation and management of nursery, rearing and grow-out ponds. Study on effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Workout of economics of different culture practices.

Estimation of live stock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

3. Ornamental Fish Production and Management 2(1+1)

Theory

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filteration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of

genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

Practicals

Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

4. Coastal Aquaculture and Mariculture 3(2+1)

Theory

An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, Seed resources. Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of Shellfish Culture rafts, racks, cages, poles and ropes., Water and soil quality management. Estimation of growth, survival and pond productivity. Seaweed culture, Pearl culture, Sea ranching.

Practicals

Identification of important cultivable species. Collection and identification of commercially important seed of fish and shellfishes. Types of fertilizers - Pond preparation. Seed selection, quality and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

5. Finfish Hatchery Management 3(2+1)

Theory

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled

hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea hourse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season andmultiple breeding of carps.

Practicals

Study of maturity stages in fishes. Collection and preservation of fish pituitary gland, preparation of PG extract, Hypophysation. Calculation of fecundity. Brood-stock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stages. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.

6. Shellfish Hatchery Management 2(1+1)

Theory

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachium rosenbergii*, *P. Vannamei*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe carb, Sepia, Loligo, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon*. and *P. Vannamei*. Induced maturation in *Penaeus monodon* and *P. Vannamei P. Indicus* by eye stalk ablation. Reproductive physiology. Reproductive harmones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *Penaeus monodon* and *Macrobrachium rosenbergii.* Breeding and hatchery management of crabslobster, mussel, edible and pearl oyster. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

Practicals

Identification of brood stock and maturity stages of important crustaceans and mollusks. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon* P. Vannamei. Identification of larval stages of important crustaceans and mollusks. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and transportation of shrimp/prawn seed and brood stock. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/ prawn hatchery.

7. Aquaculture in Reservoir 2(1+1)

Theory

Definition of reservoirs in India; nature and extent of reservoirs, topography and species

diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and post-impoundment stages and their significance in establishment of reservoirs fisheries.

Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production.

Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs

Role of cage and pen culture in enhancement of fish production from reservoirs; history of cage culture, advantages of cage culture; selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system. Integration of cage culture with other farming systems.

History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture.

Practicals

Preparation of charts on the present situation of reservoirs fisheries productivity; detailed case studies of selected reservoirs on the changing trends in capture fisheries profile; drawing inferences from the analysis of data; suggestions for the sustainable development of reservoirs fisheries. Case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation.

8. Fish Nutrition and Feed Technology 3(2+1)

Theory

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning. Methods of feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants. Feed evaluation: feed convertion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutrional deficiency diseases.

Practicals

Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality.

9. Fish Food Organisms 2(1+1)

Theory

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials - proximate composition of live feed. Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

Practicals

Methods of collection and identification of different live food organisms. Laboratory scale culture of selected live food organisms (green algae, spirulina, chetoceros, rotifer, Moina, copepod). Evaluation of live food organisms. Decapsulation and hatching method of brine shrimp cyst.

10. Introduction to Biotechnology & Bioinformatics 2(1+1)

Theory

Biotechnology**:** Introduction to Biotechnology –scope and importance in fisheries/ aquaculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting.

Bioinformatics**:** Introduction to Bioinformatics; Biological Databases and tools : Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

Practicals

Study of structure of prokaryot and Eukaoryt Cells. Study on Model of protein Synthesis, Study of models rDNA Technology, Cell Culture, Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNA sequence analysis and comparison.

11. Genetics and Breeding 2(1+1)

Theory

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over. Introduction

to population genetics. Hardy- Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability.

History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

Practicals

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt.

12. Fundamentals of Biochemistry 3(2+1)

Theory

A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Carbohydrate chemistry: Structure, classification, functions (mono, di and polysaccharides) isomerism and mutarotation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Protein chemistry: classifications and functions. Classification, structure, function and properties of amino acids. Essential and non essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Digestion and absorption of lipids. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids. Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones- chemistry and function. Structure and functions of fat and water soluble vitamins. Vitamins – classification- functions. Minerals – classification – functions. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Protein synthesis. Energy changes in chemical reactions, reversible and irreversible reactions in metabolism.

Practicals

Preparation of normal solution of acid and base, buffers and reagents. Qualitative determination of carbohydrates, proteins and lipids. Estimation of total nitrogen and crude protein of fish tissue. Estimation of carbohydrates in foods. Determination of specific gravity of oil. Extraction and estimation of total lipids in fish tissue. Determination of saponification value, iodine value and free fatty acid value.

II. FISHERIES RESOURCE MANAGEMENT

1. Taxonomy of Finfish 3(1+2)

Theory

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyotaxonomy, DNA barcoding, protein analysis and DNA polymorphism.

Practicals

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism; Visit to fish landing centres to study commercially important fishes and catch composition.

2. Taxonomy of Shellfish 2(1+1)

Theory

Study of external morphology and meristic characteristics of crustacea and mollusca. Classification of crustacea and mollusca up to the level of species with examples of commercially important species.

Practicals

Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats. Field visits for collection and study of commercially important shellfishes.

3. Anatomy and Biology of Finfish 3(2+1)

Theory

Study of external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Practicals

Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. Study of food and feeding habits. Analysis of gut contents.

Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

4. Anatomy and Biology of Shellfish 2(1+1)

Theory

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

Practicals

Study of Internal Organs commercially important crustaceans and mollusks. Study of Digestive, respiratory, circulatory, nervous and reproductive systems. Study of food and feeding habits - analysis of gut contents, age and growth, length - weight relationship and condition. Reproductive biology: maturity stages, spawning periodicity, fecundity and larval stages.

5. Physiology of Finfish and Shellfish 3(2+1)

Theory

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on physiology of fin and shellfishes. Stress related physiological changes. Structure and functions of important endocrine glands.

Practicals

Estimation of oxygen consumption, Osmoregulation, ammonia excretion and carbon-dioxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques.

6. Inland Fisheries 3(2+1)

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery-present status of their exploitation and future prospects. Cold water fisheries of India.

Practicals

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, net making yards.

7. Marine Fisheries 3(2+1)

Theory

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic - demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of the India's EEZ. GIS and Remote sensing in marine capture fishery.

Practicals

Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data. Participation in fishing cruises. GIS and remote sensing in marine capture fishery.

8. Fish Population Dynamics and Stock Assessment 3(2+1)

Theory

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Cario simulation model and ECOPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

Practicals

Study of length – weight relationship, segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

9. Aquatic Mammals, reptiles and amphibians 1(1+0)

Theory

Selected aquatic mammal, reptile, amphibian and birds species of India relevant to fisheries: taxonomic status, identification characters, distribution, abundance, habitat, exploitation, threats and conservation. Biology of aquatic animals: Cetaceans (whales. dolphins, porpoises and narwal), Sirenia (manates and dugongs), Carnivora (seals, sea lions walruses, polar bear and otter), Sea turtles, tortoise, crocodiles, sea/freshwater snakes and amphibians. IUCN criteria – Red list, Wild Life (Protection) Act.

III. AQUATIC ANIMAL HEALTH MANAGEMENT

1. Fish and Shellfish Pathology 3(2+1)

Theory

Significance of finFish and Shellfish diseases in aquaculture. Host, Pathogen and Environment Interaction. Disease development process. Stress in aquaculture and its role in disease development. Pathological processes: Cellular response to injury, Inflammatory response to diseases, Pathogencity mechanism of parasite, bacteria, virus and fungus. Casehistory and clinical sign in disease diagnosis. Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals and metabolites, free radicals, oxidants) soil and water parameters in fish health. Nutritional diseases . Non-infectious diseases.

Practicals

Live and post mortem examination of fish and shellfish. Pathology of organ systems. Histopathology of normal and diseases fish and shellfish, Diagnosis of abiotic fish diseases.

2. Microbial and Parasitic Diseases of Fish and Shellfish 3(2+1)

Theory

General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Vaccines, Immuno-stimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices. SPF and SPR stocks –development and application. Bio-security principles, Sanitary and phytosanitary Agreement, Disease control through environmental management. Importance of Biofilm, Biofloc, Periphyton in aquatic Health Management, Zoonotic diseases. Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, Rapid diagnostic methods.

Practicals

General procedure for disease diagnosis. Methods of sampling fish and shellfish for disease diagnosis. Taxonomy, lifecycle and identification of fish and shellfish parasites .Sampling, preparation of media and culture of pathogenic bacteria: Techniques for bacterial classification. Techniques in disease diagnosis: Microbiological, haematological, Histopathological, immunological, molecular techniques and Biochemical tests. Agglutination test; Challenge tests; purification of virus; Stress related study of fish and shellfish; Disease treatment.

3. Pharmacology 3(2+1)

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs.Pharmacolotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and

Excretion of drugs. Factors influencing drug metabolism. Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non receptor mediated action. Dose Response Relationship, half life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system, nervous system and cardiovascular system. Drugs used in fish transporation. Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry.

Practicals

Introduction to Pharmacy, Metrology, Prescription Writing, Preparation of drug solution, Source and chemical nature of drugs, Incompatability, Pharmacutical technology, Bioassay of drugs, Animal models in Pharmacological experiments, Methods of application of drugs in fish.

4. Therapeutics in Aquaculture 2(1+1)

Theory

Scope and current scenario of therapeutics in aquaculture.

Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc. Antibiotic resitance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoanes. Antibiotics used in aquaculture

Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders and dosage.

Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anaesthetics, flesh color enhancers, Chemicals of therapeutic value, Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices, list of the drugs used in aquaculture with therapeutics

Practicals

Regulations of drug use. Introduction to antimicrobials, preparation of potassium permanganate solution, preparation of weak Tincture Iodine. Minimum inhibitory concentration(MIC). Five-plate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.

5. Fish Toxicology 2(1+1)

Theory

General Toxicology: Definitions, Branches of Toxicology, Historical developments, Classification of poison. Types of poisoning- Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetics, Toxicodynamics, General approaches to diagnosis and treatment of poisoning.

*Systemic Toxicology:*Toxicity caused by metal and non-metals, Phytotoxins- Toxic principles of various alkaloids and toxic plants, Drug toxicity and toxicity caused by agrochemicals. Mycotoxins, Bacterial toxins. Collections and dispatch of specimens in Toxicological cases, Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish Metabolism of toxic substances by aquatic organisms.

Practicals

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe_3^+), Copper (Cu), Ammonia (ammonium ions) NH_4^+ Chloride (Cl^-), Phosphate ($P0_4$) Sulphate ($S0_4$) Flouride (Fl^-), Qualitative detection of Nitrite and Nitrate, Detection of hydrocyanic acid, Detection and Estimation of Mycotoxins, Test for detection of alkaloids, Estimation of LD_{5O} and ED_{5O} Demonstration of drug toxicity.

6. Fish Immunology 2(1+1)

Theory

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types. epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions- principle, antigenrecognition by B-cells and T cells**.**

Antigen-antibody reaction - Precipittin reactions, agglutination reactions, Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish- specific and non specific immune system. Pathogenicity and virulence.Sources of infection, transmission of disease producing organisms, portals of infection. Immunity to bacteria, fungi and parasites Role of stress and host defense mechanism in disease development. Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants –types, mechanism of action, modes of administration. Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

Practicals

Collection, separation and identification of fish leucocytes. Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types of leukocytes and isolation of macrophages. Precipitin reactions - Agglutination test,immunogel diffusion, double immuno diffusion, radial immuno diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

7. Fundamentals of Microbiology 3(2+1)

Theory

Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogrdasky. Microscopy- Principle and constructionof

brightfield, dark field, phase contrast, stereo, SEM and TEM. Microbial taxonomy –Bergy's and molecular taxonomy Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi and protozoa. Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining; enumeration of micro-organisms, culture preservation methods. Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids- types and their importance. Mutation –types and significance. Microbial ecology**:** Introduction and types of interaction, extremophiles and their significance

Aquatic Microbiology:Introduction and **s**cope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses; distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators. Economic significance of aquatic microbes.

Practicals

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry-Determination of size of micro organisms (ocular, stage micrometers). Tools and techniques in sterilization methods:Filteration, dry heat, moist heat, chemical agents Cultivation technique: Media preparation, Isolation -pure culture, subculture. Observation of fungi, blue-green algae, and protozoans. Staining techniques for bacteria– simple, differential, structural and Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems.

Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform. Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method.

IV. AQUATIC ENVIRONMENT MANAGEMENT

1. Meteorology, Climatology and Geography 2(1+1)

Theory

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: process of heat transmission; heating of

atmosphere; disposal of insulation; irregular heating of atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms. Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients. Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning. Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Effects of climate change on fisheries sector. Introductionto Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape.

Practicals

Graphic representation of structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph. Isotherms: world mean temperatures-January to July. India mean temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets. Atmospheric pressure measurement: fortin' s mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Typical landscape mapping; map reading. Geographical terms used in landscape.

2. Soil and Water Chemistry 3(2+1)

Theory

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve; nomograph.

Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters**:** surface water, ground water and sea water. Dissolved gasses: Factors

affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

Soil Chemistry: origin and nature of soils. Physical properties of soil; soil colour. texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soil samples. Determination of soil texture, water holding capacity, pH, conductivity, organiccarbon, nitrogen, phosphorus, lime requirement. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

Practicals

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis. Water analysis: measurement of temperature, turbidity, determination of pH and EC. Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO_2. Determination of total alkalinity, hardness. Determination of inorganic nitrogen, and phosphorus Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.

3. Limnology 3(2+1)

Theory

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence ofphysical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity: Aquatic plants: characterstics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic

dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

Practicals

Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies. Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Field visit to lotic and lentic water bodies.

4. Fishery Oceanography 2(1+1)

Theory

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO_2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.

Practicals

Field visits and operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder. Measurement

of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water

5. Marine Biology 3(2+1)

Theory

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, sea weeds, major zooplankton groups. Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries. Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation. Mud banks: formation, characteristics. Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms. Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species, Blooms, Red tides: cause and effects.

Practicals

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, Collection preservation and analysis of inter tidal organisms.

6. Aquatic Ecology, Biodiversity and Disaster Management 3(2+1)

Theory

Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries. Conservation programmes for endangered species, *ex situ* and *in situ* conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Disaster Management in Fisheries:

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters. Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning,

communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global levels. Sea safety and health. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counselling.

Practicals

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices.

7. Aquatic Pollution 2(1+1)

Theory

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment, Classification of pollution-physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution. Solid waste management.

Practicals

Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of

pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Study of pathogenic and coliform bacteria. Bacteriological quality of water; Colliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters. Pollution flora and fauna: indicator species- algae, protozoa and insect larva. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.

8. Coastal Zone Management 2(1+1)

Theory

Estuaries, Wet lands and Lagoons, Living resources – Non living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification. Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection. Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry. Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries. Evaluation and Methodology; Social Impact Assessment and other developmental activities.

Practicals

Field visit to different coastal environments to study erosion of beaches, Identification of ecologically sensitive areas and protection, Study of CRZ, ICZM along the coastal belt, Study on implementation and violation of CRZ, Study of application of remote sensing and GIS, Project preparation of EIA.

V. FISH PROCESSING TECHNOLOGY

Fish in Nutrition 1(1+0)

Theory

Composition of fish with emphasis on nutritional value. Concept of Biological value, Protein Efficiency ratio, Net protein utilization. Amino acids of fish and shellfishes and importance of essential amino acids. Fish lipids: fatty acids, nutritional quality. Role of fish lipids in human nutrition. Non-protein nitrogen substances in fishes. Vitamins in fish: water soluble, fat soluble, significance in human nutrition. Minerals in fish: micro- and macro-elements, trace elements, significance in human nutrition. Other functional bio-molecules in fish – peptides, collagen and squalene. Effect of different kinds of cooking fish ie. curry, frying, steaming, smoking, fermentation on nutrition value.

2. Food Chemistry 3(2+1)

Theory

Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydrates: Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic. Lipids: metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Proteins: metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins. Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human nutrition.

Practicals

Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish sample. Determination of energy value of fish. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Use of pH meter. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods.

3. Freezing Technology 2(1+1)

Theory

Introduction to freezing technology; characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants. Principles of low temperature preservations. Chilling of fish – methods and equipment for chilling; icing – quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Freezing of fish fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico– chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish for freezing. Changes that occur during frozen storage – microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments – polyphosphate, glazing, antioxidants, packaging; thawing of frozen fish – methods of thawing. Transportation of frozen fish, cold chain, quality control, HACCP in freezing industry.

Practicals

Sanitation and plant housekeeping; chilling and freezing equipment, instruments; packages and product styles; methods of icing fish; cooling rate; preservation by chilled sea water; freezing and thawing curves; freezing of different varieties of fish and shellfish; estimation of drip; determination of quality changes during frozen storage; inspection of frozen fishery products; visits to ice plants, cold storages and freezing plants.

4. Fish Canning Technology 2(1+1)

Theory

Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials and sub materials, their characteristics and suitability for canning. Classification of foods based on pH, commercial sterility, Absolute sterility, pasteurisation and sterilization. Canning process, process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Principles of thermal processing. Heat resistance of micro organisms, heat penetration studies, mechanism of heat transfer. Cold spot and its importance, convection and conduction type of packs. Process calculation by general/ graphical methods, estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D concept. Canning of commercially important fin fishes, shell fishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal. Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches.

Practicals

Types of cans, canning equipments and layout of cannery. Canning of different varieties of fish and shellfish. Cutout test of canned products. Examination of can double seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method. Study of spoilage condition in canned products. Familiarization with various packaging materials and container for fish products.

5. Fish Packaging Technology 2(1+1)

Theory

Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use in protective packaging with special reference to food. Printing for packaging and print identification. Closures of packaging, heat seals bottle closure. Principles of packaging fresh produce handling and transportation. Packaging for retail sale and storage. Packaging equipment and machinery. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. Laminations and co-extrusions. Retort pouch packaging - advantages and disadvantages. Biodegradable films,

vacuum packaging, active packaging, MAP, Polymeric Packaging.Packaging requirements of fresh fish, Frozen fish, Canned Fish. Transport worthiness of packaging materials, accelerated shelf testing.Materials and their safe use in food contact application. Safety and legislation aspects of packing. Labeling and bar coding.

Practicals

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

6. Fish Products and Value Addition 3(2+1)

Theory

Principle of fish preservation and processing. Processing of fish by traditional methods–salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting–wet salting and dry salting. Drying and dehydration- theory,importance of water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish. Fish preservation by smoking-chemical composition of wood smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and method store move them. Hurdle technology in fish preservation and processing. Marinaded and fermented fish products–role of acid sin marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Fermented fish products of Southeast Asia. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, my ofibriller protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and braided products-fishfinger, fish cutlet, fish wafer, and fish soup powder etc. And imitation products. HACC Pin safe products production.

Practicals

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinaded products. Preparation of surimi and surimi based products. Preparation of diversified and value added fish products. Quality assessment of market sample of dried and fermented fish products.

7. Fish By-Products and Waste Utilization 2(1+1)

Theory

Fish meal. Dry reduction and wet reduction methods – specification – packaging and storage. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application. Shrimp wastes – chitin – chitosan-production – uses. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat,functional fish protein concentrate and their incorporation to various products. Fish silage – acid silage – fermented silage – application. Fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark finrays, beach-de-mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

Practicals

Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure. Preparation of acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

8. Microbiology of Fish and Fishery Products 3(2+1)

Theory

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food.

Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi processed and processed fish and fishery products. Indicators of microbiological quality of fish and fishery products.

Food borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention. Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

Practicals

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae, Vibrio parahaemolyticus,*, *E coli*, *Salmonella*, *Listeriamonocytogenes* and faecal streptococci. Biochemical tests for characterization of bacteria. Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

9. Quality Assurance of Fish and Fishery Products 3(2+1)

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Pre-harvest and post harvest factors affecting quality. Assessment of quality changes in fresh and iced fish. Quality changes during processing. Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. Food laws and standards, national and international legislation, mandatory and non mandatory standards. Role of export inspection council & export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products, Legislation for export quality assurance in India. Certification system for fish & fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish & fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues. GOI notifications on fish and fishery products. General requirements for export of fish and fishery products to the EU. International regulatory framework for fish safety and quality. Prerequisites to HACCP, Labelling for product traceability and Labelling requirements- National and international, legislation on labelling, components of traceability code-nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people. EU legislation on traceability of fish and fish products, Assessment of food safety programmes, The HACCP for seafood industries and protection of food from adulterants. Standards for sea foods.FSSA, FDA, ISO.Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability. Waste management in seafood processing.

Practicals

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

VI. FISHERIES ENGINEERING

1. Aquaculture Engineering 3(2+1)

Theory

Fish Farm- Definition, objectives, types of farms; fresh water, brackish water and marine farms. Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics.

Land Surveying- definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey. Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling. Plane table surveying- instruments required, working operation, methods. Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour.

Calculation of area of regular and irregular plane surfaces, Trapezoidal and Simpson's rule, volume of regular and irregular shape as applied to stacks and heaps, calculation of volume of pond. Earth work calculations- excavation, embankment, longitudinal slope and cross slope, calculation of volume of earth work as applied to roads and channels.

Soil and its properties- classification of soil; soil sampling methods; three phase system of soil, definitions of soil properties andpermeability of soil. Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish ponds, layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds; Types of ponds; nursing ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond *etc.,* construction ponds viz., marking, excavation etc., Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes.

Water distribution system- canal, types of canals; feeder canal, diversion canal etc.,Pipe line system, Water control structures- types of inlet and out let and their construction. Water budget equation, Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc., Hatcheries- site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc, Raceway culture system- site selection, layout plan, types of raceway culture system viz.,parallel system, series system etc., Aerators- principles, classification of aerators and placement aerators. Pumps- purpose of pumping, types, selection of pump, total head, horse power calculation. Filters- types and constructions.

Practicals

Evaluation of potential site for aquaculture. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations and water requirement calculation. Visit to different types of farms.

2. Refrigeration and Equipment Engineering 3(2+1)

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work-A path function.

Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, Application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy.

Refrigeration: History of refrigeration, Definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system.

Refrigeration plant: Layout of refrigeration plant, Construction. Insulating materials used for the cold storage construction, Frozen product storage capacity of cold storage, usage of Ante-room.

Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared toother refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle.

Compressors: Definition, Types of compressor, construction, working principle advantages and disadvantages.

Evaporator: Definition, Types of Evaporator, construction, working principle advantages and disadvantages.

Condenser: Definition, Types of Condenser, Cooling Towers, construction, working principle, advantages and disadvantages.

Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages.

Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection.

Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting.

Ice-plant: Ice plant planning Brine tank construction, preparation of brine ,Types of ice, Storing of ice, Equipments used in ice plants.

Freezers: Definition, Design and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated sea water (RSW), Chilled sea water (CSW). Refrigerated transport.

Cooling load: Unit of refrigeration, coefficient of performance (C.O.P),Refrigeration effect, study and use of Psychometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipments.

Theory of machines: Transmission of power, friction wheels, shaft , gears, belt and Chain drive. Study of equipments used in fish processing with particular reference to canning, sausage, freeze drying and irradiation.

Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

Practicals

Drawing of Refrigeration and Fish processing machineries plant layout, Graphically represented symbols used in refrigeration, Handling and operation of compressors, condensers, evaporators expansion valves, low and high pressure switches. Study of auxiliary equipments: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Power transmission line diagram of different fish processing machineries. Visit to processing plant refrigeration plant, Visit to ice plant, Visit to fishing harbor to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

3. Fishing Craft Technology 2(1+1)

Theory

Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance oif fishing vessels. fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.

Practicals

Studies on traditional fishing crafts; Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing; Drawing of back bone assembly; U & V bottom hull of wooden boat; General view of boat; Drawing of sheer plan, body plan and half breadth plan; Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

4. Navigation and Seamanship 2(1+1)

Theory

Principles of navigation –terms and definitions, finding positions and method of position fixing magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay points

pelorus and azimuth mirror, method of observation. Sextant -parts and functions, finding adjustable and non adjustable errors and principles and use. Hand lead line –construction and markings and method of taking soundings. Types of speed logs –patent log, impeller log, Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions. The IALA-buoy age systems, cardinal and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system ,storm signals stations Indian coasts, Fog signals, types and methods .Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS

Principles of seamanship- Causes fire at sea, fire prevention on board the vessel and method of fire fighting at sea and recommended fire fighting appliances, Life saving appliances –life jackets, life buoys and method of operations and contents, SART and EPIRB. Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law. Preparing vessel to face heavy weather. Temporary repairs for leaks constructions of steering system and rigging emergency jury rudder .types of anchors and their applications. selection of suitable anchorage , procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust , transverse thrust mooring and securing the vessel to the jetty rigging fenders and gangways , and method of leaving vessels from the birth.

Practicals

Anchoring, coming along side the berth and leaving, practicing the different types of knots and wire splices, use of magnetic compass, GPS, Echo-sounder. CHART WORK-Finding positions by latitudes and longitudes by position lines by cross bearing, horizontal sextant, angles, vertical sextant angle and by running fix, finding position by speed, distance and time findings set and drift of current and findings course made good speed made good and steering course and finding position by counter acting the current observation of RADAR

5. Fishing Gear Technology 2(1+1)

Theory

Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG).

Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.

Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines. Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system : British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing;, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond; square hexagonal and their measurement.

Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velacity, weather resistance, melting point and visibility. Chemical and Biological properties.

Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation.

Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board

Practicals

Study of net making tools; Knots and hitches used in net making. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing: baiting, creasing and reducing mesh size step by step. Tailoring method : T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination. Joining of net pieces. Net mounting – hanging coefficient, hung depth and their calculation. Selvedging. Methods of net mounting: reeving, stapling and norselling. Mending and net shooter techniques.

6. Fishing Technology 2(1+1)

Theory

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements.

Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid water trawling.

Constructional details of single boat purse seine; two boat purse seine and method of operation. Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom, mid water and pelagic gillnetting.

Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole & line and trolling line. Operation of long line: set and drift long lining: bottom, mid water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch reducing devices.

Deck equipments – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

Practicals

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook & line.

Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

VII. FISHERIES EXTENSION, ECONOMICS AND STATISTICS

1. Statistical Methods 3(2+1)

Theory

Definition of statistics, Concepts of population, sample, Census and sample surveys, Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogives. Important measures of central tendency - arithmetic mean median and mode. Relative merits and demerits of these measures. Important measures of dispersion, Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis.

Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression, Length weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Practicals

Construction of questionnaires and schedules. Diagrams and frequency graphs. Calculation of arithmetic mean, median, mode, range, mean deviation, variance, standard deviation. Exercises on probability, Binomial and Poisson distributions, Area of normal curve ,confidence interval for population mean, Test of hypothesis based on normal, t, and chi-square. Computation of Simple correlation and regression. Fitting of length - weight relationship in fishes.

2. Fisheries Economics 3(2+1)

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost;factors of production, marginal cost and return, law of diminishing marginal return, returns toscale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost. Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving Forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

Practicals

Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products, calculation of price, income and cross elasticities. Production function – production with one or two variable inputs. Shifting demand and surplus curve and its importance in fish price. Economic analysis on cost, return and breakeven of any two production units like fish farm / shrimp farm / seed production unit /fish processing plant / export unit.

3. Fisheries Policy and Law 1(1+0)

Theory

Introduction to public administration, principles of organization and management of public enterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Present relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of department of fisheries, corporations and cooperatives. Different central and state level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community based resource management plans. Historical review of fisheries development and management in India and world. International agencies / organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact

on fisheries. Laws relating to conservation and management of fishery resources in marine and inland sectors. Recent changes in land reforms. Land reforms legislation as applicable to aquaculture. Judicial judgments relating to Aquaculture. Objectives, functions and authority of fishery regulatory agencies like Coastal Regulatory Zone (CRZ) and Aquaculture Authority of India. Brackish water aquaculture act, Marine fisheries policy, Laws relating to fish products and marketing. International Law of the Seas and international commissions on fisheries and their impact.

4. Fisheries Co-operatives and Marketing 2(1+1)

Theory

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account.

Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behavior and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification- export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector.

Practicals

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

5. Fisheries Business Management and Entrepreneurship Development 1(1+0)

Theory

Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; Generation, incubation and commercialization of ideas and innovations. Government schemes

and incentives for promotion of entrepreneurship. Preparation of enterprise budget for integrated fish farming. Fiscal and monitory policies and its impact on entrepreneurship. Infrastructural and other financial requirement for fishery entrepreneurship Government policy on Small and Medium Enterprises (SMEs) / SSIs. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of fisheries inputs industry. Characteristics of Indian fisheries processing and export industry.

Introduction to fish business management- Concept of management, management process (planning, organising, staffing, leading and controlling), Organizational behaviour, human resource planning, new dimensions in fish business environment and policies. Accounting procedures of fish business entity. Emerging trends in fish production, processing, marketing and exports. Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs. Globalisation and the emerging business /entrepreneurial environment. Social Responsibility of Business.

6. Information and Communication Technology 2(1+1)

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication

Practicals

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

7. Fisheries Extension Education 2(1+1)

Theory

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs

and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation

Practicals

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis; case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

8. Communication Skills and Personality Development 1(0+1)

Practicals

Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Compulsory Non-Credit Course (CNC)

1. Swimming 1(0+1)

Practicals

History, hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke); competitive swimming-relays and medleys, lap time practice, swimming and floating aids and their uses; diving-styles of diving, rules, regulations and precautions. Methods of life saving in water; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulations and practice.

2. Physical Education, First Aid & Yoga Practices 1(0+1)

Practicals

Introduction to physical education: definition, objectives, scope, history, development and importance; physical culture; Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination and balance; Warming up - General & Specific & its Physiological basis; Test and measurement in

physical education; Training and Coaching - Meaning & Concept; Methods of Training; aerobic and an aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports; Governance of sport in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipments, skill, technique, style and coaching of major games(Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipments and up keep. Handling and transport of injured traumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration. Treatment of injuries (wounds and bleeding)–methods of dressing and bandages; first-aid procedure for injured bones. Handling unconsciousness; Treatment of bums and scalds. Emergency procedure for poisoning with special references to snakebite. Injuries I accidents in fishing, fish processing factories, chemical laboratories and their treatments. Shock injuries to muscles and joints and treatments. Sports injuries and their treatments.

Minimum Standards for Establishing College of Fisheries

1. **Degree Nomenclature:** B.F.Sc (Bachelor of Fisheries Science)
2. **Eligibility Criteria:** 10+2/Intermediate with PCMB/PCB/Agriculture (P - Physics, C - Chemistry, M - Mathematics B - Biology) from a recognised Board/University
3. **Medium of Instruction:** English
4. **Minimum Intake :** 40 students per year
5. **Departments**
   1) Department of Aquaculture (AQ)
   2) Fisheries Resource Management (FRM)
   3) Department of Aquatic Animal Health Environment (AAHM)
   4) Department of Aquatic Environment Management (AEM)
   5) Department of Fish Processing Technology (FPT)
   6) Department of Fish Engineering (FE)
   7) Department of Fisheries Extension Economics & Statistics (FEES)

6. Faculty Requirements for Departments

Department	Faculty			Total
	Professor	Associate Professor	Assistant Professor	
Aquaculture	1	2	3	6
Fisheries Resource Management	1	2	3	6
Fish Processing, Technology	1	3	5	9
Aquatic Environment Management	1	1	3	5
Fish Engineering	1	1	2	4
Department of Aquatic Animal Health Management	1	1	2	4
Fisheries Extension, Economics, and Statistics	1	1	2	4
Total	**7**	**11**	**20**	**38**

7. Faculty Expertise

Department	Faculty Expertise
Aquaculture	- Inland Aquaculture -Freshwater Aquaculture -Brackish water Aquaculture -Mariculture -Ornamental fish culture -Cage Culture -Culture of Fish Food organisms -Aquaponics

Department	Faculty Expertise
	- Finfish & shellfish breeding and seed production -Brood stock and hatchery management -Aquaculture Engineering -Fish Farm Management
Fisheries Resource Management	- Anatomy & Biology of Fishes - Population Dynamics - Stock Assessment - Taxonomy of Fishes - Marine, Inland & Brackish water Fisheries - Fishery Regulations and Laws - Conservation & Biodiversity
Fish Processing, Technology	- Fishing gear & craft technology - Equipment Engineering & plant maintenance - Refrigeration Engineering - Marine Engines - Navigation & Seamanship - Fishing Technology - Freezing Technology - Thermal processing - Fish Processing, Product Development and waste utilization - Quality Control - Packaging Technology
Aquatic Environment Management	- Analytical Water & Soil Chemistry - Limnology - Meteorology - Physical , Chemical and Biological Oceanography - Geography - Aquatic Pollution - Aquatic Environment & Biodiversity -Planktonology
Fish Engineering	-Fish Engineering
Department of Aquatic Animal Health Management	-Fish Microbiology -Immunology -Parasitology -Pathology -Fish Disease diagnostics and management
Fisheries Extension, Economics, and Statistics	- Fisheries Administration - Project Formulation &Finance - Extension Programme Planning - Co-operative & Marketing management - Computer Science - Fisheries Statistics - Fisheries Economics - Rural Sociology & Extension education - Communication Skills - Business Organisation &Personnel Management

8. Administrative and Supporting Staff for Departments

Department	Assistant	Attendant/ Messenger	Clerk	Laboratory Assistant/ Attendant
Aquaculture	1	2	1	4
Fisheries Resource Management	1	2	1	2
Fish Processing, Technology	1	1	1	4
Aquatic Environment Management	1	1	1	2
Fish Engineering	1	1	1	2
Department of Aquatic Animal Health Management	1	1	1	2
Fisheries Extension, Economics, and Statistics	1	1	1	2
Total	**7**	**9**	**7**	**18**

9. Manpower Requirements of Dean's Office

Manpower	Number
Dean	1
A. Establishment	
PA to Dean	1
Administrative Officer	1
Superintendent	3
Steno	1
Assistant	3
Operator (Audio Visual)	1
Attendants/Messengers	4
Clerk (LDC)	4
Electrician	1
Plumber	1
Store Keeper	1
Security, Sanitation, transport and Landscaping	To be outsourced as per the requirement
B. Central Instrumentation Facilities	
Computer Assistant	1
Laboratory Technicians	2
Laboratory Assistant	1
Laboratory Attendant	3
C. Library Staff	

Manpower	Number
Assistant Librarian	1
Library Assistant	1
Clerk	1
Library attendant	2
D. Instructional Fish Farm & Hatchery	
Farm Manager	1
Field Assistant	1
Laboratory Assistant	1
Field Attendant	2
Field Staff / Fishermen	20
Security	(to be outsourced)
E. Students Welfare	
Assistant Director (Students' Welfare)	1
Medical Officer	1
Assistant Professor (Physical Education for Boys and Girls)	1+1
F. Hostel (Boys and Girls)	
Wardens	1+1
Assistant Wardens	1+1
Clerk (LDC)	2
Attendants	4
Security, Sanitation, Boarding and Landscaping	To be outsourced

10. Land Requirements

Main building and hostels:	4 ha
Instructional Farm Area:	20 ha
Play grounds & other amenities:	2ha
Total:	**26 ha**

Geographical location:

For Maritime States the most ideal location is near the coast line having access to open sea, estuaries, fishing harbours and fish processing plants with a good water source.

For Inland States, the location needs to be close to water bodies / Farm facilities.

For Hilly Regions, the land requirement may be less as per availability

11. Floor Space Requirement

A. Central Facilities

S. No.	Details	Number of Rooms	Dimensions (ft)
1.	Dean office	1	20 x 24
2.	PA room	1	20 x 12
3.	Committee room with video conferencing facility	1	20 x 48
4.	Administrative officer room	1	20 x 12
5.	Admin. Staff rooms	3	20x 36 each
6.	Examination cell	1	20 x 12
7.	Evaluation room	1	20 x 36
8.	Faculty room	1	20 x 12 each
9.	Placement cell	1	20 x 48
10.	Smart Lecture rooms	8	Seating capacity –50
11.	Auditorium (optional)	1	Seating capacity – 300
12.	Library/Book bank	1	30 x 72
13.	Examination hall (optional)	1	Seating capacity – 300
14.	Multipurpose room	1	20 x 36
15.	Laboratories	25	30 x 48 each / as per requirement
16.	Hostels	2 hostels	UG and PG Boys, UG and PG Girls
17.	Generator shed	1	20 x 36
19.	Toxic chemical waste storage/disposal Unit	1	20 x 24
20.	Canteen	1	20 x 12 (kitchen) & 20 x 36 (seating)
21.	Toilets	-	2 sets for each floor
22.	Parking space	As per requirement	For college and hostels
23.	Vehicles: Office car Staff car/Jeep Bus Pick-up van		 1 3 1 1

B. Departments

S. No.	Detail	Number of rooms	Dimensions (ft)
1.	Head of the Department	8 (one for every Department)	20 x 24 each
2.	Administrative Staff	8 (one for every Department)	20 x 36 each
3.	Faculty room	21 (as per faculty strength)	20 x 24 (3 rooms) 20 x 12 (18 rooms)
4.	Rooms for Research Scholars	8(one for every Department)	20 x 24 each
5.	Committee room cum library	8 (one for every Department)	20 x 36 each
6.	Smart Lecture cum seminar room	8 (one for every Department)	Seating capacity – 50 each

12. Equipments Requirement

A. Central Instrumentation Facility

S. No.	Name of the Equipment	Number
1	Cold room -20^{0}C	1
2	-80^0 C freezer	1
3	Chill room 4^{0}C	1
4	High Speed Centrifuge	1
5	HPLC,	1
6	GCMS	1
7	Gel doc system	1
8	Real time PCR	1
9	Research Vessel	1
10	Ultra Centrifuge	1
11	Programmable Freezer (Cryopreservation)	
12	Water Purification Unit	As per requirement
13	Ice flaker	1
14	Freeze Dryer	1
15	Atomic Absorption Spectrophotometer (AAS)	1
16	Automatic Tissue Processor	1
17	Microtome	1
18	Inverted Microscope	1
19	Generator	1

B. Instructional Farm Facilities

1	Nursery ponds	20
2	Rearing Ponds	8
3	Stocking ponds	4
4	Brood stock ponds	4
5	Chinese Circular hatchery	1
6	Wetlab facilities	As per requirement
7	Re-circulatory Systems	1

C. Departmental Laboratories

S. No.	Name of the Equipment	Total number
1	-20°C Freezer	7
2	-80°C Freezer	3
3	Autoclaves	7
4	Biosafety Cabinet	3
5	Centrifuge	7
6	Refrigerated Centrifuge	7
7	Cryo-cans	6
8	Analytical balance	7
9	Stirrer	7
10	Spectrophotometer	7
11	Research Microscope	70
12	Micropipette set	7
13	Thermocycler	7
14	Waterbath (Digital)	7
15	Salino meter (Refracto meter)	6
16	Dissolved oxygen analyzer	2
17	Hot air oven	7
18	Kjeltec for protein estimation	1
19	Soxhlet for fat estimation	1
20	Muffle furnace	2
21	Microtome	1
22	Fish deboning machine	1
23	Fish drying & smoking kiln	1
24	Vacuum packing machine	1
25	Modified atmosphere packaging	1

S. No.	Name of the Equipment	Total number
26	pH meter	7
27	Computers	7
28	Incubator	7
29	Digital colony counter	3
30	Binocular Microscope	140
31	Bomb Calorimeter	1
32	Automatic Water Analyzer	2

FOOD TECHNOLOGY

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

Degree nomenclature

At present, there is wide variation in the degree nomenclature being followed at different universities/ institutes. Moreover, the subject in which the degree is awarded also varies very widely. Looking to the market demand for the graduates/ post-graduates, the institutions are awarding degrees of B. Tech and M. Tech in majority of the cases. The duration of four years for B. Tech. and two years for M. Tech. is getting better recognition and acceptance by the Food industry.

The suggestions and recommendations received from different universities and keeping in view the wide opportunities available worldwide, the names of the degrees proposed are;

i). UG Degree: B.Tech. (Food Technology)

ii). PG Degrees: M.Tech. and Ph. D. (Food Technology)

P.G. with specializations in following disciplines:

S. No.	Specializations in M.Tech. /Ph. D
1	Food Process Technology
2	Food Process Engineering
3	Food Safety & Quality Assurance

Restructuring of UG programmes for increased practical / practice contents

A. Department-wise distribution of Credit Load

S. No	Name of Department/ Sub-discipline	Credit Hours
1	Food Processing Technology	38 (24+14)
2	Food Safety and Quality Assurance	30 (19+11)
3	Food Process Engineering	30 (20+10)
4	Food Business Management	14 (09+05)
5	Basic Engineering	15 (07+08)
6	Basic Sciences and Humanities	13 (09+04)
7	Food Plant Operations (Student READY Courses)	40 (00+40)
	Total	**180 (88+92)**
	Non-Credit Courses	00+02)
	A. Department-wise List of Courses	
	Food Process Technology	
1	Fundamentals of Food Processing	3 (2+1)
2	Processing Technology of Cereals	3 (2+1)
3	Processing Technology of Legumes and Oilseeds	3 (2+1)
4	Processing Technology of Fruits and Vegetables	3 (2+1)
5	Processing Technology of Liquid Milk	2 (1+1)
6	Processing Technology of Dairy Products	3 (2+1)
7	Processing Technology of Beverages	3 (2+1)
8	Processing of Spices and Plantation Crops	3 (2+1)
9	Processing of Meat and Poultry Products	3 (2+1)
10	Processing of Fish and Marine Products	3 (2+1)
11	Bakery, Confectionery and Snack Products	3 (2+1)
12	Food Packaging Technology and Equipment	3 (2+1)
13	Sensory Evaluation of Food Products	3 (1+2)
	Total	**38 (24+14)**
	Food Safety and Quality Assurance	
1	General Microbiology	3 (2+1)
2	Food Microbiology	3 (2+1)
3	Industrial Microbiology	3 (2+1)
4	Food Chemistry of Macronutrients	3 (2+1)
5	Food Chemistry of Micronutrients	3 (2+1)
6	Food Biochemistry and Nutrition	3 (2+1)
7	Food Biotechnology	3(2+1)
8	Food Additives and Preservatives	2(1+1)
9	Instrumental Techniques in Food Analysis	3 (1+2)
10	Food Plant Sanitation	2 (1+1)

S. No	Name of Department/ Sub-discipline	Credit Hours
11	Food Quality, Safety Standards and Certification	2 (2+0)
	Total	**30 (19+11)**
	Food Process Engineering	
1	Food Thermodynamics	3 (2+1)
2	Fluid Mechanics	3 (2+1)
3	Post Harvest Engineering	3 (2+1)
4	Heat and Mass Transfer in Food Processing	3 (2+1)
5	Unit Operations of Food Processing-I	3 (2+1)
6	Unit Operations of Food Processing-II	3 (2+1)
7	Food Refrigeration and Cold Chain	3 (2+1)
8	Food Storage Engineering	3 (2+1)
9	Food Process Equipment Design	3 (2+1)
10	Instrumentation and Process Control in Food Industry	3 (2+1)
	Total	**30 (20+10)**

	Food Business Management	
1	Business Management and Economics	2 (2+0)
2	ICT Applications in Food Industry	3 (1+2)
3	Marketing Management and International Trade	2 (2+0)
4	Project Preparation and Management	2 (1+1)
5	Communication and Soft Skills Development	2 (1+1)
6	Entrepreneurship Development	3 (2+1)
	Total	**14 (9+5)**

Food Plant Operations	
Student READY - Experiential Learning Programme - I	7 (0+7)
Student READY - Experiential Learning Programme - II	7 (0+7)
Student READY - Industrial Tour	2 (0+2)
Student READY - Research Project	3 (0+3)
Student READY - Seminar	1 (0+1)
Student READY – Internship/In-Plant Training	20 (0+20)
Total	**40 (0+40)**

	Basic Engineering	
1	Engineering Drawing and Graphics	3 (1+2)
2	Basic Electrical Engineering	3 (2+1)
3	Workshop Technology	3 (1+2)
4	Computer Programming and Data Structures	3 (1+2)

5	Basic Electronics Engineering	3 (2+1)
	Total	**15 (7+8)**

	Basic Sciences and Humanities	
1	English Language	2 (1+1)
2	Engineering Mathematics-I	2 (2+0)
3	Crop Production Technology	3 (2+1)
4	Engineering Mathematics-II	2 (2+0)
5	Environmental Science and Disaster Management	2 (1+1)
6	Statistical Methods and Numerical Analysis	2 (1+1)
	Total	**13 (9+4)**

B. Semester-wise Distribution of Courses

	Semester-I	
1	English Language	2 (1+1)
2	General Microbiology	3 (2+1)
3	Engineering Mathematics-I	2 (2+0)
4	Engineering Drawing and Graphics	3 (1+2)
5	Electrical Engineering	3 (2+1)
6	Workshop Technology	3 (1+2)
7	Crop Production Technology	3 (2+1)
8	Environmental Sciences & Disaster Management	2 (1+1)
	Physical Education	1 (0+1)*
	Total	**21 (12+9)**

* Non-Credit Course

	Semester-II	
1	Food Chemistry of Macronutrients	3 (2+1)
2	Food Microbiology	3 (2+1)
3	Food Thermodynamics	3 (2+1)
4	Computer Programming and Data Structures	3 (1+2)
5	Fluid Mechanics	3 (2+1)
6	Basic Electronics Engineering	3 (2+1)
7	Engineering Mathematics-II	2 (2+0)
8	Post Harvest Engineering	3 (2+1)
	NCC/NSS	1 (0+1)*
	Total	**23 (15+8)**
* Non-Credit Course		

Semester-III		
1	Fundamentals of Food Processing	3 (2+1)
2	Processing Technology of Liquid Milk	2 (1+1)
3	Processing Technology of Cereals	3 (2+1)
4	Industrial Microbiology	3 (2+1)
5	Food Chemistry of Micronutrients	3 (2+1)
6	Heat and Mass Transfer in Food Processing	3 (2+1)
7	Unit Operations in Food Processing-I	3 (2+1)
8	Statistical Methods and Numerical Analysis	2 (1+1)
Total		**22 (14+8)**
Semester-IV		
1	Processing Technology of Dairy Products	3 (2+1)
2	Processing Technology of Legumes and Oilseeds	3 (2+1)
3	Food Biochemistry and Nutrition	3 (2+1)
4	Unit Operations in Food Processing-II	3 (2+1)
5	Food Biotechnology	3 (2+1)
6	Food Refrigeration and Cold Chain	3 (2+1)
7	Processing of Spices and Plantation Crops	3 (2+1)
8	Business Management and Economics	2 (2+0)
	Total	**23 (16+7)**
Semester-V		
1	Processing Technology of Fruits and Vegetables	3 (2+1)
2	Processing of Meat and Poultry Products	3 (2+1)
3	Instrumental Techniques in Food Analysis	3 (1+2)
4	ICT Applications in Food Industry	3 (1+2)
5	Food Process Equipment Design	3 (2+1)
6	Food Storage Engineering	3 (2+1)
7	Bakery, Confectionery and Snack Products	3 (2+1)
8	Marketing Management and International Trade	2 (2+0)
Total		**23 (14+9)**
Semester-VI		
1	Processing Technology of Beverages	3 (2+1)
2	Food Plant Sanitation	2 (1+1)
3	Food Packaging Technology and Equipment	3 (2+1)
4	Processing of Fish and Marine Products	3 (2+1)
5	Sensory Evaluation of Food Products	3 (1+2)
6	Food Additives and Preservatives	2 (1+1)

7	Food Quality, Safety Standards and Certification	2 (2+0)
8	Instrumentation and Process Control in Food Industry	3 (2+1)
9	Project Preparation and Management	2 (1+1)
	Total	**23 (14+9)**
	Semester-VII	
1	Communication Skills and Personality Development	2 (1+1)
2	Entrepreneurship Development	3 (2+1)
3	Student READY - Experiential Learning Programme - I	7 (0+7)
4	Student READY - Experiential Learning Programme - II	7 (0+7)
5	Student READY - Research Project	3 (0+3)
6	Student READY - Seminar	1 (0+1)
	Total	**23 (3+20)**
	Semester-VIII	
1	Student READY - Industrial Tour	2 (0+2)
2	Student READY - Internship/In-Plant Training	20 (0+20)
	Total	**22 (0+22)**

Grand Total of Credit Hours **180 (88+92)**

SYLLABUS

I. Department of Food Process Technology

1. Fundamentals of Food Processing 3(2+1)

Theory

Sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality. Preservation by heat treatment: Principle and equipment for blanching, canning, pasteurization, sterilization; Preservation by use of low temperature: Principle, methods, equipment; Preservation by drying, dehydration and concentration: Principle, methods, equipment; Preservation by irradiation: Principle, methods, equipment; Preservation by chemicals- antioxidants, mould inhibitors, antibodies, acidulants, etc.; Preservation by fermentation: Principles, methods, equipment; Non-thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, etc.; Quality tests and shelf-life of preserved foods.

Practical

Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment- pasteurization; Preservation of food by high

concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives; Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze-drying process; Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut; Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.

Suggested Reading

- Stavros Yanniotis. 2008. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.
- Gaurav Tewari and Vijay K. Juneja. 2007. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.
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- Marcus Karel and Darvl B. Lund. 2003. Physical Principles of Food Preservation, 2nd Ed. Marcel Dekker, Inc., NY, USA.
- Peter Zeuthen and Leif Bùgh-Sùrensen. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.
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- Norman N. Potter and Joseph H. Hotchkiss. 1995. Food Science, 5th Ed. Chapman & Hall, NY, USA.
- Norman W. Desrosier and James N. Desrosier. 1977. The Technology of Food Preservation, 4th Ed. AVI Publishing Co., Connecticut, USA.
- Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.

2. Processing Technology of Liquid Milk 2(1+1)

Theory

Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavoured milk, fermented milk, acidophilous milk, etc.; Cream: definition, classification, manufacture of different types of cream, processing of cream; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio-chemical changes occurring during manufacture of fermented milks; Factors affecting these changes and effects of these changes on the quality of finished products; Adulterations in milk and its detection; Quality defects in milk-causes and prevention, liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk

chilling units, milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.; Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.

Practical

Platform tests of raw milk (clot on boiling (COB) test, alcohol test); Determination of physical properties of milk; Determination of proximate composition and biochemical properties of milk; Determination of microbiological properties of milk; Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings; Preparing standardized milk as per requirement; Separation of fat from milk; Pasteurization and homogenization of milk; Packaging of liquid milk; Preparation of curd and yogurt**,** Visit to chilling centre and dairy plant.

Suggested Reading

- A. Kanekanian. 2014. Milk and Dairy Products as Functional Foods. John Wiley & Sons, Ltd., UK.
- Adnan Y. Tamime. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
- Pieter Walstra, Jan T.M. Wouters, Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.
- Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
- H.G. Kessler. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R. Germany).
- Y.H. Hui. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.

3. Processing Technology of Cereals 3(2+1)

Theory

Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets; Chemical composition and nutritive value; Paddy processing and rice milling: Conventional milling, modern milling, milling operations, milling machines, milling efficiency; Quality characteristics influencing final milled product; Parboiling; Rice bran stabilization and its methods; Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; quality characteristics of flour and their suitability for baking; Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches; Barley: Malting and milling; Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, finger millets): Processing of millets for food uses; Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.

Practical

Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and milling

of wheat; Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylograph; Processing of value added products from millets; Visit to Cereal processing unit.

Suggested Reading

- Amalendu Chakraverty and R. Paul Singh. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
- Khalil Khan and Peter R. Shewry. 2009. Wheat: Chemistry and Technology, 4th Ed., AACC International, Inc., St. Paul, MN, USA.
- Colin Wrigley. 2004. Encyclopedia of Grain Science. Academic Press, London, UK.
- Elaine T. Champagne. 2004. Rice: Chemistry and Technology, 3rd Ed., AACC International, Inc., St. Paul, MN, USA.
- Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
- Pamela J. White and Lawrence A. Johnson. 2003. Corn: Chemistry and Technology, 2nd Ed., AACC International, Inc., St. Paul, MN, USA.
- David A.V. Dendy and Bogdan J. Dobraszczyk. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
- N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
- Samuel A. Matz. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd Ed. Springer Science + Business Media, NY, USA.
- E.V. Araullo, D.B. De Padna and Graham. 1976. Rice Post Harvest Technology. IDRC, Canada.

4. Processing Technology of Dairy Products 3(2+1)

Theory

Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter-defects, causes and their prevention, packaging and storage; Butter oil and ghee: Definition, composition, processing, equipment, quality tests; Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage; Ice cream and frozen desserts: Definition, composition, types, processing steps and flow diagram, equipment, quality testing, defects causes and prevention, packaging and storage. Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk, manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage; Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.

Practical

Preparation of butter/ table butter, Preparation of ghee, Preparation of paneer; Preparation of selected type of cheese; Preparation of ice-cream and selected frozen desserts; Preparation of condensed milk; Preparation of milk powder; Preparation of selected Indian dairy products; Determination of selected quality parameters of selected dairy products; Visit to dairy plant.

Suggested Reading

- A. Kanekanian. 2014. Milk and Dairy Products as Functional Foods. John Wiley & Sons, Ltd., UK.
- Adnan Y. Tamime. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
- Pieter Walstra, Jan T.M. Wouters, Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.
- Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
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- Y.H. Hui. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
- Aneja, R. P.; Mathur, B. N.; Chandan, R. C.; Banerjee, A. K., 2002, Technology of Indian Milk Products: Handbook of Procees Technology Modernization for Professionals Entrepreneurs and Scientists, Dairy India Yearbook

5. Processing Technology of Legumes and Oilseeds 3(2+1)

Theory

Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti-nutritional compounds; Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes; Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; Desolventization; Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, their principles and process controls; Hydrogenation of oils; New technologies in oilseed processing; Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.

Practical

Determination of physical properties of legumes and oil seeds; Determination of proximate composition of selected pulses and oilseeds; Determination of nutritional quality of selected pulses and oilseeds; Study of mini dhal mill; Study of mini oil mill; Preconditioning of pulses before

milling; Preconditioning of oilseeds before milling; Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation; Laboratory milling of selected oilseeds and its quality evaluation; Laboratory refining of selected oils; Laboratory hydrogenation of selected oils; Study of cooking quality of dhal; Processing of composite legume mix and preparation of value added products; Visit to commercial dhal mills and oil mills.

Suggested Reading

- Guriqbal Singh, Harbhajan Singh Sekhon, Jaspinder Singh Kolar and Masood Ali. 2005. Pulses. Agrotech Publishing Academy, Udaipur.
- A. Chakraverty. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Frank D. Gunstone. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.
- Fereidoon Shahidi. 2005. Bailey's Industrial Oil & Fat Products, 6th Ed., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA.
- Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
- K.M. Sahay and K.K. Singh. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida.

6. Processing Technology of Fruits and Vegetables 3(2+1)

Theory

Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables; Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching operations and equipment; Canning: Definition, processing steps, and equipment, cans and containers, quality assurance and defects in canned products; FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.; Processing and equipment for above products; FSSAI specifications; Preparation, preservation and machines for manufacture of crystallized fruits and preserves, jam, jelly and marmalades, candies, Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, lather, dehydrated, wafers and papads, soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products.

Practical

Primary processing of selected fruits and vegetables; Canning of Mango/Guava/ Papaya; Preparation of jam from selected fruits; Preparation of jelly from selected fruits; Preparation of fruit marmalade; Preparation of RTS; Preparation of squash; Preparation of syrup; Preparation of

raisins, dried fig and dried banana; Preparation of anardana; Preparation of papain; Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers; Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.

Suggested Reading

- U.D. Chavan and J.V. Patil. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
- S. Rajarathnam and R.S. Ramteke. 2011. Advances in Preservation and Processing Technologies of Fruits and Vegetables. New India Publishing Agency, New Delhi.
- Y.H. Hui. 2006. Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford, UK.
- W.V. Cruess. 2004. Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur.
- Y. H. Hui, Sue Chazala, Dee M. Graham, K.D. Murrell and Wai-Kit Nip. 2004. Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.
- A.K. Thompson. 2003. Fruit and Vegetables: Harvest, Handling and Storage, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.
- Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
- R.P. Srivastava and Sanjeev Kumar. 2002. Fruit & Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi.
- P.H. Pandey. 1997. Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.
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- Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
- EIRI Board of Consultants and Engineers. Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.

7. Processing of Meat and Poultry Products 3(2+1)

Theory

Sources and importance of meat and poultry; Status of Meat and poultry industry in India; Pre-slaughter operations and slaughtering operations for animals and poultry; Evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat; Preservation of meat by chilling, freezing, pickling, curing, cooking and smoking, dehydration, radiation, chemical and biological preservatives; Meat tenderization; Meat emulsions; Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation; Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages

and their quality evaluation; Abattoir design and layout; Eggs: Structure, composition, quality characteristics, processing, preservation of eggs; Processing and preservation of poultry meat and chicken patties; Meat plant sanitation and safety; By-products of meat, poultry and eggs and their utilization; Safety standards in meat industry: HACCP/ISO/MFPO/FSSAI/Kosher/Halal.

Practical

Pre-slaughter operations of meat animals and poultry birds; Slaughtering and dressing of meat animals; Study of post-mortem changes; Meat cutting and handling; Preservation of meat by freezing; Preservation of meat by curing and pickling; Preservation of meat by dehydration; Evaluation of quality and grading of eggs; Preservation of shell eggs; Preparation of value added poultry meat products; Value added egg products; Visit to abattoir.

Suggested Reading

- Vikas Nanda. 2014. Meat, Egg and Poultry Science & Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.
- B.D. Sharma and Kinshuki Sharma. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
- Fidel Toldrá, Y. H. Hui, Iciar Astiasarán, Wai-Kit Nip, Joseph G. Sebranek, Expedito-Tadeu F. Silveira, Louise H. Stahnke, Régine Talon. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.
- Joseph Kerry, John Kerry and David Ledward. 2005. Meat Processing-Improving Quality. Woodhead Publishing Ltd., Cambridge, England.
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- R.A. Lawrie. 1985. Meat Science, 4th Ed. Pergamon Press, Oxford, UK.

8. Processing Technology of Beverages 3(2+1)

Theory

History and importance of beverages and status of beverage industry; Processing of beverages: Packaged drinking water, juice based beverages, synthetic beverages, still, carbonated, low-calorie and dry beverages, isotonic and sports drinks, dairy based beverages, alcoholic beverages, fruit beverages, speciality beverages, tea, coffee, cocoa, spices, plant extracts, etc.; FSSAI specifications

for beverages; Ingredients, manufacturing and packaging processes and equipment for different beverages; Water treatment and quality of process water; Sweeteners, colorants, acidulants, clouding and clarifying and flavouring agents for beverages; Carbon dioxide and carbonation; Quality tests and control in beverages; Miscellaneous beverages: Coconut water, sweet toddy, sugar cane juice, coconut milk, flavoured syrups.

Practical

Quality analysis of raw water; Determination of density and viscosity of caramel; Determination of colours in soft drinks by wool technique; Preparation of iced and flavoured tea; Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages; Determination of brix value, gas content, pH and acidity of beverages; Quality analysis of tea and coffee; Preparation of miscellaneous beverages; Visit to carbonation unit; Visit to mineral water plant.

Suggested Reading

- Hans Michael Eblinger. 2009. Handbook of Brewing: Processes, Technology, Markets. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim. Germany.
- Y.H. Hui. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
- Philip R. Ashurst. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.
- Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
- V.K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation – Microbiology, Biochemistry and Technology, Vol. II. Educational Publishers & Distributors, New Delhi.
- Alan H. Varnam and Jane P. Sutherland. 1994. Beverages: Technology, Chemistry and Microbiology. Chapman, London, UK.

9. Bakery, Confectionery and Snack Products 3(2+1)

Theory

Bakery products: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Product quality characteristics, defects, causes and corrective measures; Snack foods: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings; Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing.

Practical

Identifications and composition of various ingredients for snacks, bakery and confectionery products; Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items; preparation, packaging and quality evaluation of selected bakery items; preparation, packaging and quality evaluation of selected confectionery items; preparation, packaging and quality evaluation of selected chocolates; Preparation of traditional Indian confection. Visit to bakery, confectionary and snack units (industry).

Suggested Reading

- NIIR Board of Consultants & Engineers. 2014. The Complete Technology Book on Bakery Products (Baking Science with Formulation & Production), 3rd Ed. NIIR, New Delhi.
- Peter P. Grewling. 2013. Chocolates & Confections, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
- E.J. Pyler and L.A. Gorton. 2009. Baking Science & Technology, Vol. II: Formulation & Production, 4th Ed. Sosland Publishing Company, Kansas City, MO, USA.
- E.J. Pyler and L.A. Gorton. 2008. Baking Science & Technology, Vol. I: Fundamentals & Ingredients, 4th Ed. Sosland Publishing Company, Kansas City, MO, USA.
- Y.H. Hui. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
- John J. Kingslee. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.
- Harold Corke, Ingrid De Leyn, Nanna A. Cross, Wai-Kit Nip, Y.H. Hui. 2006. Bakery Products: Science and Technology. Blackwell Publishing Ltd., Oxford, UK.
- Joseph Amendola and Nicole Rees. 2003. Understanding Baking: The Art and Science of Baking, 3rd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
- Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd Ed. Woodhead Publishing Limited, Cambridge, England.
- N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
- E.B. Jackson. 1995. Sugar Confectionery Manufacture, 2nd Ed. Springer-Verlag, US.
- Samuel A. Matz. 1976. Snack Food Technology, 2nd Ed. AVI Publishing Co., Inc., Westport, Connecticut, USA.
- US Wheat Associates. Baker's Handbook on Practical Baking.

10. Food Packaging Technology and Equipment 3(2+1)

Theory

Backaging situations in World, India; Need of packaging; Package requirements, package functions; Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.; Glass as package material, manufacture, advantages, disadvantages; Metal (Aluminium/ tin/ SS) as package material-manufacture, advantages, disadvantages, plastic as package material, classification of

polymers, properties of each plastics, uses of each plastics; Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging; Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods; Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package.

Practical

Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paperboards; Measurement of water absorption of paper, paper boards; Measurement of bursting strength of paper, paper boards; Measurement of tear resistance of papers; Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers; Determination of gas and water transmission rate of package films; Determination of laquer integrity test; Drop test, Box compression test; Identification of plastic films; Determination of seal integrity, ink adhesion; packaging practices followed for packing fruits and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machine, bottle filling machine and form-fill-seal machine.

Suggested Reading

- Gordon L. Robertson. 2014. Food Packaging: Principles and Practice, 3rd Ed. CRC Press, Boca Raton, FL, USA.
- Gordon L. Robertson. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.
- Jung H. Han. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.
- Jung H. Han. 2005. Innovations in Food Packaging. Elsevier Science & Technology Books, UK.
- Richard Coles, Berek McDowell and Mark J. Kirwan. 2003. Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK

11. Processing of Fish and Marine Products 3(2+1)

Theory

Fisheries resources, global and Indian scenario; Types of fish and other marine products; Classification of fish (fresh water and marine), composition of fish, characteristics of fresh fish, spoilage of fish- microbiological, physiological, biochemical; Relationship between chilling and storage life, MAP, general aspects of fish freezing, changes in quality during chilled and frozen storage; Principles of canning, effect of heat processing on fish, storage of canned fish, pre-process operations, post-process operations, cannery operations for specific canned products; Fish products: Introduction, fish muscle proteins, surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH);

Preparation protocols of indigenous products: Fish sauce and paste. Novel methods; Low dose irradiation; High pressure treatment, MAP, vacuum packaging, gas packaging; Oxygen absorbents and CO_2 generators, ethanol vapour generation, hurdle barrier concept, value added fish products, packaging; Sea food quality assurance, HACCP, EU hygienic regulations and ISO 9000 standards; New kinds of quality and safety problems emerging in sea food processing and preservation.

Practical

Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products - Selection and grading; Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Utilization of fish by-products; Preparation of marine algal products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process; Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA; Determination of iodine value; Protein estimation by Folin-Lowrey's method; Visit to fish and prawn processing industry.

Suggested Reading

- D.P. Sen. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.
- Brigitte Maas-van Berkel, Brigiet van den Boogaard and Corlien Heijnen. 2004. Preservation of Fish and Meat. Agromisa Foundation, Wageningen.
- FAO. 2003. Code of Practices of Canned Fishery products. FAO, UN, Rome.
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- G.M. Hall. 1997. Fish Processing Technology, 2nd Ed. Chapman & Hall, London, UK.
- C.O. Chichester and H.D. Graham. 1973. Microbial safety of Fishery products. Academic Press, New York.
- American Public Health Association. 1970. Recommended Procedures for the Bacteriological examination of Seawater and shell fish. APHA, USA.
- George Borstorm. 1961. Fish as Food - Vol. I, II, III and IV. Academic Press, New York.
- K. Gopakumar. View Larger ImageTextbook of Fish Processing Technology. ICAR, New Delhi.
- Charles L. Cutting. Processing and Preservation of Fish. Agro Bios, New Delhi.

12. Processing of Spice and Plantation Crops 3(2+1)

Theory

Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: Post harvest technology, composition; processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom. Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon; Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram. Rosemary, saffron, sage; Savory, thyme, ajowan; Asafetida, curry leaves; Post harvest technology for Tea, coffee, cocoa; Vanilla and annatto processing; Post harvest technology and processing of

areca nut, cashew nut, oil palm; Flavours of minor spices; Flavour of major spices; Spice oil and oleoresins: Extraction techniques; Standard specification of spices; Functional packaging of spices and spice products; By-products of plantation crops and spices.

Practical

Identification and characterization of flavouring compounds of spices; Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli; Extraction of oleoresins: Turmeric, ginger, pepper, clove; Peperine estimation in pepper oleoresin; Steam distillation of spices; Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, valuable oil, specific gravity, refractive index, acid value; Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to spice industry.

Suggested Reading

- K.G. Shanmugavelu. Spices and Plantation Crops. Oxford & IBH Publishing Co., New Delhi
- J.W. Purseglave, E.G. Brown, C.L. Green and Robins. Spices,Vol. I and II. SRJ Academic Press, New Delhi.
- J.S. Pruthi. 2001. Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.
- J.S. Pruthi. 2001. Spices and Condiments – Minor Spices of India. National Book Trust, New Delhi.
- Kenji Hirasa and Mitsuo Takemasa. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
- H. Panda. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
- S. Gupta. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.

13 Sensory Evaluation of Food Products 3(2+1)

Theory

Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects; factors affecting food acceptance. Terminology related to sensory evaluation. Principles of good practice: the sensory testing environment, test protocol considerations, Basic principles: Senses and sensory perception, Physiology of sensory organs, Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Discrimination Tests, Procedure: Types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, Hedonic scale and descriptive tests. Panel selection, screening and training of judges; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Consumer Research – Affective Tests: Objectives. Methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and Consumers studies, limitations. Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests; Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control.

Practical

Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo-trio, triangle); Determination of threshold value for various odours; Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Descriptive analysis methodology; Sensory evaluation of various food products using different scales, score cards and tests; Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.

Suggested Reading

- Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
- Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
- Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.
- Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applicatons in Foods. Marcel Dekker.
- Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press.
- Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
- Piggot, J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science Publ.
- Potter, N.N. and Hotchleiss, J.H. 1997. Food Science. 5th Ed. CBS Publishers, Delhi.
- Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
- Stone, H. and Sidel, J,L. 1985. Sensory Evaluation Practices. Academic Press.
- Harry, T. Lawless, Hildegarde Heymann. 2010. Sensory Evaluation of Food: Principles and Practices. 2nd Ed., Springer, New York or Dordrecht Heidelberg, London.

II. Department of Food Safety and Quality

1. General Microbiology 3(2+1)

Theory

Evolution and scope of microbiology; History of microbiology; Microbial classification, nomenclature and identification; Taxonomic groups; General methods of classifying bacteria; Microscopy and microscopes: Smears and staining; Morphology and fine structure of bacteria; Cultivation of bacteria, nutritional requirements; Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria, Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus : Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis; Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants;

Destruction of microorganisms: Physical agents and chemical agents; Chemotherapeutic agents and chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

Suggested Reading

- Gerard J. Tortora, Berdell R. Funke, Christine L. Case. 2014. Microbiology: An Introduction, 12th Ed. Prentice-Hall, NY, USA.
- Johanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2013. Prescott's Microbiology, 9th Ed. McGraw-Hill Higher Education, NY, USA.
- Michael J. Pelczar Jr., E.C.S. Chan and Noel R. Krieg. 1998. Microbiology, 5th Ed. Tata McGraw-Hill Education, New Delhi.

2. Food Chemistry of Macronutrients 3(2+1)

Theory

Nature Scope and development of food chemistry; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems; Carbohydrates: Changes of carbohydrates on cooking, modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates; Proteins in foods: Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein; Lipids in foods: Role and use of lipids/fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, safety use of oils and fats in food formulation; Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques chemical aspects of lipids, antioxidants;.

Practical

Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Rheological properties of food systems; Determination of crude proteins by micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and concentrate of proteins; Determination of acid value, saponification value and iodine number of fat/oil; Assay of amylases, papain and lipases.

Suggested Reading

- John W. Brady. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.
- H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemisry, 4th Ed. Springer-Verlag Berlin Heidelberg.
- Owen R, Fennema. 1996. Food Chemistry, 3rd Ed. Marcel Dekker, Inc., New York, USA.
- Lillian Hoagland Meyer. 1974. Food Chemistry. The AVI Publishing Co Inc., Connecticut, MA, USA.

3. Food Microbiology 3(2+1)

Theory

Importance and significance of microbes in food science; Microbial spoilage of foods Factors affecting kinds, numbers, growth and survival of microorganisms in foods; Intrinsic factors; pH,, water activity, nutrients etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere; Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances; Contamination of foods; Sources of contamination, Genera of bacteria, Maintenance of anaerobic conditions; Asepsis, removal of microorganisms; Intermediate moisture foods; Microbiology of milk and milk products; Microbiology of fruits and vegetables, Microbiology of cereal and cereal products, Microbiology of meat and meat products, Microbiology of fish and other sea foods; Microbiology of poultry and eggs: Microbiology of sugar and sugar products; Microbiology of salts and spices, Microbiology of canned foods, Shelf life: Calculation of shelf lif, Shelf life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf life simulation for moisture, oxygen, and light sensitive products; Food borne intoxications and infections types of food involved, toxicity and symptoms, chemical properties, environmental conditions; Food borne viruses: Polio, hepatitis A & E, noroviruses, rota viruses, prion diseases, types of food involved, toxicity and symptoms, chemical properties, environmental conditions.

Practical

Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation; Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation; Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation; Microbial examination of milk and milk products: Identification, isolation and confirmation; Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation; Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of *Staphylococcus aureus* from food sample.

Suggested Reading

- Martin R. Adams and Maurice O. Moss. 2008. Food Microbiology, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.
- James M. Jay. 2000. Modern Food Microbiology, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
- George J. Banwart. 1989. Basic Food Microbiology, 2nd Ed. Chapman & Hall, New York, USA.
- William C. Frazier and & Dennis C. Westfoff. 1987. Food Microbiology, 4th Ed. Tata McGraw-Hill Education, New Delhi.

4. Industrial Microbiology 3(2+1)

Theory

History of industrial microbiology; Primary and secondary metabolites produced by the microorganisms; Screening of microorganisms; Preservation of microorganisms; Organizations involved in microbiological work; Fermentation media, Industrial sterilization; Definition, thermal death time, media heat sterilization, advantages of continuous sterilization, design of sterilization, deterministic and probabilistic approach in designing of sterilizing equipments, sterilization charts; Fermentor: Components of a fermentor, parts of fermentors, peripheral parts and accessories, additional accessories and peripherals. Types of fermentors: Types of fermentations; Industrially important secondary metabolites; and microorganisms involved; Probiotics: Importance, role in fermented foods, organisms involved, beneficial effects; Bacteriocins; Nisin: Production of microbial enzymes; Downstream processing; Cell disruption methods: Mechanical disruption methods and non-mechanical disruption methods; Extraction; Purification; Concentration; Product recovery;

Practical

Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes, Production of citric acid/Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid; Standardization of physical factors for higher yields of citric acid; Isolation, identification of cultures producing bio-colours; Production, purification and estimation of beer/ ethanol; Production, purification and assay of fungal amylases/proteases/Lipase; Production and assay of nisin from lactic acid bacteria; Single cell protein production; Starter activity of Baker's yeast Mushroom production;

Suggested Reading

- Nduka Okafor. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.
- Dennis E. Briggs, Chris A. Boulton, Peter A, Brookes and Roger Stevens. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.
- G. Reed. 2004. Prescott & Dunn's Industrial Microbiology, 4th Ed. AVI Publishers, Connecticut, USA.
- Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.
- L.E. Casida Jr. 1968. Industrial Microbiology. New Age International Publishers, New Delhi.

5. Food Chemistry of Micronutrients 3(2+1)

Theory

Chemistry of food flavour; Philosophy and definitions of flavour, flavourmatics/flavouring compounds, sensory assessment of flavour, technology for flavour retention; Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behaviour; Technology for retention of natural colours of food stuffs; Food colorants; Regulatory use of regulatory dyes; Colour losses during thermal processing; Vitamins and minerals: Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins and minerals, optimization and retention of vitamins and minerals; Chemistry of anti-nutritional factors.

Enzymes in food industry: Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid and ingredients

Practical:

Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium; Determination of phosphorus; Determination of iron; Estimation of magnesium; Estimation of tannins and phytic acid from food; Determination of vitamin A (Total carotenoids); Determination of ascorbic acid by dye method; Determination of thiamin and riboflavin; Determination of food colors; Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables.

Suggested Reading

- H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemisry, 4th Ed. Springer-Verlag Berlin Heidelberg.
- Owen R, Fennema. 1996. Food Chemistry, 3rd Ed. Marcel Dekker, Inc., New York, USA.

6. Food Biochemistry and Nutrition 3(2+1)

Theory

Biochemistry and its scope, cellular biochemistry; Carbohydrates: Occurrence, classification and structures, physicochemical and metabolic functions, metabolism; Proteins: Occurrence, classification and structures, physicochemical and metabolic functions, metabolism; Lipids: Occurrence, classification and structure, physicochemical and metabolic functions, metabolism; Nucleic acids: Properties, structure and metabolism; Vitamins and minerals: Chemistry and metabolic functions; Enzymes: Chemical nature and nomenclature, classification, sources and properties, mechanism of action, coenzyme and prosthetic groups; Concepts and content of nutrition: metabolic function of nutrients; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Functions of food; Basic food groups; nutrients supplied by food; Mechanism of enzyme action: Introduction to enzymes, coenzymes, regulation of enzymatic activity, enzyme kinetics,

inhibition effects of pH, allosteric enzymes, derivation of Michaelis-Menten equation; Nucleic acids; Nutrients: Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings; Metabolism of carbohydrates: Biological role of carbohydrates, glycolysis and respiration, production of ATP, brief description of electron transport chain, oxidative and substrate phosphorylation; Metabolism of lipids: Biological role of lipids, breakdown of triglycerides and phospholipids, β-oxidation of long chain fatty acids, ketosis, biosynthesis of fatty acids, triglycerides and phospholipids; Metabolism of proteins: Breakdown of proteins, transamination, deamination, decarboxylation, nitrogen fixation, urea cycle; Minerals: Functions, sources, factors affecting absorption of minerals, absorption promoters, absorption inhibitors, effect of deficiency; Vitamins and hormones: Classification, functions, sources, effects of deficiency, fat soluble vitamins, water soluble vitamin; Relationship between vitamins and hormones in terms of their biological role; Physico-chemical and nutritional changes during processing: Changes during food processing treatment of drying and dehydration, irradiation, freezing, fermentation, canning, restoration, enrichment, fortification and supplementation of foods.

Practical

Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates; Qualitative and quantitative determination of amino acids; Qualitative and quantitative determination of proteins; Qualitative and quantitative determination of lipids; Qualitative and quantitative determination of vitamins; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pka of acid; Determination of pI for casein; Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of amino acid using Biuret reaction; Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis; Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples; Estimation of β-carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments.

Suggested Reading

- Gaile Moe, Danita Kelley, Jacqueline Berning and Carol Byrd-Bredbenner. 2013. Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.
- David L. Nelson and Michael M. Cox. 2012. Lehninger Principles of Biochemisry, 6th Ed. Macmillan Learning, NY, USA.
- Donald Voet and Judith G. Voet. 2011. Biochemisry, 4th Ed. John Wiley and Sons, Inc., NY, USA.
- Carolyn D. Berdanier, Elaine B. Feldman and Johanna Dwyer. 2008. Handbook of Nutrition and Food, 2nd Ed. CRC Press, Boca Raton, FL, USA.
- Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones. 2002. Biochemistry & Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer and Gregory J. Gatto, Jr. 2002. Biochemisry, 7th Ed. W.H. Freeman and Company, NY, USA.

7. Food Biotechnology 3(2+1)

Theory

Chemical nature of the genetic material, properties and functions of the genetic material, organization of the genetic material in bacteria, eukaryotes and viruses; DNA replication: Replication fork, DNA polymerases, other enzymes and proteins required for DNA replication, origin of replication, replication of circular DNA molecule; Transcription and translation: RNA synthesis, types of RNA, genetic code; Mutation and DNA repair, mechanisms of repair of damaged DNA (photo reactivation, excision repair, recombination repair, SOS repair, mismatch repair), transposable elements, plasmids, types of plasmids, genetic recombination in bacteria, transformation, transduction, conjugation, regulation of gene expression in prokaryotes; Expression of foreign genes; Promoter enzymes; Recombinant DNA technology: Restriction enzymes, cloning vectors, cloning procedure, cloning of specific gene and their identification (colony hybridization, C-DNA, southern blotting, polymerase chain reaction); Gene cloning: Production of identical cells, isolation and purification of insert DNA, isolation of vector DNA, construction of recombined DNA, introduction of recombined DNA into host cell, identification and selection of cells containing cloned genes; Biosensors: Classification, application in food industry; Application of biotechnology in food: Immobilization of enzymes: Arresting of cell in insoluble matrix, immobilized cell systems, cell attachment in a surface, aggregation, entrapment, containment, physical adsorption, covalent bonding, cross linking, entrapment into polymeric films, microencapsulation, large scale cell immobilization, uses and applications in industries; Ethical issues concerning GM foods: Testing for GMOs, current guidelines for production, release and movement of GMOs, labeling and traceability, trade related aspects, bio-safety, risk assessment, risk management, public perception of GM foods, IPR, GMO Act 2004;

Practical

Study of auxotroph; Micro-propagation through tissue culture; Strain improvement through U.V. mutation for lactose utilization; Chemical mutagenesis using chemical mutagens (Ethidium bromide); Determination of survival curves using physical and chemical mutagens; Isolation and analysis of chromosomal/genomic DNA from *E. coli* and *Bacillus cereus*; Separation of protoplast using cellulytic enzymes; Production of biomass from fruit and vegetable waste; Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA; Pesticide degradation by pseudomonas spp.

Suggested Reading

- B.D. Singh. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.
- Meenakshi Paul. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.
- James D. Watson. 2013. Molecular Biology of the Gene, 7th Ed. Benjamin Cummings, San Francisco, USA.
- Oliver Brandenberg, Zephaniah Dhlamini, Alessandra Sensi, Kakoli Ghosh and Andrea Sonnino 2011. Introduction to Molecular Biology and Genetic Engineering. FAO, Rome, Italy.
- S.B. Primrose and R.M. Twyman. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Victoria, Australia.

- Ashok Agarwal and Pradeep Parihar. 2005. Industrial Microbiology: Fundamentals and Applications. Agrobios India, Jodhpur.

8. Instrumental Techniques in Food Analysis 3(1+2)

Theory

Concepts of food analysis; Rules and regulations of food analysis; Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods; Methods of analysis: Proximate constituents, moisture, adulterations, minerals analysis; Principles and methodology involved in analytical techniques: ion selective electrodes, spectroscopy, ultraviolet visible, florescence, infrared spectro-, atomic absorption and emission, mass spectroscopy, nuclear magnetic resonance and electron spin resonance; Chromatography: Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method, gas-liquid, high performance liquid chromatography; Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing, isotopic techniques, manometric techniques; Immuno assay techniques in food analysis; Evaluation of analytical data: Accuracy and precision, statistical significance, co-relations regression, result interpretation; Instrumentation and sensors for the food industry; Food compositional analysis using near infra-red absorption technology: Principles of measurement, instrumentation, applications in the food industry, power of process monitoring and trending, practical considerations for implementing on-line measurement, practical aspects of infra-red remote thermometry, radiation thermometers, measurement principles, practical situations, miscellaneous techniques; In-line and off-line FTIR measurements, food applications, calibration and general aspects of routine use;Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors; Electronic noses and tongues: Sensors for food flavour and freshness, electronic noses, tongues and testers; Introduction to flavour assessment, modelling the human nose, electronic nose, electronic tongue, marker chemical approach, Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, ions, gases and volatiles, amperometric, potentiometric and thermometric biosensors; Acoustic sensors, optical immunosensors; Fluorescence sensor systems; Novel sensing receptors, sensor arrays, commercial biosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Sensory evaluation of products; Quality evaluation of raw materials: Fruits, vegetables, cereals, dairy products, meat, poultry products; Quality evaluation of food products for color and taste of marketed products; Analysis of heavy metals using atomic absorption spectrophotometer; Estimation of physic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Identification of sugars in fruit juice using TLC; Separation of pralines by ion-exchange chromatography; Molecular weight determination using sephadox-gel; Identification of organic acids by paper electrophoresis; Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE; Quantitative make-up of water and fat soluble vitamins using HPLC; Separation of sugars by paper chromatography; Analysis of wheat flour; Analysis of foods for pesticide and drug residues; Study of colorimetry and spectrophotometry; Spectrophotometric method of total chlorophyll (A & B).

Suggested Reading

- S. Suzanne Nieisen. 2010. Food Analysis Laboratory Manual, 2nd Ed. Springer, NY, USA.
- Semih Ötles. 2009. Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
- Da-Wen Sun. 2008. Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.
- S. Suzanne Nieisen. 2003. Food Analysis, 3rd Ed. Kluwer Academic, New York, USA.

9. Food Plant Sanitation 2(1+1)

Theory

Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices, sanitation; Sanitation and the food industry: Sanitation, sanitation laws and regulations and guidelines, establishment of sanitary, potential risks of food borne bioterrorism, bioterrorism protection measures, role of pest management in bio-security; Relationship of microorganisms to sanitation,allergens, allergen control; Food contamination, protection against contamination; Personal hygiene and sanitary food handling: Role of HACCP in sanitation, quality assurance for sanitation cleaning compounds, handling and storage precautions; Sanitizers,sanitizing methods, sanitation equipment, waste product handling,solid waste disposal, liquid waste disposal; Pest control:Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management; Sanitary design and construction for food processing:Site selection, site preparation, building construction considerations, processing and design considerations, pest control design; Low-moisture food manufacturing and storage sanitation: Sanitary construction considerations, receipt and storage of raw materials, cleaning of low-moisture food manufacturing plants; Dairy processing plant sanitation: Role of pathogens, sanitary construction considerations, soil characteristics in dairy plants, sanitation principles, cleaning equipment; Meat and poultry plant sanitation:Role of sanitation, sanitation principles, cleaning compounds for meat and poultry plants, sanitizers for meat and poultry plants, sanitation practices, sanitation procedures; Sea food plant sanitation: Sanitary construction considerations, contamination sources, sanitation principles, recovery of by-products; Fruit and vegetable processing plant sanitation:Contamination sources, sanitary construction considerations, cleaning considerations, cleaning of processing plants, cleaners and sanitizers, cleaning procedures, evaluation of sanitation effectiveness; Beverage plant sanitation:Mycology of beverage manufacture, sanitation principles, non-alcoholic beverage plant sanitation, brewery sanitation, winery sanitation, distillery sanitation;

Practical

Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand); Determination of hardness of water; Good Manufacturing Practices (GMPs) and personal hygiene; Sewage treatment: Primary, secondary, tertiary and quaternary; Aerobic and anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant; Isolation and identification of Actinomycetes; Enrichment and isolation of cellulose degrading bacteria; Biodegradation of phenol compounds; Bacteriological examination of water: Coliform MPN test; Sampling of airborne microorganisms; Sampling of surfaces - equipment and physical plant; Aerosol sampling and measurement guidelines.

Suggested Reading

- Michael M. Cramer. 2013. Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices. CRC Press, Boca Raton, FL, USA.
- Ralph Mitchell and Ji-Dong Gu. 2010. Environmental Microbiology, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
- Norman G. Marriott and Robert B. Gravani. 2006. Principles of Food Sanitation, 5th Ed. Springer Science+Business Media, Inc., NY, USA.
- I.L. Pepper and C.P. Gerba. 2005. Environmental Microbiology: Laboratory Manual, 2nd Ed. Elsevier Academic Press, Amsterdam.
- Y. H. Hui, Bernard L. Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong and Phil Ventresca. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.

10. Food Quality, Safety Standards and Certification 2(2+0)

Theory

Food quality: Definition and its role in food industry; Quality attributes, classification; Color and gloss: Definition, different colors, color measurement by spectrophotometer, Muncell color system and Lovibond tintometer; role in food qualities. Role of viscosity and consistency in food quality; Physical properties: Size and shape, weight, volume, weight volume ratio, length, width, diameter, symmetry, curvature, area; Defects, classification. Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring, curled aves, pathological defects; Mechanical defects, extraneous or foreign material defects; Measurement of defects: Improving visibility by dilution, white background, color differences, standardization of conditions, reference standards, counts and measures, isolation of defects by floatation, elution, electronic sorting and internal defects; Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odor intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste; Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, dilution procedures, descriptive sensory analysis, contour method, other procedures; Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey; Quality of raw materials: Physical, chemical and microbial quality; Quality of products during processing and after processing: Color, taste, texture, flavour, appearance; Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of

finished products. Recording and reporting of quality. Quality inspection, quality control; Quality management and quality assurance: Total quality management, good manufacturing practices, good agricultural practices, good laboratory practices; Quality management systems, QSS; Quality circles, SQC; ISO system. HACCP: Principles, implementation; Plan documentation, types of records; Auditing: Surveillance, audit, mock audit, third party quality certifying audit, auditors and lead auditors; Certification, certification procedures, certifying bodies, accrediting bodies, international bodies.

Suggested Reading

- Inteaz Alli. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA.
- Ronald H. Schmidt and Gary E. Rodrick. 2003. Food Safety Handbook. John Wiley & Sons, Inc., Hoboken. New Jersey, USA.
- R.E. Hester and R.M. Harrison. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK.

11. Food Additives and Preservatives 2(1+1)

Theory

Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic); Identification of food colour by TLC (organic and inorganic); Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in frozen fish; Role of leaving agent in baked food product; Preservation of coconut shreds using humectants.

Suggested Reading

- H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemistry. 4th Edition. Springer-Verlag, Berlin,Heidelberg.
- S.N. Mahindru. 2008. Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.
- S.S. Deshpande. 2002. Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.

III. Department of Food Process Engineering

1. Food Thermodynamics 3(2+1)

Theory

Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat; First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis; Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale, entropy, availability and irreversibility; Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule; Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, Rankine Reheat cycle, air standard Otto cycle, air standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle; Psychometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms, three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity, Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

Practical

Determination of dryness fraction of steam. Determination of state of air using psychometric chart and hygrometer; Use of psychometric chart during drying process/ humidification process; Demonstration of equilibrium sorption isotherms; Use of psychometric chart during drying process/ humidification process; Visit to food plant with steam utilization.

Suggested Reading

- R.K. Rajput. 2007. Engineering Thermodynamics, 3rd Ed. Laxmi Publications (P) Ltd., Bangalore.
- J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.
- Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
- Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
- Donald B. Brooker, Fred W. Bakker-Arkema and Carl W. Hall. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.

2. Fluid Mechanics 3(2+1)

Theory

Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure,

absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces; Flow behavior of viscous foods; Compressible and non-compressible fluids; Surface tension, capillarity; Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer; Floating bodies: Archimedis principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height; Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Navier-Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries; Flow past through the immersed solids, packed and fluidized beds; Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude; Turbines and pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps; Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps; Open channel hydraulics: Classification of open channel and definitions, most economical sections of regular cross-sections; Specific energy concept-critical depth, energy diagrams; Velocity and pressure profiles in open channels; Hydraulic jumps-types.

Practical

Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank; Determination of critical Reynold's number by Reynold apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of rotameter; Study of different types of valves; Study of pumps for viscous fluid; Floating bodies, liquid flow, venturimeter, orifice, weir, flow through pipes.

Suggested Reading

- Frank M. White. 2010. Fluid Mechanics, 7th Ed. McGraw-Hill Book Co., Inc., Boston, USA.
- Yunus A. Çengel and John M. Cimbala. 2006. Fluid Mechanics: Fundamentals and Applications. McGraw-Hill, Inc., New York, USA.
- Bruce R. Munson, Donald F. Young and Theodore H. Okiishi. 2002. Fundamentals of Fluid Mechanics, 4th Ed. John Wiley & Sons, Inc., New York, USA.
- E. John Finnemore and Joseph B. Franzini. 2002. Fluid Mechanics with Engineering Applications, 10th Ed. McGraw-Hill, Inc., New York, USA.

- R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot. 2002. Transport Phenomena, 2nd Ed. John Wiley & Sons, Inc., New York, USA.
- Noel de Nevers. 1991. Fluid Mechanics for Chemical Engineers. McGraw-Hill, Inc., New York, USA.
- Victor L. Streeter. 1962. Fluid Mechanics, 3rd Ed. McGraw-Hill Book Co., Inc., Boston, USA.

3. Post Harvest Engineering 3(2+1)

Theory

Overview of post harvest technology: Concept and science, production and post harvest losses, reasons for losses, importance of loss reduction; Water activity, water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture; Post Harvest Handling operations; Cleaning: Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance; Separation: Magnetic separator, destoners, electrostatic separators, pneumatic separator; Decorticating and shelling: Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.; Grain drying theory, grain dryers; Liquid dryers; Parboiling: process, changes during parboiling, parboiling methods, advantages and disadvantages of parboiling with respect to milling, nutritional and cooking quality of grain, significance of glass transition temperature; Milling: milling, polishing, grinding, milling equipments, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement; Materials handling: Introduction to different conveying equipments used for handling of grains, fruits and vegetables; Scope and importance of material handling devices; Study of different material handling systems: Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types; Pneumatic conveying system: Capacity and power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Practical

Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze

dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

Suggested Reading

- Amalendu Chakraverty and R. Paul Singh. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
- A. Chakraverty. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
- James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.
- K.M. Sahay and K.K. singh. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
- G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
- R.L. Earle. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
- Carl W. Hall and Denny C. Davis. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
- S.M. Henderson and R.L. Perry. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.

4. Heat and Mass Transfer in Food Processing 3(2+1)

Theory

Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section and with Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins; Introduction to unsteady state heat conduction: System with negligible internal resistance and in various geometries; Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer; Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heat transfer to flowing fluids; Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Introduction to condensing and boiling heat transfer: Film- and drop-wise condensation, effect of non-condensable gases, boiling heat transfer; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Application of different types

of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Practical

Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry; Preparation and calibration of thermocouples; Determination of thermal conductivity of different food products; Study of working principle and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry; Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer.

Suggested Reading

- Eduardo Cao. 2010. Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.
- J.P. Holman. 2010. Heat Transfer, 10th Ed. McGraw-Hill Book Co., Boston, USA.
- Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
- John H. Lienhard IV and John H. Lienhard V. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
- Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
- Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
- J, M. Coulson, J. F. Richardson, J. R. Backhurst and J. H. Harker. 1999. Coulson & Richardson's Chemical Engineering, Vol. 1, Fluid Flow, Heat Transfer and Mass Transfer, 6th Ed. Butterworth–Heinemann, Oxford, UK.
- M. Necati Özişik. 1993. Heat Conduction, 2nd Ed. John Wiley & Sons, NY, USA.
- Robert E. Treybal. 1980. Mass Transfer Operations, 3rd Ed. McGraw-Hill Book Company, Auckland, USA.

5. Unit Operations of Food Processing-I 3(2+1)

Theory

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping); Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices,

other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids; Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machines; Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids; Membrane separation: General considerations, materials for membrane construction, ultra-filtration, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and micro filtration.

Practical

Determination of fineness modulus and uniformity index; Determination of mixing index of a feed mixer; Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law. Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of centrifugal separator; Study of freeze dryer and freeze drying process; Study on osmosis in fruits; Determination of solid gain and moisture loss during osmosis; Study of reverse osmosis process; Study of ultra filtration/membrane separation process.

Suggested Reading

- Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
- Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
- George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
- J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed. Butterworth–Heinemann, Oxford, UK.

6. Food Refrigeration and Cold Chain 3(2+1)

Theory

Principles of refrigeration: Definition, background with second law of thermodynamics,, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization; Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; Liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid

sub cooling, actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine, Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; Azeotropes; Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture, principles and systems of ice production, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations; Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display;Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling load calculations: Load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration, peak load; etc.

Practical

Study of vapour compression refrigeration system; Determination of COP of vapour compression refrigeration system; Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems; Study of refrigerants, their properties and charts; Study of direct and indirect contact freezing equipment for foods; Study of spray freezing process for foods; Study of food cold storage; Estimation of refrigeration load for cold storage; Estimation of refrigeration load for meat and poultry products; Study of refrigeration system of dairy plant; Estimation of refrigeration load for ice-cream; Study of cooling system for bakery and estimation of refrigeration loads; Estimation of refrigeration load during chocolate enrobing process; Study of refrigerated van; Study of deep freezing and thawing of foods; Study of refrigerated display of foods and estimation of cooling load.

Suggested Reading

- William C. Whitman, William M. Johnson, John A. Tomczyk and Eugene Silberstein. 2009. Refrigeration & Air Conditioning Technology, 6th Ed. Delmar, Cengage Learning, NY, USA.
- C.P. Arora. 2000. Refrigeration and Air Conditioning, 2nd Ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- W.F. Stoecker and J.W. Jones.1982. Refrigeration and Air Conditioning, 2nd Ed. McGraw-Hill Book Co., New York, USA.

7. Food Storage Engineering 3(2+1)

Theory

Storage: Importance of scientific storage systems, post harvest physiology of semi-perishables and perishables, climacteric and non climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis; Damages: Direct damages, indirect damages, causes of spoilage

in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control; Storage structures: Traditional storage structures, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos; Storage of grains: respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation; Aeration and stored grain management: purposes of aeration, aeration theory, aeration system design, aeration system operation; Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control; Storage of perishables: cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage; Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.

Practical

Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity; Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage;. Design of cold storage for particular capacity and commodity; Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity; Drawing and layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.

Suggested Reading

- P.H. Pandey. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
- Myer Kutz. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
- A.M. Michael and T.P. Ojha. 2004. Principal of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.
- L.W. Newbaver and H.B. Walker. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.
- J. Whitaker. 2002. Agricultural Buildings and Structures. Reston Publishing Home, Reston, Virgenia, USA.
- G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
- C.W. Hall. 1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA.
- Donald B. Brooker, F.W. Bakker-Arkema, Carl W. Hall. 1974. Drying and Storage of Grains and Oilseeds. The AVI Publishing Company, Inc., Westport, Connecticut, USA.

8. Food Process Equipment Design 3(2+1)

Theory

Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes; Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations; Design of pressure and storage vessels: Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories; Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort; Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystalliser and entrainment separator; Design of agitators and separators: Design of agitators and baffles; Design of agitation system components and drive for agitation; Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems; Design of freezing equipment: Design of ice-ream freezers and refrigerated display system; Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer; Design of conveyors and elevators: Design of belt, chain and screw conveyor, design of bucket elevator and pneumatic conveyor; Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin screw extruder; Design of fermenters: Design of fermenter vessel, design problems; Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

Practical

Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort; Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer; Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer; Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor; Design of twin screw extruder; Design of fermenter.

Suggested Reading

- R. Paul Singh and Dennis R. Heldman. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.
- Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
- George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
- R. K. Sinnott. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Ed. Butterworth-Heinemann, Oxford, UK.
- Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

- Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.
- J.F. Richarson and D.G. Peacock. 1994. Coulson & Richardsons's Chemical Engineering, Vol. 3, Chemical & Biochemical Reactors & Process Control, 3rd Ed. Elsevier Butterworth-Heinemann, Amsterdam, The Netherlands.

9. Unit Operations of Food Processing-II 3(2+1)

Theory

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation; Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchanges; Recompression heat and mass recovery and vacuum creating devices; Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice. Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations; Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization; Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/differential distillation, fractional distillation, steam distillation, distillation of wines and spirits; Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment; Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger; Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipments; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package; Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Blanching: principle and equipment; Homogenization, Emulsification.

Practical

Study of working principle open pan and vacuum evaporator; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of

multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of sterilizer; Design problems on freezers; Numerical problem on thermo bacteriology (D, Z and F); Study of freezers; Freezing of foods by different methods; Determination of freezing time of a food material; Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar; Study of blancher, pasteurizers, fryers, homogenizers, irradiators; Determination of oil uptake by the food product during frying; Study on qualitative changes in the fried food product; Visit sugar processing industry.

Suggested Reading

- R. Paul Singh and Dennis R. Heldman. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.
- Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
- Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
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- George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
- J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed. Butterworth–Heinemann, Oxford, UK.
- P. Fellows. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.
- R. K. Sinnott. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Ed. Butterworth-Heinemann, Oxford, UK.
- Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.
- Robert E. Treybal. 1980. Mass Transfer Operations, 3rd Ed. McGraw-Hill Book Company, Auckland, USA.

10. Instrumentation and Process Control in Food Industry 3(2+1)

Theory

Introduction, definitions, characteristics of instruments, static and dynamic characteristics; Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure; Liquid level measurement, different methods of liquid level measurement; Flow measurement: Kinds of flow, rate of flow, total flow differential pressure meters, variable area meters, food flow metering; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale; Measurement of moisture content, specific gravity, measurement of humidity, measurement of viscosity, turbidity, color, measurement of density, brix, pH, enzyme sensors, automatic valves; Transmission: Pneumatic and electrical; Control elements, control actions, pneumatic and electrical control systems; Process control: Definition, simple system analysis,

dynamic behaviour of simple process, Laplace transform, process control hardware; Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis; Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices; Controllers and indicators: Temperature control, electronic controllers, flow ratio control, atmosphere control, timers and indicators, food sorting and grading control, discrete controllers, adaptive and intelligent controllers; Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing.

Practical

Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer.

Suggested Reading

- Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
- Bela G. Liptak. 2003. Instrument Engineer's Handbook, Vol. I and II, 4th Ed. CRC Press, Boca Raton, FL, USA.
- Curtis D. Johnson. 2003. Process Control Instrumentation Technology, 7th Ed. Prentice Hall of India Pvt. Ltd., New Delhi.
- D.V.S. Murty. 2004. Transducers and Instrumentation. Prentice-Hall of India Pvt. Ltd. New Delhi.

IV. Department of Food Business Management

1. Business Management and Economics 2(2+0)

Theory

Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line, line and staff, matrix, hybrid; Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity; Markets: Types of markets and their characteristics; National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production. Law of variable proportions and law of returns to scale; Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Finance management: Definition, scope, objective; Different systems of accounting: Financial accounting, cost accounting, management accounting; Human resource management: Definitions, objectives

of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

Suggested Reading

- L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
- Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
- P.C. Thomas. Managerial Economics, 9th Ed. Kalyani Publishers.
- K.K. Dewett and M.H. Navalur. Modern Economic Theory. S. Chand & Sons, New Delhi.
- P. Subba Rao. Human Resource Management. Himalaya Publications.
- S.P. Jain. Financial Accounting. Kalyani Publications, Ludhiana.

2. Marketing Management and International Trade 2(2+0)

Theory

Marketing: Concept, functions, scope and marketing management; Process: Concepts of marketing-mix, elements of marketing-mix; Market structure and consumer buying behaviour: micro- and macro-environments; Marketing research and marketing information systems; Market measurement, market forecasting, market segmentation, targeting and positioning; Allocation and marketing resources; Marketing planning process; Product policy and planning: Product-mix, product line, product life cycle; New product development process; Product brand, packaging, services decisions; Marketing channel decisions; Retailing, wholesaling and distribution; Pricing decisions; Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry; Promotion-mix decisions; Advertising: Objectives, budget and advertising message, media planning, personal selling, publicity, sales promotion; World consumption of food: Patterns and types of food consumption across the globe; Salient features of international marketing, composition and direction of Indian exports, international marketing environment, deciding which and how to enter international market; Direct exports, indirect exports, licensing, joint ventures, direct investment and internationalization process, distribution channels; WTO and world trade agreements related to food business, export trends and prospects of food products in India; Government institutions related to international food trade: APEDA, Tea Board, Spice Board, MOFPI, etc.

Suggested Reading

- Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha. 2013. Marketing Management: A South Asian Perspective, 14th Ed. Pearson Education.
- Willium J. Stanton. 1984. Fundamentals of Marketing. Tata McGraw-Hill Publication, New Delhi.
- C.N. Sontakki. Marketing Management. Kalyani Publishers, New Delhi.
- John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. International Business, 15th Ed., Pearson Education.
- Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi.
- Fransis Cherunilam. International Business: Text and Cases, 5th Ed. PHI Learning, New Delhi.

3. Project Preparation and Management 2(1+1)

Theory

Overview of project management: Functions and viewpoints of management, evolution of project management, forms and environment of project management; Project life cycle; Project selection: Project identification and screening, project appraisal, project charter, project proposal, project scope, statement of work; Project planning and scheduling: Work breakdown structure, planning and scheduling of activity networks, network scheduling, precedence diagrams, critical path method, program evaluation and review technique, assumptions in PERT modelling, decision CPM, GERT; Project cost estimating: Types of estimates and estimating methods, dynamic project planning and scheduling, time-cost trade-offs, resource considerations in projects, resource profiles and levelling, limited resource allocation; Project implementation, monitoring and control: Project management process and role of project manager, team building and leadership in projects, organizational and behavioural issues in project management, project monitoring and control, PERT/cost method, earned value analysis; Project completion and future directions: Project completion and review; Project management: Recent trends and future directions; Computers in project management.

Suggested Reading

- R. Panneerselvam. 2004. Operations Research, 2nd Ed. International Book House, Mumbai.
- Prasanna Chandra. Projects. Tata McGraw-Hill Publication, New Delhi.
- John M. Nicholas. Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.
- Harold Kerzner. Project Management – A System Approach to Planning, Scheduling, and Controlling. CBS Publishers & Distributors.
- Prasanna Chandra. Projects – Planning, Analysis, Selection, Financing, Implementation, and Review. Tata McGraw-Hill Publishing Company Ltd.
- P. Gopalakrishnan and V.E. Rama Moorthy. Textbook of Project Management. Macmillan

4. ICT Applications in Food Industry 3(1+2)

Theory

Importance of computerization in food industry, operating environments and information systems for various types of food industries, Supervisory control and data acquisition (SCADA); SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems; Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems, use of add-ins, use of solver; Web hosting and webpage design; file transfer protocol (FTP), on-line food process control from centralized server system in processing plant; Use of MATLAB in food industry; computing with MATLAB, script files and editor/debugger, MATLAB help system, problem solving methodologies, numeric, cell, arrays, matrix operations, user defined functions, programming using MATLAB; debugging MATLAB programs, applications to simulations; Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, interactive plotting in MATLAB, function discovery, regression, the basic fitting interface, three dimensional plots; Introduction to toolboxes useful to food industry, curve fitting toolbox, fuzzy logic toolbox, neural network

toolbox, image processing toolbox, statistical toolbox;Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Applications of CFD in food and beverage industry; Introduction to CFD software, GAMBIT and FLUENT software; LabVIEW – LabVIEW environment: Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition, sound card, front panel/block diagram, toolbar/tools palette; Components of a LabVIEW application: Creating a VI, data Flow execution, debugging techniques, additional help, context help, tips for working in LabVIEW; LabVIEW typical programs: Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O; LabVIEW results: Displaying data on front panel, controls and indicators, graphs and charts, arrays, loop timing, signal processing, textual math, math script.

Practical

Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add-Ins in spread sheet and statistical data analysis using Analysis Tool pack; Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet; Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB; Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software; Creation of geometry for laminar flow through pipe using GAMBIT; Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using FLUENT; Introduction to LabVIEW and NI-DAQ.

Suggested Reading

- R. Paul Singh. 2014. Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical and Process Analysis. Academic Press, London.
- William J. Palm III. 2011. Introduction to MATLAB for Engineers, 3rd Ed. McGraw-Hill Companies, Inc., NY, USA.
- Da-Wen Sun. 2007. Computational Fluid Dynamics in Food Processing. CRC Press, Boca Raton, FL, USA.
- Nigel Chapman and Jenny Chapman. 2006. Web Design: A Complete Introduction. John Wiley & Sons, USA.
- National Instruments Corporation. 2005. Introduction to LabVIEW: 3-Hour Hands-On. NI, Austin, Texas.
- David Bailey and Edwin Wright. 2003. Practical SCADA for Industry. Elsevier, Burlington, MA

5. Communication and Soft Skills Development 2(1+1)

Practical

Introduction to soft skills and hard skills; Communication skills, verbal and non-verbal

communication, listening and note taking, writing skills, oral presentation skills, public speaking; Self development: Etiquette and manners; Break the ice berg – FEAR; Priority management and time management; Positive attitude and self confidence, motivation skills and personality; Goal setting; Decision making; Career Planning: Resume building, interviewing skills, group discussions.

Suggested Reading

- Mamatha Bhatnagar and Nitin Bhatnagar. 2011. Effective Communication and Soft Skills. Person Education.
- Meenakshi Raman, Sangeeta Sharma. Technical Communication Principles and Practice
- Harold Wallace and Ann Masters. Personality Development. Cengage Publishers.
- Andrea J. Rutherford. Basic Communication Skills for Technology. Pearson Education.

6. Entrepreneurship Development 3(2+1)

Theory

Entrepreneurship: Importance and growth, characteristics and qualities of entrepreneur, role of entrepreneurship, ethics and social responsibilities; Entrepreneurship development: Assessing overall business environment in the Indian economy; Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs; Globalization and the emerging business/entrepreneurial environment; Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, entrepreneurship development programs, SWOT analysis, generation, incubation and commercialization of ideas and innovations; Women entrepreneurship: Role and importance, problems; Corporate entrepreneurship: Role, mobility of entrepreneur; Entrepreneurial motivation; Planning and evaluation of projects: Growth of firm, project identification and selection, factors inducing growth; Project feasibility study: Post planning of project, project planning and control; New venture management; Creativity. Government schemes and incentives for promotion of entrepreneurship; Government policy on small and medium enterprises (SMEs)/SSIs; Export and import policies relevant to food processing sector; Venture capital; Contract farming and joint ventures, public-private partnerships; Overview of food industry inputs; Characteristics of Indian food processing industries and export; Social responsibility of business.

Practical

Visit to public enterprise; Visit to private enterprise; Visit to agro-processing/food business centres; SWOT analysis of public enterprises; SWOT analysis of private enterprises; Project proposals as entrepreneur – individual and group; Presentation of project proposals in the class.

Suggested Reading

- C.B. Gupta and N.P. Srinivasan. 2012. Entrepreneurship Development. S. Chand & Sons, New Delhi.
- Anil Kumar, S., Poornima, S.C., Mini, K., Abraham and Jayashree, K. 2003. Entrepreneurship Development.New Age International Publishers, New Delhi.

- Gupta, C.B. 2001. Management: Theory and Practice.Sultan Chand & Sons, New Delhi.
- Vasant Desai. 2000. Dynamics of Entrepreneurial Development and Management.Himalaya Publishing House, New Delhi.

V. Basic Engineering

1. Engineering Drawing and Graphics 3(1+2)

Theory

First and third angle methods of projection; Preparation of working drawing from models and isometric views; Drawing of missing views; Different methods of dimensioning; Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts; Types of rivet heads and riveted joints; Processes for producing leak proof joints. Symbols for different types of welded joints; Nomenclature, thread profiles, multi-start threads, left and right hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

Practical

Introduction of drawing scales; Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications; Interpretation of sectional views of food equipment and components; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.

Suggested Reading

- Ibrahim Zeid. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.
- Kunwoo Lee. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.
- N.D. Bhat and V.M. Panchal. 1995. Machine Drawing. Charotar Publishing House, Anand.
- N.D. Bhat. 1995. Elementary Engineering Drawing. Charotar Publishing House, Anand.

2. Basic Electrical Engineering 3(2+1)

Theory

AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, reluctance etc, laws of magnetic circuits, Phase relations and vector representation, AC through resistance, inductance and capacitance, A.C. series and parallel circuits, Simple R-L, R-C and R-L-C circuits, 3 Phase Systems: Star and Delta connections,

Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement. Transformer : Principle of working, construction of single phase transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test. Single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors. Poly-phase induction motor: Construction, operation, equivalent circuit, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics, D.C. Motors, their starting, speed controls and characteristics. Electric Power Economics, Maximum demand charge, Load factor, power factor and power factor improvement, Measuring Equipment's: Classification, Characteristics of different electrical measuring systems and equipment's, Electrical Wiring, system of wiring, domestic wiring installation, industrial electrification, protection devices, Earthing, use of Multimeter, Circuit protection devices, fuses, MCB, ELCB & relays.

Practical

Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, Starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Problems on Industrial Electrification. Study of various circuit protection devices. Study of various measuring instruments.

Suggested Reading

- B.L. Theraja and A.K. Theraja. 2005. A Textbook of Electrical Technology, Vol. II. S. Chand & Company Ltd., New Delhi.
- Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall India Private Ltd., New Delhi.

3. Workshop Technology 3(1+2)

Theory

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications; Safety measures in workshop; Indian Factory Acts on safety; Measuring and Gauging: Basic measuring instruments and gauges; Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.; Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding

joints, edge preparation, welding techniques and equipments; Gas welding and gas cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost; Smithying and forging: Introduction to different tools and their uses; Different forging operations, defects of forging; Brief ideas about power hacksaw, etc.; Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.; Machinery: Introduction to various workshop machines (1) Lathe, (2) Milling machine, (3) Shaper and planner, (4) Drilling and boring machine, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for casting, shaping, slotting and planning operations, work holding and tool holding devices; Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

Practical

Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipments, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

Suggested Reading

- B.S. Raghuwamsi. 1996. A Course in Workshop Technology, Vols. I and II. Dhanpet Rai & Sons, New Delhi.
- W.A.J. Chapman. 1989. Workshop Technology, Parts I and II. Arnold Publishers (India) Pvt. Ltd., New Delhi.
- S.K. Hazra Choudari and S.K. Bose. 1982. Elements of Workshop Technology, Vols. I and II. Media Promoters and Publishers Pvt. Ltd., Mumbai.

4. Computer Programming and Data Structures 3(1+2)

Theory

Introduction and historical background: Review of computer technology; Processor, memory, secondary storage, display devices and other peripheral devices; Basic computer organization, future trends; Brief review of present-day applications, programming; Introduction to systems software, applications software and programming language; Algorithms and flow-charts: Input-processing-output model of a computer program; Role of the compiler and the integrated development environment; Introduction to C: Structure of a C program, simple data types, declarations, operators and expressions; The assignment statement; Library functions; Control Structures: Conditional and iterative execution of statements; Importance of documentation;

Nesting of control structures and the use of indentation to indicate nesting levels; Labels and the "go to" statement; Arrays; Single and multi-dimensional arrays: Character strings and string functions; Functions: Scope rules; Argument passing by reference and by value; Storage classes; Use of function prototypes; Structures, unions and user-defined types; Operations on files: Concept of standard input and output files; Formatting of data on input and output; Use of include files; Introduction to high level languages; Primary data types and user defined data types, variables, typecasting, operators, building and evaluating expressions, standard library functions, managing input and output, decision making, branching, looping, arrays, user defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, string functions, structures and union, pointers, stacks, push/pop operations, queues, insertion and deletion operations, linked lists.

Practical

Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global and external variables; Using pointers; Implementing stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/deletion in data structures.

Suggested Reading

- Mark Allen Weiss. 2014. Data Structures and Algorithm Analysis in C++, 4th Ed. Pearson Education, Boston, USA.
- Svetlin Nakov & Co. 2013. Fundamentals of Computer Programming with c#. Sofia, Bulgaria.
- F. Balagurusamy. 2008. Object Oriented Programming with C++, 4th Ed. Tata McGraw-Hill Publishing Company Limited, New Delhi.

5. Basic Electronics Engineering 3(2+1)

Theory

Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier, clipper, clamper, voltage multiplier, filter circuits; Diode circuits for OR and AND (both positive and negative logic) bipolar junction transistor: Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider); Coupling of amplifiers, h-parameter model of a transistor, analysis of small signal, CE amplifier, phase shift oscillator, analysis of differential amplifier using transistor, ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiting, OP-AMP voltage regulators; Basic theorem of Boolean algebra; Combinational logic circuits (basic gates, SOP rule and K-map, binary ladder D/A converter of displacement, temperature, velocity, force and generalized instrumentation, measurement

of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples.

Practical

Study of diode characteristics; Study of triode characteristics; Study of Zener diode; Study of V-I characteristics of P-n junction diode; Study of RC coupled amplifier; Study of RC phase shift oscillator; Study of full wave rectifier; Verification of logic gates; Determination of energy gap in a junction diode; Study of transistor characteristics in CE configuration; Study of OP-Amp IC 741 as differential amplifier; Study of half wave rectifier; Study of OP-AMP IC 741 as a active rectifier; Study of transistor characteristics; Study of temperature characteristics of resistor; Study of diode as clipper and clamper.

Suggested Reading

- A. Anand Kumar. 2014. Fundamentals of Digital Circuits. PHI Pvt. Ltd., New Delhi.
- A.K. Sawhney. 2010. Course in Electrical and Electronics Measurements and Instrumentation. Dhanpat Rai Publications (P) Limited, New Delhi.
- V.K. Mehta and Rohit Mehta. 2008. Principles of Electronics. S. Chand and Co., New Delhi.
- D. Choudhury Roy. 2003. Linear Integrated Circuits. John Wiley International, NY.
- Sanjeev Gupta. 2002. Electronic Devices and Circuits. Dhanpat Rai Publications (P) Limited, New Delhi.

VII. Basic Sciences and Humanities

1. English Language 2(1+1)

Theory

Introduction: Importance of language and communication skills in the engineering profession; Spoken and conversational English: Main features, agreement, disagreement, likes, dislikes and enquiries; Debate and discussion. Basic sentence patterns in English: Agreement between subject and verb; Proper use of pronouns, adjectives and adverbs; Proper use of pharses and clauses; Some basic rules of composition; Concept of register; development of vocabulary; Reference skills: Dictionary, thesaurus, indexing, contents, glossary; Reading of selected texts and discussions; Vocabulary building tasks; Note-taking and note-making, linkage, development of paragraphs; Cohesion, coherence and style.

Practical

Grammar tenses; Voice-change; Direct/indirect narration; Prepositions and determiners; Word-formation with parts of speech; Types of sentences; Elementary knowledge of English sound with word-stress, intonation pattern; Composition, letter, application, summary and report writing.

Suggested Reading

- Alice Oshima and Ann Hogue. 1998. Writing Academic English. Addison Wesley Longman, White Plains, NY, USA.
- N. Krishnaswamy and T. Sriraman. 1995. Current English for Colleges. Macmillan India Ltd., Chennai.

2. Engineering Mathematics-I 2(2+0)

Theory

Differential calculus: Taylor's and Maclaurin's expansions, indeterminate form; Curvature, asymptotes, tracing of curves, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima; Integral calculus: Reduction formulae, rectification of standard curves, volumes and surfaces of revolution of curves, double and triple integrals, change of order of integration, gamma and beta functions, application of double and triple integrals to find area and volume; Ordinary differential equations: Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations; Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; Line, surface and volume integrals, Stoke's, divergence and Green's theorems.

Suggested Reading

- B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
- Shanti Narayan. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
- Shanti Narayan. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
- Shanti Narayan. 2004. A Textbook of Vector Calculus. S. Chand and Co. Ltd. New Delhi.

3. Crop Production Technology 3(2+1)

Theory

Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage; Soil-water-plant relationship, crop rotation, cropping systems, relay cropping and mixed cropping; Crop production technology for major cereal crops viz., paddy, wheat, maize, pearl millet, sorghum, etc.; Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.; Crop production technology for major oilseed crops viz., groundnut, sesame, rapeseed, mustard, castor, etc.: Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.; Crop production technology for major pulse crops viz., pigeon pea, cowpea, gram, green gram, black gram, etc.: Major varieties,

sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.; Crop production technology for major spices and cash crops viz., cumin, coriander, funnel, ginger, garlic, sugarcane, etc.: Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.; Horticulture: Scope of horticultural crops. Soil and climatic requirements for fruits and vegetables, nursery raising and management; Crop production technology for major fruit crops viz., mango, banana, sapota, aonla, pomegranate, guava, etc.: Major varieties, time of transplanting, spacing, inter-culturing, fertilizer and water requirement, time and method of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.; Crop production technology for major vegetable crops viz., potato, onion, tomato, chilli and other green and leafy vegetables: Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.

Practical

Examination of soil profile in the field; Introduction to different equipments utilized in a weather observatory; Identification of seed of different agricultural crops and their varieties; Study of seed viability and germination test; Identification of different weeds and methods of their control; Use of different inter-culturing equipments; Study of water requirement of different crops; Fertilizer application methods and equipments; Judging maturity time for harvesting of crop; Identification and description of important fruit and vegetable crops; Preparation of nursery; Study of different garden tools; Practices of pruning and training in some important fruit crops.

Suggested Reading

- S. Prasad and U. Kumar. 2010. Principles of Horticulture. Agrobios, New Delhi.
- T. Yellamanda Reddy and G.H. Shankar Reddy. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.
- S.S. Singh. Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana.

4. Engineering Mathematics-II 2(2+0)

Theory

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, consistency and solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, bilinear and quadratic forms; Functions of a complex variable: Limit, continuity and derivative of complex functions, analytic function, Cauchy-Reimann equations, conjugate functions, harmonic functions; Fourier series: Infinite series and its convergence, periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, harmonic analysis; Partial differential equations: Formation of partial differential equations, Lagrange's linear equation, higher order linear partial differential equations with constant coefficients, solution of non-linear partial

differential equations, Charpit's method, application of partial differential equations (one-dimensional wave and heat flow equations, two-dimensional steady state heat flow equation (Laplace equation).

Suggested Reading

- B.V. Ramana. 2008. Engineering Mathematics. Tata McGraw-Hill Book Co., New Delhi.
- B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
- Shanti Narayan 2004. A Textbook of Matrices. S. Chand and Co. Ltd., New Delhi.

5. Environmental Sciences and Disaster Management 2(1+1)

Theory

Environment, ecology and ecosystem: Definition and inter-relationships amongst and between them, components of environment, relationship between different components; Man-environment relationship; Impact of technology on the environment; Environmental degradation;

Ecology and ecosystems: Introduction; Ecology: Objectives and classification, concepts of an ecosystem structure and function of ecosystem; Components of ecosystem: Producers, consumers, decomposers; Bio-geo-chemical cycles: Hydrological cycle, carbon cycle, oxygen cycle, nitrogen cycle, sulfur cycle; Energy flow in co-system; Food chains: Grazing, detritus, food webs; Ecological pyramids; Major ecosystems: Forest ecosystem, Grassland ecosystem, desert ecosystem, aquatic ecosystem, estuarine ecosystem; Population and natural resources: Development of habitation patterns and environmental factors governing human settlement; Population and pollution, reasons for overpopulation, population growth, demographic projections and population structures, production of food; Renewable and non-renewable resources: Renewable resources, non-renewable resources, destruction versus conservation; Water resources: Water resources, Indian scenario; Water sources: Surface and ground water sources, uses and overuses of water resources, problems due to over exploitation of water resources; Forest resources: Indian scenario; Importance of forests-ecologically and economically, uses of forest products, forest types; Deforestations: Causes and effects, forest degradation in India; Energy resources: Indian scenario, conventional energy sources and its problems; Non-conventional energy sources: Advantages and its limitations, problems due to overexploitation of energy resources. Environmental pollution - Water pollution: Introduction, water quality standards, sources of water pollution, classification of water pollutants, effects of water pollutants, eutrophication; Air pollution: Composition of air, structure of atmosphere, ambient air quality standards, classification of air pollutants, sources of common air pollutants like SPM, SO_2, NO_X, natural and anthropogenic sources, effects of common air pollutants; Land and noise pollution: Introduction, lithosphere, land uses, causes of land degradation, sources of noise pollution, effects of noise pollution; Radioactive pollution; Food processing industry waste and its management; Management of urban waste water; Recycling of organic waste; Recycling of factory effluent; Control of environmental pollution through law; Composting of biological waste; Sewage, uses of water disposal effluent treatment; Current environmental global issues: Global warming and green houses effects, acid rain, depletion of ozone layer.

Practical

Environment and its analysis; Water quality parameters; Collection of sample for pollution study; Determination of pH/acidity/alkalinity from sample; Estimation of dissolved oxygen; Estimation of BOD; Estimation of COD; Estimation of nitrates; Estimation of phosphates; Estimation of pollutant elements; Estimation of heavy/toxic elements; Estimation of lead / mercury; Visit to industrial sewage disposal unit.

Suggested Reading

- Gilbert M. Masters and Wendell P. Ela. 2013. Introduction to Environmental Engineering and Science. Pearson Education Limited, NY, USA.
- Suresh K. Dhameja. 2009. Environmental Engineering and Management. S. K. Kataria & Sons, New Delhi.
- Bernard J. Nebel and Richard T. Wright.1993. Environmental Science: The Way the World Works. Prentice-Hall Professional, New Delhi.

6. Statistical Methods and Numerical Analysis 2(1+1)

Theory

Statistical methods, testing of hypothesis, concepts, testing of significance based on Z-test, t-test, F-test, Chi-square test, contingency table, correlation, regression, testing of significance of correlation and regression, multiple linear regression, ANOVA, one-way and two-way classifications, factorial experiment concepts (2^2, 2^3, mixed factorials); Numerical analysis: Finite differences, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, numerical integration, numerical integration by Trapezoidal, Simpson's and Weddle's rules; Numerical solution of ordinary differential equations by Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method; Laplace transforms: Definition of Laplace transform, Laplace transforms of elementary functions, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, integrals, transform of function multiplied by t^n, transform of function divided by t, convolution theorem, application of Laplace transforms to solve ordinary differential equations and simultaneous differential equations; Experimental designs: Basic designs, completely randomized design (CRD) - Layout and analysis with equal and unequal number of observations, randomized block design (RBD) - Layout and analysis, Latin square design (LSD) - Layout and analysis; Response surface methodology.

Practical

Problems on one sample, two sample Z-tests when population S.D. is known and unknown; Problems on one sample, two sample and paired t-test; Chi-square test – 2×2 and m×n; Contingency table and F-test; Calculation of correlation coefficient and its testing; Fitting of simple linear regressions; Fitting of multiple regression equations; ANOVA: One way/two way; 2^2,

2^3 and mixed factorial experiments; Problems on Newton's forward and backward interpolation formula for equal intervals; Problems on trapezoidal rule; Problems on Simpson's 1/3 and 3/8 rules; Problems on solution of ordinary differential equations of first order and second orders by Runge-Kutta method; Problems on Euler's method; Problems on Laplace transforms; Problems on inverse transformations; Problems on solutions of first order differential equations. Problems on response surface methodology.

Suggested Reading

- Erwin Kreyszig, 2006. Advanced Engineering Mathematics, 9th Ed. John Wiley & Sons, New York, USA.
- B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
- P.P. Gupta and C.C. Malik. 1993. Calculus of Finite Differences and Numerical Analysis. Krishna Prakash Mandor, Meerut.

VIII. Non-Credit Courses

1. Physical Education 1(0+1)

Practical

Introduction to physical education: Definition, scientific machine principles, objectives, scope, history, development and importance; Physical training and health; Fartlek training and circuit training; Body mechanism and body type: Kretchmark's and Sheldon's classification; Theories of learning; Exercises for good posture; Exercises to develop physical fitness, growth, flexibility - components, speed, strength, endurance, power, flexibility, agility, coordination and balance; Test and measurement in physical education: Physical fitness test, motor fitness test, ability test, cardiovascular efficiency test and physical fitness index; Calisthenics, weight training, aerobic and anaerobic exercises; Circuit training, interval training, far trek training, pressure training and resistance training; Importance of *Asanas*, free hand exercises and yoga; Recreation: Definition, agencies promoting recreation, camping and re-recreation; Governance of sports in India; Organization of tournaments; National and international events; Drawing of fixtures; Rules and regulations; Coaching and fundamentals of skill development of major games, coaching and tactic development of athletic events.

2. NSS 1(0+1)

Practical

Orientation of students towards national problems; Study of the philosophy of N.S.S., fundamental rights, directive principles of state policy, socio-economic structure of Indian society, population and five year plans; Functional literacy: Non-formal education of rural youth, eradication of social evil, awareness programmes, consumer awareness, highlights of the Consumer Act, environment enrichment and conservation, health, family welfare and nutrition; Right to information act.

Minimum Standards for Establishing a College of Food Technology

1. **Degree Nomenclature :** B. Tech. (Food Technology)
2. **Eligibility Criteria:** 10+2/Intermediate with PCMB/PCM (P- Physics, C-Chemistry, M-Mathematics, B-Biology) from a recognized Board/university
3. **Medium of Instruction :** English
4. **Minimum Intake:** 40 students per year
5. **Name of Departments**
   1) Department of Food Processing Technology
   2) Department of Food Safety & Quality Assurance
   3) Department of Food Process Engineering
   4) Department of Food Business Management
   5) Department of Food Plant Operations

6. Faculty and Supporting Staff Requirement

Department	Faculty			Supporting staff			
	Prof & Head	Assoc Prof.	Assist Prof.	Res/ Teach Assistant	Office Assistant	Lab Technician	Lab Attendant
Food Process Technology	1	2	4	2	1	6	2
Food Safety and QualityAssurance	1	2	4+3*	2	1	4+2*	2
Food Process Engineering	1	2	4+5**	2	1	4+4**	2
Food Business Management	1	2	4+3*	2	1	2	2
Food Plant Operations	1	2	4	2	1	6***	6
Total	**5**	**10**	**31**	**10**	**5**	**28**	**14**

* For basic sciences, humanities subjects (One each for English, Chemistry, Microbiology, Mathematics, Statistics, Agriculture)
** For basic engineering subjects (one each for Mechanical, Electrical, Computer, Electronics & Instrumentation, Civil Engineering)
*** Pilot Plant Operators & Mechanics

7. Administrative Stafffor College

Office	Position	Number	Remarks
Main College Office	Dean/Assoc. Dean/Principal	1	
	Administrative cum Accounts Officer or Asstt. Registrar	1	
	PS to Dean/Principal	1	
	Senior Clerk	4	1 Admin, 1 Estt., 1 Accounts, 1 Academics
	Junior Clerk	4	1 Admin, 1 Estt., 1 Accounts, 1 T&P
	Store keeper	1	
	Attendant	3	
	Driver	2	1 each for car & bus
Hostels & Students Welfare	Hostel Assistant Warden	2	1 Male & 1 Female
	Hostel Attendant	2	1 Male & 1 Female
	Physical Instructor	1	Physical Education

8. Staff for College Library

Designation	Number
Assistant Librarian	1
Library Assistant	1
Clerk	1
Shelf Assistant	2

9. Department wise Name of Laboratories

The following can be the nomenclature of the teaching laboratories;

Sl. No.	Name of Department	Name of Laboratory
1	Food Processing Technology	Food Process Technology Lab, Food Product Development Lab, Dairy Technology Lab Meat and Fish Processing Lab, Packaging Technology Lab, Food Rheology and Sensory Lab
2	Food Safety and Quality Assurance	Food Chemistry Lab, Food Microbiology Lab Food Biotechnology Lab, Food Analytics Lab
3	Food Process Engineering	Heat and Mass Transfer Lab, Fluid Mechanics Lab' Unit Operations Lab Mechanical Workshop, Electrical and Electronics Engineering Lab, Instrumentation and Process Control Lab, Drawing Hall

Sl. No.	Name of Department	Name of Laboratory
4	Food Business Management	Language Lab Computer Lab Personality Development Lab Technology Transfer Lab/Prototype Lab
5	Food Plant Operation	Experiential Learning Units / Pilot plants

10. Land requirement : 4 ha.

11. Floor Space Requirement:

Sr.	Description	Number	Dimension (ft)
1	Dean/Principal office	01	20x40
2	Main administrative office	01	40x60
3	Head of department	05 (one for each department)	15x 20 each
4	Dept. Admin. Office	05	15x20
5	Faculty room	-	10x12 for each faculty
6	UG smart class room	04	Sitting capacity of 60
7	PG smart class room	As per requirement	
8	Examination hall	02	Sitting capacity of 120
9	Laboratories	21	30x40 each
10	Seminar room	01	Sitting capacity of 150
11	Meeting room	01	Sitting capacity of 50
12	Common room for students	02	15x 20 each
13	Auditorium	01	As per requirement
14	NCC/NSS/Student welfare office	01	15x 20 each
15	Library	01	-
16	ELP Building	02	As per the requirement of pilot plants
17	Gymnasium, indoor games, Outdoor facilities	01	-
18	Canteen	01	-
19	Toilets	Sufficient numbers	At every wing/floor
20	Parking space	As per requirement	For college and hostels
21	Hostel	2	1 for Boys 1 for Girls

Sr.	Description	Number	Dimension (ft)
22	DG set shed	As per requirement	

Vehicles -

1. Office car
2. Student Bus
3. Mobile refrigerated vehicle

12. Department wise list of Minimum Equipment/Instruments in Laboratories

1. Department of Food Process Technology

Sr.	Name of Equipment
1	Fruit/ vegetable Blancher
2	Exhaust Box
3	Retort system
4	Kettle (steam jacketed)
5	Steam generator
6	Fruit/vegetable peelers
7	Homogenizer
8	Mixers
9	Fruit cutting/ slicing machine
10	Spice mixing machine
11	Dough Mixer
12	Dough divider
13	Table Sheeter
14	Dough moulds
15	Baking oven
16	Bread slicer
17	Pasta making machine
18	Laboratory ovens
19	Cooling chamber
20	Pouch sealing machine
21	Lab Roller dryer
22	Lab Spray dryer
23	Lab Tray dryer
24	Lab Fluidized bed dryer
25	Lab Vacuum dryer
26	Lab Cabinet dryer

Sr.	Name of Equipment
27	Lab freeze dryer
28	Foam mat dryer
29	Grain dryer
30	Osmotic dryer
31	Weighing machines
32	High precision digital balance
33	Munshell colour chart
34	Lovibond tintometer
35	Hunter colour lab meter
36	Disc colour meter
37	Portable chromameter
38	Viscometer
39	Shrink wrap packaging machine
40	Form fill and sealing machine
41	Vacuum packaging machine
42	Heat sealing machine
43	Fruit/ vegetable sorter
44	Fruit/ vegetable Grader
45	Vernier callipers of different sizes
46	Colour dictionary chart for grain
47	Angle of repose unit
48	Hardness tester
49	Soxhlet apparatus
50	Kjeldhal apparatus
51	Muffle furnace
52	pH meter

Sr.	Name of Equipment
53	Refractometers for different ranges
54	Incubator
55	Germinator
56	Laboratory modern rice mill
57	Laboratory modern dhal mill
58	Flaking machine
59	Popcorn machine
60	Falling number apparatus
61	Lab oil expeller
62	Amylograph
63	Extensiongraph
64	Farinograph
65	Sieve analysis set up
66	Hammer mill
67	Modem wheat milling machine
68	Extruder
69	Meat mincer
70	Dumber and slaughtering machine
71	Defeathering machine
72	Plate freezer
73	Meat cutter/ chopper
74	Conching unit
75	Cocoa roaster
76	Cocoa tempering unit
77	Chocolate moulder
78	Rolling machine
79	S.S. utensils (pan/ fry pan/Kadhai/ spoon plates/ knife, etc)
80	Basket press
81	Screw type juice extractor
82	Centrifugal Juice extractor
83	Hydraulic press
84	Fruit Pulper/ Crusher
85	Juice dispensing machine
86	Bottle filling machine

Sr.	Name of Equipment
87	Bottle washing machine
88	Crown corking machine
89	Texture analyser
90	Gas chromatography unit
91	Respirometer
92	Sensory evaluation set
93	Milkotester
94	Gerber butyrometer
95	Cream separator
96	Butter making machine
97	Ice cream machine
98	Khoa making machine
99	Multiple effect evaporator
100	Cryoscope
101	Melting point apparatus
102	Double distillation unit
103	Scavengerapparatus
104	Polarimeter
105	Ultrafiltration system
106	Water analysis unit (kit)
107	Density meter
108	TDS meter
109	Conductivity meter
110	Nephlometric turbidity unit
111	Water baths
112	Autoclave
113	Carbonation unit
114	BOD incubators
115	Bomb calorimeter
116	Rotary Shaker
117	Puncture resistance tester
118	Bursting strength tester
119	Tearing strength tester
120	Tensile testing machine

Sr.	Name of Equipment
121	Box compression tester
122	Drop tester
123	Modified atmospheric storage
124	Water vapour transmission measuring unit
125	Oxygen transmission measuring unit
126	Super critical fluid extraction system
127	Rotary vacuum evaporator
128	Lab Aseptic processing system
129	Lab IQF system
130	Small Cold storage
131	Laboratory Fermenter
132	Microwave ovens
133	Moisture meters

2. Department of Food Process Engineering

Sr.	Name of Equipment
1	Flow over notches apparatus
2	Bernoulli's apparatus
3	Reynolds apparatus
4	Flow measurement by venturi meter and orifice meter
5	Centrifugal pump (model)
6	Reciprocating pump(model)
7	Gear pump model
8	Submersible pump
9	Positive displacement pump
10	Fluid friction measurement devices
11	Minor head loss apparatus
12	Model of Lancashire boiler
13	Model of Packaged Boiler/ model
14	Model of Babcock and Wilcox boiler
15	Vertical water tube boiler
16	Solar water heater
17	Steam jet condenser: parallel flow
18	Steam jet condenser: counter flow
19	Surface condenser

Sr.	Name of Equipment
20	Evaporative condenser
21	Shell and tube heat exchanger
22	Plate Type Heat Exchanger
23	Double pipe heat exchanger
24	Natural convection apparatus
25	Forced convection apparatus
26	Thermal conductivity apparatus for solid and liquid
27	Working model of belt conveyor
28	Working model of bucket conveyor
29	Working model of chain conveyor
30	Working model of screw conveyor
31	Universal testing machine
32	Ball fall viscometer
33	Capillary tube viscometer
34	Rotational viscometer
35	Model of multiple effect evaporator
36	Rotary vacuum flash evaporator
37	Cabinet drier
38	Screw gauges
39	Vernier calipers
40	Micrometers
41	B.O.D. incubators
42	Desiccators
43	Refrigerated centrifugal machine
44	Ultra filtration apparatus
45	Micro wave oven
46	Infra red moisture meter
47	Universal moisture meter
48	Hammer mill
49	Magnum mill
50	Colloid mill
51	Ball mill
52	Sieve analyser
53	Vapour compression refrigeration cycle

Sr.	Name of Equipment
54	Refrigeration tutor
55	Air-conditioning tutor
56	Model of ammonia ice plant
57	Model of cooling tower
58	Water baths
59	Ammeters
60	Voltmeters
61	Wattmeters
62	Wet and dry bulb thermometers
63	Hygrometers
64	Anemometer with digital display
65	Pressure measurement devices
66	Different manometers
67	U tube double column Manometer
68	Multimeters
69	Clamp-on meters
70	Portable energy meters
71	Pyranometer
72	Transducers
73	Flow meters
74	Particle size analyser
75	Dielectric Properties Analyzer
76	Microwave power leakage detector
77	Industrial PID controller and PLC units
78	Agitation and mixing system
79	Crystallizer
80	CNC lathe machine
81	Grinding machine
82	Drilling machines
83	Welding machines
84	Student drawing boards
85	Electronics engineering tutor set
86	Electrical engineering tutor set
87	Process control tutor set

3. Departments of Food Safety & Quality

Sr.	Name of Equipment
1	Different Microscopes
2	Autoclave
3	Hot Air Ovens
4	Vacuum ovens
5	Colony Counter
6	Rotary Shaker
7	Lab Centrifuge
8	Deep Freezers of different temperature ranges
9	Laminar Flow Unit
10	Water Baths
11	Oil baths
12	BOD incubators
13	Ozone washer
14	Distillation Unit
15	Lab Scale Fermentor
16	Serological water bath
17	Water distillation unit
18	Digital weighing balances
19	pH meter
20	Protein digestion unit
21	Protein distillation unit
22	Soxhlet unit
23	Desiccators
24	Digital moisture meter
25	Protein estimation assembly
26	Digital pH meter
27	Digital Thermometers
28	Muffle Furnace
29	Spectrophotometer
30	Vortex mixture
31	Colorimeter
32	Bomb calorimeter
33	Vacuum flash evaporator set

Sr.	Name of Equipment
34	Paper Chromatography set
35	Thin layer Chromatography Set
36	Paper electrophoresis unit
37	Magnetic stirrer with hot plate
38	Roto-viscometer
39	Flame photometer
40	Gas chromatography system
41	HPLC systetem
42	Refrigerated centrifuge
43	Scanning Electrons Microscope

4. Department of Food Business Management

1) A set of computer server, working nodes, printer for 25 students
2) Language lab set with audio management system for 25 students
3) LCD projectors with screens and other accessories
4) LED display systems
5) Internet connectivity with Wi-Fi component

5. Department of Plant Operations

A set of pilot plants adequately equipped as ELUs

FORESTRY

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i). UG degree: B. Sc. (Hons) Forestry

ii). PG degree: M.Sc. (Forestry) and Ph.D. (Forestry)

PG with following specializations:

S. No.	Specialization in M.Sc. / Ph.D.
1	M.Sc./P.hD. Forestry (Silviculture & Agroforestry)
2	M.Sc./P.hD. Forestry (Forest Biology & Tree Improvement)
3	M.Sc./P.hD. Forestry (Natural Resource Management)
4	M.Sc./P.hD. Forestry (Forest Products & Utilisation)
5	M.Sc./P.hD. Forestry (Wildlife Sciences)

Restructuring UG practical for increased practical contents

DEPARTMENTWISE DISTRIBUTION OF COURSES

1. Silviculture and Agroforestry (SA)

SA 1101	Introduction to Forestry	2+0
SA 1102	Dendrology	2+1
SA 1203	Theory and Practice of Silviculture	2+1
SA 2104	Principles of Agroforestry	2+1
SA 2105	Forest Mensuration	2+1
SA 2206	Forest Management	2+1
SA 2207	Silviculture of Indian Trees	2+1
SA 3108	Forest Hydrology and Watershed Management	2+1
ELU-I	Experiential Learning	0+5
SA 3209	Plantation Forestry	2+1
ELU-II	Experiential Learning	0+5

FOWE	Forestry Work Experience (Student READY, FOWE)	0+20
SA 4210	Agroforestry Systems and Management	2+1
PW	Project Work & Dissertation	0+10
	Total	**20+49=69**

2. Forest Biology and Tree Improvement (FBT)

FB 1201	**Plant Physiology**	**2+1**
FB 1202	Plant Cytology and Genetics	1+1
FB 2103	Tree Improvement	2+1
FB 2204	Seed Technology & Nursery Management	2+1
ELU I	Experiential Learning	0+5
ELU II	Experiential Learning	0+5
FOWE	Forestry Work Experience (Student READY, FOWE)	0+20
FB 4205	Forest Biotechnology	2+1
PW	Project Work & Dissertation	0+10
	Total	**9+45=54**

3. Natural Resource Management (NRM)

NR 1101	Introduction to Agronomy and Horticulture	2+1
NR 1102	Geology & Soils	2+1
NR 1203	Forest Protection	2+1
NR 2104	Environmental Studies and Disaster Management	2+1
NR 2105	Forest Survey & Engineering	2+1
NR 2106	Soil Biology & Fertility	2+1
NR 2107	Forest Ecology & Biodiversity	2+1
NR 2208	Rangeland and Livestock Management	1+1
NR 3109	Climate Science	2+1
ELU-I	Experiential Learning	0+5
NR 3210	Forest Laws, Legislation and Policies	2+0
NR 3211	Geomatics	1+2
NR 3212	Recreation & Urban Forestry	1+1
NR 3213	Restoration Ecology	1+1
ELU-II	Experiential Learning	0+5
FOWE	Forestry Work Experience (Student READY, FOWE)	0+20
NR 4214	Forest Inventory and Yield Prediction	1+1
PW	Project Work & Dissertation	0+10
	Total	**23+54=77**

4. Forest Products and Utilization (FPU)

FP1201	Wood Anatomy	2+1
FP 2202	Wood Products & Utilization	2+1
FP2203	Ethnobotany, Medicinal and Aromatic plants	2+1
FP 3104	Wood Science and Technology	2+1
FP 3105	Logging and Ergonomics	1+1
ELU -I	Experiential Learning	0+5
FP 3206	Non-Timber Forest Products	2+1
FP 3207	Certification of Forest Products	2+0
ELU -II	Experiential Learning	0+5
FOWE	Forestry Work Experience (Student READY, FOWE)	0+20
PW	Project Work & Dissertation	0+10
	Total	**13+46=59**

5. Wildlife Sciences (WLS)

WL 1201	Wildlife Biology	2+1
WL 2202	Ornithology & Herpetology	2+1
ELU-I	Experiential Learning	0+5
ELU-II	Experiential Learning	0+5
FOWE	Forestry Work Experience (Student READY, FOWE)	0+20
WL 4203	Wildlife Management	1+1
PW	Project Work & Dissertation	0+10
	Total	**5+43=48**

6. Basic and Social (BS)Science

BS 1101	Information and Communication Technology	1+1
BS 1102	Communication Skills and Personality Development	1+1
BS 1103	Plant Biochemistry	1+1
BS 1104	Forest Botany/Basic Mathematics	1+1
BS 1105	Physical Education-I	0+1*
BS 1106	NCC-I/NSS-I	0+1*
BS1207	Statistical Methods & Experimental Designs	2+1
BS 1208	Physical Education-II	0+1*
BS 1209	NCC-II/NSS-II	0+1*
BS 2110	Physical Education-III	0+1*
BS 2111	NCC-III/NSS-III	0+1*
BS 2212	Forest Tribology & Anthropology	2+0

BS 2213	Study Tour	0+1*
BS 3107	Forest Extension & Community Forestry	2+1
BS 3108	Entrepreneurship Development & Business management	1+1
BS 3109	Forest Economics and Marketing	2+1
BS 4218	Agricultural Informatics	2+1
ELU-I	Experiential Learning	0+5
ELU-II	Experiential Learning	0+5
BS 4117	All India Study Tour	0+3*
FOWE	Forestry Work Experience (Student READY, FOWE)	0+20
	Total	**15+49=64**

Experiential Learning Modules

FP	Production and Marketing of high value forest produce	0+5
SA/FB	Raising Quality Planting Materials for forest regeneration	0+5
FB/NR/WL	Apiculture/Sericulture	0+5
BS/WL	Ecotourism	0+5
WL	Wild Animal Health Management	0+5

Forestry Work Experience (FOWE)

Orientation (10 days)	0+1
Forest Range Training Programme (50 days)	0+12
Industrial placement (20 days)	0+3
Weapon Training and First-Aid Training (5+3=8 days)	0+1
Socio-economic Surveys and Village Attachment (20 days)	0+2
Report writing and presentations (12 days)	0+1

Semester-wise courses in B.Sc. (Hons) Forestry

Semester I (12+9=21 Credit Hours including 2 Non-Credit)

Sl.No.	Catalog	Course	Credit
1.	SA 1101	Introduction to Forestry	2+0
2.	SA 1102	Dendrology	2+1
3.	NR 1101	Introduction to Agronomy and Horticulture	2+1
4.	NR 1102	Geology & Soils	2+1
5.	BS 1101	Information and Communication Technology	1+1
6.	BS 1102	Comunicaion Skills and Personality Development	1+1
7.	BS 1103	Plant Biochemistry	1+1
8.	BS 1104	Forest Botany/Basic Mathematics	1+1

Sl.No.	Catalog	Course	Credit
9.	BS 1105	Physical Education-I	0+1*
10.	BS 1106	NCC-I/NSS-1	0+1*
		TOTAL	**12+9**

Semester II (13+9=22 Credit Hours including 2 Non-Credit)

1.	FB 1201	Plant Physiology	2+1
2.	FB 1202	Plant Cytology and Genetics	1+1
3.	SA 1203	Theory and Practice of Silviculture	2+1
4.	FP 1201	Wood Anatomy	2+1
5.	WL 1201	Wildlife Biology	2+1
6.	NR 1203	Forest Protection	2+1
7.	BS 1207	Statistical Methods & Experimental Designs	2+1
8.	BS 1208	Physical Education-II	0+1*
9.	BS 1209	NCC-II/NSS-II	0+1*
		TOTAL	**13+9**

Semester III (14+9=23 Credit Hours including 2 Non-Credit)

1.	NR 2104	Environmental Studies and Disaster Management	2+1
2.	NR 2105	Forest Survey & Engineering	2+1
3.	NR 2106	Soil Biology & Fertility	2+1
4.	NR 2107	Forest Ecology & Biodiversity	2+1
5.	FB 2103	Tree Improvement	2+1
6.	SA 2104	Principles of Agroforestry	2+1
7.	SA 2105	Forest Mensuration	2+1
8.	BS 2110	Physical Education-III	0+1*
9.	BS 2111	NCC-III/NSS-III	0+1*
		TOTAL	**14+9**

Semester IV (15+8=23 Credit Hours including 1 Non-Credit)

1.	SA 2206	Forest Management	2+1
2.	SA 2207	Silviculture of Indian Trees	2+1
3.	FP 2202	Wood Products & Utilization	2+1
4.	FP 2203	Ethnobotany, Medicinal and Aromatic plants	2+1
5.	WL 2202	Ornithology & Herpetology	2+1
6.	FB 2204	Seed Technology & Nursery Management	2+1

7.	NR 2208	Rangeland and Livestock Management	1+1
8.	BS 2206	Forest Tribology & Anthropology	2+0
9.	BS 2213	Study Tour of State Forest	0+1*
		TOTAL	**15+8**

Semester V (12+12=24 Credit Hours)

1.	SA 3108	Forest Hydrology and Watershed Management	2+1
2.	NR 3109	Climate Science	2+1
3.	FP 3104	Wood Science and Technology	2+1
4.	FP 3105	Logging and Ergonomics	1+1
5.	BS 3107	Forest Extension & Community Forestry	2+1
6.	BS 3108	Entrepreneurship Development & Business Management	1+1
7.	BS 3109	Forest Economics and Marketing	2+1
8.	EL-I	Experiential Learning	0+5
		TOTAL	**12+12**

Semester VI (11+11=22 Credit Hours)

1.	SA 3209	Plantation Forestry	2+1
2.	NR 3210	Forest Laws, Legislation and Policies	2+0
3.	NR 3211	Geomatics	1+2
4.	NR 3212	Recreation & Urban Forestry	1+1
5.	NR 3213	Restoration Ecology	1+1
6.	FP 3206	Non-Timber Forest Products	2+1
7.	FP3207	Certification of Forest Products	2+0
8.	EL II	Experiential Learning	0+5
		TOTAL	**11+11**

Semester VII (0+23=23 Credit Hours including 3 Non-Credit)

1.	FOWE	Forestry Work Experience	0+20
2.	BS 4117	All India Study Tour	0+3*
		TOTAL	**0+23**

Semester VIII (8+15=23 Credit Hours)

1.	NR 4214	Forest Inventory and Yield Prediction	1+1
2.	FB 4205	Forest Biotechnology	2+1
3.	SA 4210	Agroforestry Systems and Management	2+1
4.	WL 4203	Wildlife Management	1+1
5.	BS 4218	Agricultural Informatics	2+1
6.	PW	Project Work & Dissertation	0+10
		TOTAL	**8+15**
	Grand Total		**85+96=181**

Note : *Non credit courses.

Department-wise Course details

I. Silviculture and Agroforestry (SA)

a). Introduction to Forestry 2(2+0)

Theory

Forests - definitions, role, benefits - direct and indirect. History of Forestry - definitions, divisions and interrelationships. Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests - even and uneven aged stands. Forest types of India- classification. Agroforestry - farm forestry, social forestry, joint forest management - concepts, programmes and objectives. Important acts and policies related to Indian forests. Global warming - forestry options for mitigation and adaptation - carbon sequestration. Important events/dates related to forests and environment - themes and philosophy.

Introduction to world forests - geographical distribution and their classification, factors influencing global forests distribution - productivity and increment of world forests. Forest resources and forestry practices in different regions of the world - Western Europe, North America, Central Africa, Australia, Central America, Russia, Japan, and China. General problems of forest development and economy. Forest based industries in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations in forestry.

Suggested Readings

- Beazley, M. 1981. The International Book of Forest. Mitchell Beazly Publishers, London.
- Champion, H, G and Seth, S.K. 1968. Forest types of India,a revised survey of forest types of India, GOI Press,New Delhi, 404p.
- Grebner, D.L., Bettinger, P and Siry, J.P. 2012. Introduction to Forestry and Natural Resources. Academic Press. 508p (Google eBook).
- Khanna, L.S. 1989. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi, 473p.
- Mather, A.S. 1990. Global forest resources. Belhaven, London.
- Persson, R. 1992. World forest resources. Periodical experts, New Delhi.
- Westoby, J. 1991. Introduction to World Forestry. Wiley, 240p.

b). Dendrology 3(2+1)

Theory

IIntroduction – importance and scope of dendrology, Principles and systems of plant classification systems. Detailed study of Bentham and Hooker natural system, its advantages and disadvantages. Plant Nomenclature –objectives, principles and International Code of Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of bole, general form of woody trunk and deviations like buttresses, flutes, etc. Morphology and description of barks of common trees. Characteristics of blaze, bark colour, exudations etc. Morphology of leaf, different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts. Detailed study of the families- diagnose the features-floral variations–distribution and economic importance-systematic position as per Bentham &Hooker Sytem of classification-Magnoliaceae, Annonaceae, Guttiferae, Dipterocarpaceae, Malvaceae, Sterculiaceae, Tiliaceae, Rutaceae, Meliaceae, Sapindaceae, Anacardiaceae, Leguminosae, Rhizophoraceae, Combretaceae, Myrtaceae, Rubiaceae, Sapotaceae, Apocyanaceae, Bignoniaceae, Lamiaceae, Lauraceae, Euphorbiaceae, Orchidaceae, Palmae and Graminae. Brief description of the families-Bombacaceae, Santalaceae, Casuarinaceae.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. General study of herbarium. Dissection of flowers-making sketches-construction of floral diagrams of one species of the following families: Annonaceae and Guttiferae, Dipterocarpaceae and Malvaceae, Sterculiaceae and Tiliaceae, Rutaceae and Meliaceae, Sapindaceae and Anacardiaceae, Leguminosae- Papilionaceae- Mimosae–Caesalpiniaceae, Rhizophoraceae, Combretaceae, Myrtaceae, Rubiaceae, Sapotaceae, Apocyanaceae and Bignoniaceae, Lamiaceae, Euphorbiaceae, Santalaceae and Casuarinaceae, Orchidaceae, Graminae and Pinaceae.

Suggested Reading

- Ashok Kumar (2001). *Botany in Forestry and Environment*. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
- Bor N. L. (1990). *Manual of Indian Forest Botany*. Periodical Expert Book Agency. New Delhi.
- Brandis. D. Revised by R. D. Jakarti (2010). *Indian Trees.* Dehradun.
- Charles McCann. (1966). *100 Beautiful Trees of India*. D. B. Taraporevala Sons & C. Pvt. Ltd. Mumbai. (Available online PDF)
- Eric A. Bourdo Jr. (2001). *The Illustrated Books of Trees. A Visual Guide to 250 species.* Published by Salamander Books Pvt. Ltd. London. (Available online PDF)
- Father H. Santapau. (1966). *Common Trees*. (Available online PDF)
- Gurucharan Singh. (2000). *Plant Systematics*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Hardin, W., Harrar, E.S., and White, F.M. (1995) Textbook ofDendrology (8th Edition). McGraw-Hill Companies, London

- Jain S. K. and R. R. Rao. (1977). *Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers. New Delhi.
- Lawrence, G.H.M.(1967). Taxonomy of Vascular Plants. Oxford&IBH, New Delhi.
- Mishra. S.R.(2010). *Textbook of Dendrology*. Discovery Publishing House Pvt. Ltd. New Delhi.
- Naqshi. R. (1993). *An Introduction to Botanical Nomenclature*. Scientific Publishers. Jodhpur.
- Pandey S. N. and S. P. Mishra. (2008). *Taxonomy of Angiosperms*. Ane Books India, New Delhi.
- Parker. R. N. (1933). *Forty Common Indian Trees and How to know them*. (Available online PDF)
- Pradip Krishnen (2013). *Jungle Trees of Central India*. Published by Penguin Books India Pvt. Ltd. New Delhi.
- Randhawa. M. S. (1957). *Flowering Trees in India*. Sree Saraswati Press Ltd. Kolkatta.
- Rendle,A.B.(1979). Classification of flowering plants. Vol. I&ICUP–VIKAS
- Sahni. K. C. (2000). *The Book of Indian Trees*. Bombay Natural History Society. Mumbai.
- Tewari D. N. (1992). *Tropical Forestry in India*. International Book Distributors, Dehradun.

c). Theory and Practice of Silviculture 3(2+1)

Theory

Definitions: Forests and Forestry- Silviculture objectives and scope of silviculture-relation with other branches of Forestry Silvics. Site factors - climatic, edaphic, physiographic, biotic and their interactions. Trees and their distinguishing features, growth and development. Root growth-fine root/functional root production- Direct and indirect benefits- biophysical interactions- trees and buffering functions- C sequestration potential of forests. Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration-accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

Regeneration of forests – objectives - ecology of regeneration- natural, and artificial regeneration. Natural regeneration- seed production, seed dispersal, germination and establishment, requirement for natural regeneration, advance growth, coppice, root sucker, regeneration survey, natural regeneration supplemented by artificial regeneration. Artificial regeneration - object of artificial regeneration - advantages. Factors governing the choice of regeneration techniques. Tree planting- Sowing v/s planting different kinds of pits- tending and cultural operations- weeding- kinds of weeding- release operations- singling, cleaning–liberation cutting

Practical

Acquaintance with modern silvicultural tools. Visits to different forest areas/types. Study of forest composition. Visiting plantations raised by forest department, Exercise on nursery practice-seed collection, seed pre-treatment- nursery stock preparation- field preparation- marking, alignment and stacking, pit making-planting, various tending operations- weeding, cleaning, singling, pruning, pollarding, lopping, and thinning- fertilization in trees-plant protection and sanitation measures.

Suggested Reading

- Baker, F.S.1950. Principles of Silviculture, Mc Graw Hill, N.Y.
- Champion, H.G. and Trevor,G.1936. Handbook of Silviculture, Cosmo Publication, New Delhi
- Daniel, T.W., Helms,J.A., Baker, F.S. 1970. Principles of Silviculture, Mc Graw Hill, N.Y.
- Duryea, M.L. and Landis, T.D.(eds.)1984. Forest Nursery Manual: Production of bareroot seed lings. Martinus Nijhoff/Dr W. Junk Publishers. The Hague/Boston/Lancaster, 386p.
- Dwivedi. A.P. 1993. Text book of Silviculture. International Book Distributors.
- Evans, JE.1982. Plantation For estryinthe Tropics.The English Language Book Society and Clarend on Press–Oxford
- Gunter, S.,Weber, M,M Stimm, Band Mosandl, R. 2011. Silviculture inthe Tropics. Springer-Verlag- Berlin.
- Haig, I. T. Huberman, M. A. and Aung Din, U. 1986. Tropical Silviculture, Vol. I and II.
- Food andAgriculture Organization of the United Nations Rome andPeriodical Experts BookAgency, D-42, Vivek Vihar,Delhi–110032.
- Khanna, L.S.1989. Principles and Practice of Silviculture. Khanna Bandhu, 7 Tilak Marg, Dehradun
- Kostler, J.1956. Silviculture. International Book Distributors, P.O. Box4. Dehradun
- Lal, J.B.2003. Tropical Silviculture, New Imperatives: New Systems, International Book Distributors, P.O. Box 4. Dehradun
- Smith, D.M.1986. The Practice of Silviculture, Edn8. New York, John Wiley.

d). Principles of Agroforestry 3(2+1)

Theory

Overview of the Agriculture scenario – its structure and constraints. Concept of sustainable agriculture and land use management. Paradigm shift in Agriculture development- impacts of green revolution – Agrobiodiversity – significance, threats and conservation strategies. Agroforestry – definition and scope – rising demands of fuel wood, fodder and timber. Social, ecological, and economic reasons for agroforestry. History of agroforestry. Components of Agroforestry-Provisioning and regulator services of agroforestry- Nutrient cycling, Soil improvement, Increased production and productivity, Microclimate amelioration and carbon sequestration – Tree-crop interaction in agroforestry– Definition, kind of interaction – Positive interactions-complimentarity - compatibility - mutualism, commensalism - Negative interactions – allelopathy and competition-Interaction management - Aboveground and belowground interactions-Manipulation of density, space, crown and roots. Tree Management – structure and growth of trees, crown and root architecture, agroforestry practices to minimize negative interaction – coppicing, thinning, pollarding and pruning – crop planning and management –selection of suitable crops –management of nutrients, water and weeds – Classification of agroforestry systems – National Agroforestry Policy 2014—National and International organizations in Agroforestry.

Practical

Visit to social / Urban / Community forestry plantations and study their impact on socio – economic status of rural people- Traditional agroforestry systems in the country and visits to

some of the local agroforestry systems. Agroforestry systems in different agroecological zones-their structural and functional features. Visit to on farm agroforestry models. Studies on fodder banks and live fences. Studies on light and below ground interactions in agroforestry systems-MPTs and Nitrogen fixing trees in agroforestry- Studies on allelopathy- Design & Diagnostics exercise in agroforestry- Land capability classification of various topographic regions- Visit to industrial plantations.

Suggested Reading

- Huxley, P.A. 1983 (ed). Plant Research and Agroforestry, ICRAF, Nairobi, Kenya.
- Huxley, P. 1999. Tropical Agroforestry. Wiley: 384p.
- Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p
- Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi.
- Nair, P.K.R, Rao MR, and Buck, L.E (eds), 2004. New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.
- Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Nair, P.K.R. Agroforestry Systems in the Tropics. Springer. 680p.
- Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. J. Plant Nutr. Soil Sci. 172: 10–23.
- Pathak P.S. and Ram Newaj (eds.) 2003. Agroforestry: Potentials and Opportunities. Agrobios, Jodhpur.

e). Forest Mensuration 3(2+1)

Theory

Forest Mensuration - Definition and objectives - Scales of measurement- Units of measurements - Precision, bias and accuracy- Diameter and girth measurements- Breast height measurements instruments used- Measurement of height-Definitions- Methods of measurement of height-occular-non instrumental and instrumental methods- Sources of error in height measurements-leaning trees. Tree stem form-Metzgr's theory –form factor- types of form factor-form height for quotient-form class. Volume measurements of standing trees-logs-branch wood- formulae-involved Definitions - Volume tables preparation of volume tables-graphical method-regression method- Determination of growth of trees- Increment-CAI & MAI- increment percent-increment borer- Stump analysis- Stem analysis. Measurement of tree crops-objects-crop diameter-crop height-crop age-crop volume.

Practical

Determination of pace length- Measurements of diameter-girth and basal area of trees using Callipers, Tape, Ruler, Penta Prism Tree Calliper etc. Measurement of height using non instrumental method- Preparation and use of simple height measuring instruments- Christens Hypsometer-Smithies Hypsometer- Modified Smithies Hypsometer-Measurement of tree height

using instrumental methods- Abneys level- Haga altimeter- Relaskop- Clinometer- Blumeleiss Hypsometer-Laser Hypsometer- Volume determination of standing and felled trees. Exercise on Stump analysis. Exercise on stem analysis-Annual ring counting using ring borer. Preparation of volume tables- local volume table.

Suggested Reading

- Chaturvedi, A.N and L.S. Khanna. 2011. Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.
- Forest mensuration: A Handbook for Practitioners. 2006. Forestry Commission Publications. 330 pp.
- Husch, B., Beers, T.W. and Kershaw, J. J.A. 2002. Forest Mensuration (4th edition). John Wiley & Sons, Nature. 456 pp.
- Laar, V. A. and Akca, A. 2007. Forest Mensuration. Managing Forest Ecosystems. Vol.13. Springer.384pp.
- Manikandan, K. and Prabhu, S. 2012. Indian Forestry. Jain Brothers. New Delhi. 590 pp.
- West, P.W. 2009. Tree and Forest Measurement (2nd edition). Springer. 192pp.

f). Forest Management 3(2+1)

Theory

Definition, scope, objective and principles of forest management, organization of state forests-sustained yield-definition, principles and limitations. Sustainable forest management-criteria and indicators-Increasing and progressive yields-Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations-objectives and uses-forest maps and their uses. Joint forest management-concept and principles-Modern tools in forest management. Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry- Forests and man- Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups- Gender dimensions in Community forest management. Social Forestry- definition –NCA report of 1976- need and purpose- Social Forestry for – fodder production – fuel wood – leaf manure –timber production. Integrated rural development approach – with proper marketing facility – employment generation in raising, tending and harvesting of tree crops. Place of social forestry in the national forest policy of India-role of forest department.

Practical

Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan.

Suggested Reading

- Balakathiresan, S (1986).Essentials of Forest Management, Nataraj Publishers, Dehradun. Bhatta charya P.,Kandya A.K. and Krishna Kumar (2008).Joint Forest Managementin India, Aavishkar Publisher, Jaipur.
- Desai, V.(1991). Forest Managementin India–Issues and Problems. Himalaya Pub. House, Bombay. Edmunds, Dand Wollen berg, E(2003). Essentials of Forest Management, Natraj Publishers, Dehradun.
- Jerome L Cutteretal. (1983). Timber Management: A Quantitative Approach.John Wiley and Sons
- National Working Plan Code(2014). Mo EF, New Delhi. Ramprakash, (1986).Forest Management, IBD, Dehradun.
- Recknagel, Aand Bentley.J. (1988). Forest Management. IBD, Dehradun.
- Trivedi, P, Rand Sudarshan, K,N. (1996). Forest Management. Discovery publications, New Delhi.

g). Silviculture of Indian Trees 3(2+1)

Theory

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices pest and diseases and economic importance of the following tree species of India. Broadleaved species: *Tectona grandis*, *Shorea robusta, Dalbergia latifolia, Dalbergia sissoo, Anogeissus spp, Terminalia spp., Santalum album, Swietenia macrophylla, Albizia spp, Pterocarpus marsupium, Gmelina arborea, Pterocarpus santalinus, Azadirachta indica, Hopea parviflora, Lagerstroemia microcarpa,* Bamboos, reeds and rattan, *Quercus* spp. Conifers: *Abies pindrow, Picea smithiana, Cedrus deodara, Pinus roxburghii, Pinus wallichiana.* Fast growing MPTs: Tropical pines, *Eucalyptus spp, Casuarina equisetifolia, Leucaena leucocephala, Ailanthus triphysa, Grevillea robusta, Pongamia pinnata, Melia dubia, Acacia spp, Populus spp*.

Practical

Study the morphological description and field identification characteristics of trees, seeds and seedlings. Phenology, Collection of seeds. Planting and stand management practices of *Tectona grandis, Dalbergia latifolia, Santalum album, Swietenia macrophylla,* eucalypts, acacias, bamboos, fast growing MPTs etc. Study the silviculture of trees in response to light, fire, drought, frost, root suckering, coppicing and pollarding, etc. Visit various problem areas and study on species suitability. Visit forest plantations and other woodlots. Study the planting density and stand management regimes for various end uses such as timber, pulpwood, plywood, cottage industries etc.

Suggested Reading

- Bebarta, 1999. Teak: Ecology, Silviculture, Management and profitability, IBD, Dehra Dun
- Champion, H.G. and A.L. Griffith. 1989. Manual for General Silviculture for India
- ICFRE booklets on tree species

- Kadambi, K. 1993. Silviculture and Management of teak. Nataraj Publishers, Dehra Dun. p. 137.
- Lamprecht H 1989. Silviculture in the Tropics. GTZ, GmBH, FRG
- Troup, RS 1922. Silviculture of Indian Trees, Vol. 1-4, Revised and Enlarged Edition, Forest Research Institute and Colleges, Dehra Dun, 1975.
- Renuka, C., Pandalai, R.C. and Mohanan, C. 2002 Nursery and silvicultural techniques for rattan, Kerala Forest research Institute.

h). Forest Hydrology and Watershed Management 3(2+1)

Theory

Importance and scope of Hydrology. Definftions. Hydrological cycle. Energy and water balance equations precipitation- rain and snow hydrology. Interception, infiltration, evaporation and transpiration- paired water sheds, surface water, run off processes and hydrograph. Soil water energy concept, movement, availability and measurement. Watershed management- an approach for sustainable productivity-principles and practices- Methods for water conservation- water harvesting techniques. Role of trees in water conservation- natural terracing- species suitability- Recharging of water springs. Forest treatment and water yield. Application of GIS in watershed delineation.

Practical

Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Visit to forest watersheds to study the effect of forest treatment on hydrological properties. Assessemnt of the impact of watershed treatments such as afforestation/restocking, assisted regeneration etc. on the watershed functioning- field layout- regeneration assessment- interpretation of results.

Suggested Reading

- Bennet, H. H. 1965. Elements of Soil conservation. Mc Graw Hill Book Co. Inc. New York
- Dhruva Narayana V. V. 1993. Soil and Water Conservation Research in India, ICAR, New Delhi
- Dhruva Narayana V. V., G. Sastry and U. S. Patnaik. 1997. Watershed Management. Indian Council of Agricultural Research, New Delhi, 176 p
- Gurmail Singh et al., 1988. Manual of Soil and Water Conservation. Oxford IBH Publishing Co. New Delhi
- Hamilton L. S. 1983. Tropical Forested Watersheds: hydrologic and soils response to major uses or conversions. International Book Distributors, Dehra Dun
- Hamilton, L.S. (ed.). 1983. Forest and Watershed Development snd Conservation in Asia and the Pacific. International Book Distributors, Dehra Dun
- Hewlett, JD and Nutter, WL 1969. An Outline of Forest Hydrology. University of Georgia Press, Athens 132p
- Hudson, N. 1981. Soil Conservation. BT Batsford Limited, London 324 p.
- Lal R. 2000. Integrated Watershed Management in the Global Ecosystem. CRC Press, London

- Michael, A.M. 2008. Irrigation theory and practice, Vikas Publishing House Pvt Ltd. 768p
- Morgan, R.P.C. 1988. Soil Erosion and Conservation. English Language Book Society, Longman, London
- Murthy, V.N.N. 1983. Land and Water Management Engineering, Kalyani Publishers, New Delhi.
- Rama Rao, M.S.V. 1962. Soil Conservation in India, ICAR, New Delhi
- Riedl, O. and Zachar, D. 1984. Forest Amelioration. Elsevier, Amsterdam
- Satterlund, DR. 1972. Wildland Watershed Management. The Ronald Press Company, New York
- Seshagiri Rao, K. V. 2000. Watersheds, Comprehensive Development. B. S. Publications, Hyderabad
- USDA 1961. A Manual on Conservation of Soil and Water. Oxford and IBH Publishing Company

i.) Plantation Forestry 3(2+1)

Theory

Plantations-definition and scope. History of plantations, Development of plantation forestry, Plantation organization and structure, Land and plantation development. Plantation planning-National and regional planning-project appraisal and project implementation– feasibility studies. Plantation silviculture - Choice of species- Plantation establishment- Plantation maintenance-Nutrition in plantations- use of fertilizers- Major pest and disease in plantations- sanitation and control measures. Dynamics of stand growth- CCF-MCA- stand density management in plantations- Thinning regimes- improvement fellings, Site quality evaluation, stand basal area- site index concept in plantation forestry- plantation productivity assessment- growing stock assessment- MAI, sustainability of plantations. Plantation records- plantation journal. Industrial plantations- paper and pulp wood- match wood, plywood plantations- Plantations yielding NTFPs- Energy plantation- high density short rotation plantations- petro crops- avenue plantations- Plantations as potential carbon sinks carbon sinks- Economic factors in plantation development- social and cultural considerations.

Practical

Study the tools and materials for plantation establishment- Visit small and large plantations-study their management and functioning- Exposure to plantation project preparation- economic evaluation and feasibility studies of plantation projects. Study of planting operations- study of tending techniques- Planting methods and techniques fo different types of plantations including energy plantations, canal bank plantations - pulp wood plantations- study of Forest Development Corporation plantations-road side plantations plantation planning- Plantation journal- Choice of species for plantations-economic considerations in plantation- Study of govt vs. pvt. Plantations.

Suggested Reading

- Bowen, G.D., E. K. S. Nambiar, E.K.S 1984. Nutrition on Plantation Forests. Academic Press, 1984 -Nature - 516 pages
- Evans, J. 1992. Plantation Forestry in the Tropics, 2nd edition. Oxford, UK, Clarendon Press.

- Evans, J. and Turnbull, J.W. 2004. Plantation Forestry in the Tropics: The Role, Silviculture and Use of Planted Forests for Industrial, Social, Environmental and Agroforestry Purposes. OUP Oxford, 467p.
- Krishnapillay.B. 2000. Silviculture and Management of teak plantations. Unasylva. 201. Vol 51. 14-21p
- Nambiar, E.K.S. and Brown, A.G. 1997. Management of Soil, Nutrients and Water in Tropical Plantation Forests. Australian Centre for Internat. Agricultural Research. 571p.
- Nambiar, E.K.S., Cossalter, C and Tiarks.A. 1998. Site Management and Productivity in Tropical Plantation Forests. Workshop Proceedings, South Africa.
- Suzuki, K., Ishii, K., Sakurai, S. and Sasaki, S. 2006. Plantation Forestry in the Tropics. Springer Tokyo.

j.) Agroforestry Systems and Management 3(2+1)

Theory

Land use and land capability classification- overview of agroforestry around the world – agroforestry systems in India. Classification of agroforestry systems – structural, functional, agroecological, socio-economic and physiognomic basis. Agrosilvicultural systems – Improved fallows in shifting cultivation – soil dynamics in shifting cultivation – Taungya systems – Alley cropping –structural and functional attributes. Multipurpose trees and shrubs on farmlands, agricultural fields- Plantation crop combinations- commercial crops under shade of planted trees and natural forests- Windbreaks & Shelterbelts. Silvopastoral systems – protein banks, Live fence of fodder trees and hedges, trees and shrubs in pastures. Pastoral silviculture systems- grassland and tree management in the humid, arid and semi- arid regions. Agrosilvopastoral systems – tropical home gardens –structural and functional attributes. Other systems – apiculture, sericulture and mixed woodlots. Major Agroforestry practices in different agroecological zones of India- arid and semi arid regions- agroforestry practices for wasteland reclamation. Agroforestry practices for salt affected soils – Agroforestry practices for wetlands and waterlogged areas. Non-wood forest products based agroforestry – Soil fertility improvement and water conservation through agroforestry. Socio-economic analysis of various agroforestry systems.

Practical

Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes. Assessment of standing stock of tree species in various agroforestry systems such as homegardens. Survey of agroforestry practices in local/adjoining areas. Field observations to characterize the structural, functional and economic attributes of the following agroforestry systems and practices- agrosilviculture systems, silvopastoral systems, pastoral silviculture systems, agrosilvopastoral systems, shelterbelts and windbreaks, live fences; fodder trees and protein banks. Exercise on Diagnosis and Design of agroforestry systems and practices. Assessment of productivity of tree crop combinations. Studying resource partitioning in agroforestry systems - water, light and nutrients. Analysis of soil and plant samples for organic carbon N, P and K.

Suggested Reading

- Huxley, PA 1983 (ed). *Plant Research and Agroforestry*, ICRAF, Nairobi, Kenya.

- Huxley, P. 1999. Tropical Agroforestry. Wiley: 384p.
- Kumar, B. and Nair, P.K.R. (eds). 2006. *Tropical Homegardens*: A Time-Tested Example of Sustainable Agroforestry. Volume 3 in the Book Series "Advances in Agroforestry". Springer Science, the Netherlands
- Kumar, B.M. 2011. Species richness and aboveground carbon stocks in the homegardens of central Kerala, India. Agriculture, Ecosystems and Environment. 140: 430–440
- Kumar, B.M. and Nair, P.K.R. 2004. The enigma of tropical homegardens. 2004. Agroforestry Systems. 61: 135–152.
- Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p
- Michael P. 1984. *Ecological Methods for Field and Laboratory Investigations*. Tata McGraw-Hill Pub. Co. New Delhi.
- Mohan, S., Nair, P.K.R., Long, A.J. 2007. An Assessment of Ecological Diversity in Homegardens: A Case Study from Kerala State, India. Journal of Sustainable Agriculture. Volume 29, Issue 4: 135-153.
- Nair, P.K.R, Rao MR, and Buck LE (eds), 2004. *New Vistas in Agroforestry*: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.
- Nair, PKR 1993. *An Introduction to Agroforestry*. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Nair, P.K.R. Agroforestry Systems in the Tropics. Springer. 680p.
- Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. J. Plant Nutr. Soil Sci. 172: 10–23.
- Pathak P.S. and Ram Newaj (eds.) 2003. *Agroforestry: Potentials and Opportunities*. Agrobios, Jodhpur.

II. Forest Biology and Tree Improvement (FB)

a.) Plant Physiology 3(2+1)

Theory

Introduction to tree physiology. Photosynthesis - C3, C4 and CAM plants - Photorespiration - Factors affecting photosynthesis. Respiration - energetics of dark respiration. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology stomatal conductance – resistance. Mineral nutrition macromicro nutrients Arnon's criteria of essentiality – deficiency. Plant growth regulators – classification. Tree structure, Growth and development growth kinetics. Growth regulation and co-ordination- Plant growth analysis Canopy architecture. Forest Biomes. Light interactions models of forest canopies - Sun plants and shade plants shade tolerance. Temperature temperature influence on forest development energy budgets low and high temperature - Physiological adaptations for high temperature chilling injury. Water stress - Mechanism of drought tolerance and drought resistances - Physiological basis of drought avoidance and tolerance. Water relations of forest trees – Transpiration from forest canopies – Evapotranspiration models of forest stands - Water use efficiency of forest stands. Salinity stress its effects on tree growth. Resistance to salinity. Forest and microclimate . Carbon

balance and dry matter production in forest trees - Dry matter production and partitioning – source/ sink - . GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S.

Practical

Preparation of solutions. C3 and C4 leaf anatomy. Estimation of transpiration using porometer. Estimation of photosynthesis using IRGA. Extraction and estimation of chlorophyll in plants. Estimation of stomatal index. Demonstration of plasmolysis. Estimation of water potential in plants using Plant water status console. Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, and LAR specific leaf area and leaf weight ratio LAI CGR – LAD etc… Measurement of moisture stress tolerance parameters in trees - membrane stability, chlorophyll stability, proline content, wax and cuticle thickness. Measurement of relative water content, leaf water potential, osmotic potential. Measurements of stomatal resistance/stomatal conductance under varying stress condition. Observation on tree architecture of important species

Suggested Reading

- Hopkins, W.G. and Huner, N.P.A. (2008) Introduction to plant physiology. Wiley.
- Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York
- Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Springer Science & Business Media
- Lambert, Chapin, F.S. and Pons, T.L. (1998). Plant Physiological Ecology. Springer Scientific+ Business Media inc. Newyork.
- Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London
- Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Managment. Academic Press Inc., London.
- Nobel P. S. (2005). Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, Amsterdam
- Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd. Singapore.
- Taiz, L. and Zeiger, E. (2010) 5th edition Plant Physiology. Sinauer Associates, Inc., Massachusetts

b.) Plant Cytology and Genetics 2(1+1)

Theory

History of genetics. Mendel's principles of inheritance – segregation – independent assortment. Cell – structure and functions. Cell organelles. Cell reproduction – mitosis – meiosis and its significance. Chromosome theory of inheritance. Modification to Mendelian inheritance – multiple alleles – codominance – gene interaction – epistasis –pleotrophy – polygenic inheritance – penetrance and expressivity – cytoplasmic inheritance. Linkage and crossing over – cytological consequence of crossing over. Detection of linkage and linkage maps. Chromosomal aberrations-numerical and structural. Structure of DNA and types and its replication. Chromosomes – its structure and function. Fine structure of gene; Gene expression and their functions. RNA its structure function and types. Gene action – protein synthesis. Mutation, its classification and uses.

Practical

Study of fixatives and stains. Preparation of slides showing various stages of mitosis. Preparation of slides showing various stages of meiosis. Working out problems related to monohybrid cross, dihybrid cross, independent assortment, linkage, gene mapping, probability and chi-square, multiple alleles etc.

Suggested Reading:

- Fletcher, H. and Hickey, I. (2012). Genetics. Garland Science,
- Garner, E. J., Simmons, M. J. and Sunstad, P. D. (2008). Principles of Genetics (8th edn.). Wiley India (P.) Ltd., Daryaganj, New Delhi.
- Gupta P. K. (1999). Cytogenetics Rastogi Publishers, Meerut
- Strickberger, M.W. (1996). Genetics (3rd edn.). Mac Millan Publishing Co., New Delhi
- Tamarin, R. (2002). Principles of Genetic (7th Ed). Tata McGraw-Hill Education.
- White, T.L., Adams, W.T., and Neale, D.B. (2007). Forest Genetics. CABI

c.) Tree Improvement 3(2+1)

Theory

Introduction – history and development of tree improvement – its relation to other disciplines of forestry. Reproduction in forest trees. Anthesis and pollination – their importance in tree breeding. Incompatibility and sterility. Quantitative inheritance. Relevance in forestry. Genetic, environmental and interaction components of varitation - heritability and genetic advance. Genetic basis of tree breeding. Natural variability in trees – types and importance.- forces that change variability. Exotic forestry. Provenance testing. Selection- seed production areas–seed orchards. Progeny trial and improvement of seed orchards. Combining ability and genetic gain – Hybridization in trees – back cross breeding, heterosis breeding. Breeding for resistance to insect pest's diseases, air pollution and for wood properties. Vegetative propagation and clonal forestry. Conservation of forest tree germplasm. Recent techniques in tree improvement.

Mutation breeding; Ploidy breeding. Breeding objectives and concepts of breeding in self polinated, cross pollinated and vegetatively propagated crops. Breeding of important tree species. Breeding procedures for development of hybrids, / varieties of various crops. DUS testing, Concepts of Geographical indications. Artificial hybrids in trees-crossing in trees-problems and perspectives-crossing hybrids and hybrid breakdown. Hybrid nomenclature in trees- Future of hybrid in applied tree improvement.

Practical

Floral biology and phonological observations in some important species. Pollen morphology. Estimation of pollen sterility and viability. Emasculation and hybridization in forest tree species. Different breeding methods – flow chart. Recording observations in provenence trial. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus tree selection – recording data – design and observation in teak, eucalyptus seed orchard.

Suggested Reading:

- Allied T.L. White and Adams (2010). Forest Genetics.Bedell P. E. (2007). Tree Breeding for Genetic Improvement of Tropical Tree Species (1st Ed).
- Surendran, C., Sehgal, R.N. and Parmathma, M. (Eds.) (2003). A text book of Forest Tree Breeding. ICAR, New Delhi.
- Wright, J. (2012). Introduction to Forest Genetics. Elsevier.
- Zobel, B. and Talbert, J. (2003). Applied Forest Tree Improvement. Blackburn Press.

d.) Seed Technology & Nursery Management 3(2+1)

Theory

Importance of seed in present day forestry, seed and fruit development, seed dispersal. Planning seed collection-Collection of immature fruits - Methods of seed collection. Fruit and seed handling - maintaining viability and identity- special precautions for recalcitrant seeds. Seed processing- operations prior to extraction-pre-cleaning, methods of extraction- operations after extraction- cleaning, grading and control of moisture level- factors affecting drying of orthodox seeds. Seed storage- definition- purpose, recalcitrant seeds- Harrington's rule of thumb, seed maturity- parental and annual effects. Storage condition and ageing of seeds. Storage methods - Storage containers. Seed dormancy- types of dormancy, treatments for breaking exogenous and endogenous dormancy. Seed dressing and pelleting. Seed testing - definition- ISTA rules. Sampling- seed weight- moisture- authenticity- seed health. Germination testing- germination equipment- conditions for selected species. Germination evaluation- germination testing in nursery. Indirect tests of viability. Seed Act and Seed Certification. Introduction and scope of Forest nursery. Nursery establishment - site selection – planning, and layout of nursery area. Types of forest nursery, types of nursery beds, preparation of beds, fumigation. Methods of seed sowing and mulching, seedling growth and development, pricking, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Containerised nursery technique - advantages, disadvantages - root deformations - container designs and types/root trainers and rooting media. Conditions/practices affecting survival and early growth, acclimating containerised stock, field handling of containerised stock, planting techniques for containerized stock. Planting bare-root seedlings: advantages, disadvantages. Methods for field handling and planting bare-root stock. Containerised nursery technique- Type and size of containers. Merits and demerits of containerized nursery. Root trainer techniques- Preparation of ingredient mixture. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept.

Practical

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; Study of seed collection and equipments; Planning of seed collection; Seed collection; Seed extraction; Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments. Preparation of

production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium, and large sized seeds. Mother beds and transplant bed preparation- Pricking and transplanting of in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers. Visit to tree nurseries.

Suggested Reading

- Agrawal, R.L. 1986. Seed Technology. Oxford - IBH Publishing Co. New Delhi
- Ahuja, P.S. et al. 1989. Towards developing "Artificial Seeds" by shoot and root encapsulation. In: Tissue Culture and Biotechnology of Medicinal and Aromatic Plants. CIMAP, Lucknow, India, P. 22-28.
- Bewely, J.D and Black, M. 1985. Seed- Physiology of development and germination
- Bose, T.K; Mitra, S.K. and Sadhu, M.K. 1986 Propagation of tropical and sub tropical Horticultural crops. Naya Prakash, Calcutta
- Chin, H.F. and Roberts, E.H. 1980. Recalcitrant Crop Seeds. Tropical Press Sdn. Bhd. Kuala Lumpur - 22-03, Malaysia
- Duryea, M.L. and Landis, T. D. (eds.) 1984. Forest Nursery Manual: Production of Bareroot Seedlings. Martinus Nijhoff/ Dr. W. Junk Publishers, The Hague/Boston/Lancaster for Forest Research Laboratory, Oregon State University, Corvallis, 386 p.
- Evans, J. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Claredon Press - Oxford. 472p.
- Hartmann, H.T and Kester, D.E. 1968. Plant propagation – principles and practice prentice – Hall of India Private Limited, New Delhi.
- ISTA. 1993. International Rules for Seed Testing Rules. International Seed Testing Association, Zurich, Switzerland, 1993.
- Khullar, P. et. al. 1992. Forest Seed. ICFRE, New Forest, Dehra Dun
- Leadem, C.L. 1984. Quick Tests for Tree Seed Viability. B.C. Ministry of Forests and Lands, Canada.
- Liegel, L.H. and Venator, R. 1987. A Technical Guide for Forest Nursery Management in the Carribean and Latin America. Gen. Tech. Rep. SO-67, New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 156p.
- May, J.T., Belcher, Jr. E. W., Cordell, C.E., Filer, Jr. T. H., David South, and Lantz. C. W. 1985. Southern Pine Nursery Handbook,USDA Forest Service, Southern Region, Cooperative Forestry
- Mehta, A.R and Bhatt, P.N. 1990. Hand book of plant tissue and all cultures. Academic book centre, Ahmedabad
- Napier, I. and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal-UK Forestry Research Project, Kathmandu
- Prakash, R. 1990. Propagation Practices of Important Indian Trees. International Book Distributors, Dehra Dun.
- Schmidt, L. 2000. Guide to Handling Tropical and Subtropical Forest Seed. Danida

e.) Forest Biotechnology 3(2+1)

Theory

Concepts and history of Plant Biotechnology: Scope and importance in tree Improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of in-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in tree improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants. their applications , achievements and biosafety regulations, Blotting techniques – DNA finger printing and bar coding – DNA based markers – RFLP, AFLP, RAPD, SSR , VNTRS,CAPS, SNPs, ESTs and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in tree improvement.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis technique

Suggested Reading

- Bajaj, Y.P.S. (Ed) (1988). Biotechnology in Agriculture and Forestry 2. Crops 1. Springer-Verlag, Berlin.
- Dhawan, V (2012) Applications of Biotechnology in Forestry and Horticulture. Springer US
- Guptha, P.K. (2000). Elements of Biotechnology. Rastogi publications, Meerut.
- Neumann, K.H., Kumar, A., and Sopory, S.K. (2008) Recent Advances in Plant Biotechnology and Its Applications. I. K. International Pvt Ltd
- Punia, M.S. (1998). Plant Biotechnology and Molecular Biology. A laboratory manual. Scientific Publishers, Jodhpur
- Thieman, W.J. and Palladino, M.A. (2009). Introduction to Biotechnology, Second Edition. Pearson Benjamin Cummings, San Fransis

III. Natural Resource Management (NR)

a.) Introduction to Agronomy and Horticulture 3(2+1)

Theory

Agronomy, scope and its role in crop production-Major Field crops of India – classification, area, distribution and productivity of major Field crops. Farming and cropping systems –

mono, sole and multiple cropping, relay, sequential and inter cropping. Tillage- definition-objectives – types of tillage- tillage implements – tilth - characteristics of good tilth - Soil productivity and fertility- Crop nutrition – nutrients –classification – Nutrient sources-organic manures –fertilizers – biofertilizers- Integrated Nutrient Management-Importance of water in plant growth- Soil properties influencing moisture availability – texture, structure and organic matter status-Irrigation and drainage. Weed control – definition and characteristics of weeds, classification of weeds – damages due to weeds - benefits of weeds. -Control vs prevention of weeds – methods of weed control-Classification of herbicides–Integrated weed management. Soil and its management-Definitions and importance of horticulture- Economic importance and classification of horticultural crops and their culture and nutritive value- area and production- exports and imports- fruit, vegetables, plantation and spice crops-soil and climate–principles-planning and layout- management of orchards- planting systems and planting densities- Principles and methods of pruning and training of fruit, plantation crops-use of growth regulators in horticulture crops-Horticultural zones of state and country.

Practical

Identification of field crop and tillage implements. Preparation of seed beds, identification of fertilizers and manures – mixing chemical fertilizers – calculating fertilizer requirements. Identification of green manure plants. Identification of important weeds of the region with particular reference to forest plantations. Preparation of weed herbarium. Calculations of spray volume and herbicide concentrations. Methods of application of herbicides. Identification of horticultural crops-garden tools and implements. planning and layout of orchard and plantations. Digging and filling of pits for fruit and plantation crops-planting systems, training and pruning of orchard trees-preparation and application of regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits-bearing habits and maturity standards, harvesting, grading, packaging and storage.

SuggestedReading

- Agrawal, R.L.1980. Seed technology. Oxford & IBH Publishing Co., New Delhi
- Balasu bramaniyan, P and Palaniap pan, S.P. 2001. Principles and Practices of Agronomy. Agro Bios (India)Ltd., Jodhpur.
- Bose, T.K. 1985. Fruits of India- Tropical and subtropical. Naya Prakash, Calcutta
- Brady, N.C. and Well, R.R.2002. The Nature and Properties of Soils (13th ed.). Pearson Education, Delhi.
- De, G.C.1989. Funda mentals of Agronomy. Oxford & IBH Publishing Co., New Delhi
- Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. Soil Fertility and Fertilizers: An Introduction to Nutrient Management(7th ed.). Pearson Education, Delhi.
- ICAR.2006. Hand book of Agriculture, ICAR, New Delhi.
- Nair, P.K.R.1979. Intensive multiple cropping with co conuts in India. Verlag Paul Pary, Berlin
- Palaniappan, S.P. 1988. Cropping systems in the tropics - Principles and management. Wiley Eastern Limited, New Delhi
- Randhawa, M.S.1982. History of agriculturein India,VolI, II&III. ICAR, New Delhi
- Reddy. T.Yand Reddy, G.H.S.1995. Principles of Agronomy, Kalyani Publishers, Ludhiana.

- Reddy, S.R.1999. Principles of Agronomy, Kalyani Publishers, Ludhiana.
- Sankaran, S. and Subbiah Mudaliar, V.T. 1991. Principles of Agronomy. The Bangalore Printing & Publishing Co., Bangalore
- Tisdale, S.L. etal.1985.Soil fertility and fertilizers. Macmillan Pub.Co., New York

b). Geology and Soils 3(2+1)

Theory

Introduction to geology - its significance, composition of earth's crust, soil as a natural body - major components by volume. Pedology -rocks- types – igneous, sedimentary and metamorphic, classification - soil forming minerals - definition, classification-silicates, oxides, carbonates, sulphides, phosphates-occurrence. Weathering of rocks and minerals -weathering factors -physical-chemical-biological agents involved, weathering indices. Factors of soil formation-parent material, climate, organism, relief, time. Soil forming processes-eluviations and illuviation, formation of various soils. Physical parameters- texture-definition, methods of textural analysis, Stokes law, textural classes, use of textural triangle, absolute specific gravity-definition apparent specific gravity/bulk density-factors influencing-field bulk density, relation between bulk density-particle density. Pore space-definition-factors affecting capillary and non capillary porosity- soil colour-definition-its significance - colour variable-hue, value, chroma, Munsell colour chart-factors influencing-parent material-soil moisture-organic matter. Soil structure-definition-classification-clay- prism like structure-factors influencing genesis of soil structure, soil consistency, plasticity-Atterberg's constants. Soil air-composition, factors influencing-amount of air space. Soil temperature-sources and distribution of heat-factors influencing-measurement. Chemical properties -soil colloids organic- humus-inorganic-secondary silicate-clay-hydrous oxides. Soil organic matter decomposition - concept of pH - soil acidity -nutrient availability-soil buffering capacity – a brief overview of saline, sodic and calcareous soils. Soil water-forms-hygroscopic, capillary and gravitational-soil moisture constants-hygroscopic coefficient-wilting point-field capacity-moisture equivalent, maximum water holding capacity, energy concepts-pF scale measurement-gravimetric-electric and tensiometer methods-pressure plate and pressure membrane apparatus-Neutron probe-soil water movement-saturated and unsaturated infiltration and percolation. Elementary knowledge of soil classification – soil orders. Forest soils-characteristics- distinguishing features- changes in physical and chemical properties compared to agricultural soils.

Practical

Identification of rocks and minerals; Collection and preparation of soil samples; Soil analyses for moisture, colour, bulk density, organic matter, pH, EC; Textural analysis by hydrometer method; Study of soil profile; Study tour for identification of rocks and minerals and profile studies; Practicals on introduction to Tensiometer, pressure plate and neutron probe etc.

Suggested Reading

- Biswas, T.D. and Mukherjee, S. K. 1987. Test Book of Soil Science,Tata McGraw Hill Publishing Co., New Delhi
- Brady, N. C. 1990. Nature and Properties of Soils. 10th ed., Macmillan Publishing Co. Inc., New York

- Foth, H.D. and Turk, L. M. 1972. Fundamental of Soil Science. 5th edn. Wiley Eastern Pvt. Ltd., New Delhi
- Gupta, P,K. 2007.Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodpur
- Indian society of soil science (ISSS). 2002. Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi
- Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edn. Kalyani Publishers, Ludhiyana
- Pritchett and Fisher R, F. 1987. Properties and Management of Forest Soils. John Wiley, New York.

c). Forest Protection 3(2+1)

Theory

Introduction – Importance of protection in Indian Forestry – classification of injurious agencies. Injury to forest due to fires, causes and character of forest fires – fire prevention activity – fire suppression – fire fighting equipments – fire control policy and objectives. Fire fighting in other countries. Injury to forest due to man, lopping – cutting for fuel wood – Encroachment- different types, control of encroachment illegal felling of trees- method of control legislation. Forest weeds and weed management, management of woody climbers, parasites and epiphytes.

Importance of Forest Pathology, tree disease classification, Principles of tree disease management, - Causes and symptoms- losses due to forest tree diseases, root diseases (wilt, root- and butt rot), stem diseases (heart rots, stem blisters, rusts, stem wilt, cankers, pink diseases, gummosis, water blister) and foliar diseases (rust, powdery mildew, leaf spot, leaf and twig blight, abnormal leaf fall, needle blight etc.) Etiology, symptoms, mode of spread, epidemiology and management, including chemical, biological, cultural and silvicultural practices. Nursery diseases and their management. Disease due to physiological causes. Abiotic diseases.

Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest and Plantation forest species. Insect pests of freshly felled trees, finished timbers and their management.

Practical

Visit to forest areas with fire damages, Studying fire registers as records, studying encroachments and problems caused due to disturbance-visit to illegally felled areas- Visit to fire station, Study and acquaint with machinery used for fire control, identification of weeds, parasites and epiphytes. Observation of symptoms in laboratory and in forests - examination of scrapings - host-parasite relationships - causal organisms of above forest diseases. Examination of cultures of important pathogens. Visit to nurseries and plantations. Insect pests of forest seeds; forest nurseries; standing trees; freshly felled trees and finished products. Survey and identification of invertebrate fauna from forest areas. Methods of isolating soil invertebrate macro and micro fauna. Insecticides and their formulations, plant protection appliances.

Suggested Reading:

- Agrios, G.N. (1997). Plant Pathology. 4thEdn, Horcourt Asia Pvt. Ltd., Singapore.
- Bakshi, B.K. (1976), Forest Pathology; Principles and Practices in Forestry. Pub. Comptroller of Publications, Delhi. 400p.
- Basher, A.E.S. (1983).Forest Fires and Their Control. Gulab Primlani Amerind Publishing, New
- Boyce, J.S. (1961). Forest Pathology, 3rd edition. McGraw-Hill. New York, New York. 572 pp
- Brown, A.A and Davis, K.P. (1973). Forest Fire Control and Use. Mc Graw Hill Book Co. New York. Delhi.159p.
- Devasahayam, H.L. and Henry, L.D.C. (2009). Illustrated Plant Pathology- Basic Concepts. New India Publishing Agency
- Elton, C. S. (2000). The Ecology of Invasions by Animals and Plants. University of Chicago Press.
- Fuller, M. (1991). Forest Fires. Wiley Nature Editions, New York.
- Ghadekar, S.R. (2003) Meteorology. Agromet Publishers, Nagpur
- Hal, R.B. (1990). Principles and Procedure of Range Management. International Book Distributors, Dehra Dun.
- Johnson, A.E and Miyanishi, K. (2001). Forest Fires: Behavior and Ecological Effects. Academic Press.
- Khanna, L.S. (1988). Forest Protection. Khanna Bandhu, Dehradun.206p.
- Lenka, D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi
- Luna, R.K. (2007). Principles and Practices of Forest Fire Control.International Book Distributors, Dehradun.466p.
- Mavi, H.S. (1994) Agrometerology. Oxford &IBH, New Delhi
- Mohanan, C. (2011). Macro fungi of Kerala, KFRI, Peechi.p.597
- Negi, S.S. (1999). Handbook of Forest Protection. International Book Distributors.271p.
- Pathak, V.N., Khatri, N.K. and Manish Pathak. (2000). Fundamentals of Plant Pathology. Eds. Agribios (India), Jodpur. 356 p.
- Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,
- Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg
- Singh, R.S (2002).Introduction Principles of Plant Pathology. Oxford & IBH, New Delhi
- Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR, New Delhi

d). Environmental Studies and Disaster Management 3(2+1)

Theory

Environmental studies Definition, scope and importance, Natural Resources, Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Ecosystems-Concept of an ecosystem, Structure and function of an ecosystem, Biodiversity and its conservation, Value, Environmental Pollution, Solid Waste Management, Social Issues, Environmental ethics, Wasteland reclamation, Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection

Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation.Public awareness, Environment and human health, Women and Child Welfare, Natural Disasters, Climatic change, Man Made Disasters, Disaster Management

Practical

Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, Study and documentation of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Suggested Reading:

- Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. Coping with catastrophe. Handbook of Disaster Management. Routledge.
- Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

e). Forest Survey & Engineering 3(2+1)

Theory

Forest survey, scope and types of surveying, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chain of sloppy grounds, chaining across obstacles; cross staff surveying, Areas of irregularly bounded fields- different methods; Simpson's, trapezoidal rule; compass surveying, chain and compass traversing, magnetic and true bearing, prismatic compass, local attraction. Computation of interior angles and balancing of closed traverse. Plane table surveying; plane table and its accessories, methods of plane table surveying. Leveling: terms used types of level. Theodolite and its uses. Contour surveying buildings materials- types, strength and characteristics, site selection for building construction, forest roads- alignment, construction and drainage; retaining walls, breast wall, water ways and culverts; bridges-types, selection of site, simple wooden beam bridge, check dams, spurs, farm ponds, earth dams.

Practical

Chain surveying, compass traversing; plane table surveying, leveling, calculations of earth work for construction of forest; roads & earth dams; alignment of forest roads; preparation building plans; design of water ways; design of simple wooden beam bridge; design of retaining walls. Design of check dams.

Suggested Reading

- Kanetkar, T.P. and Kulkarni, S.V. (1989). Surveying and levelling. Vidyarthi Griha Prakashan, Pune.
- Masani, N.J. (2006). Forest Engineering -without tears (2nd edition). Natraj Publishers, Dehra Dun.
- Murthy, V.V.N. (1985). Land and water management engineering. Kalyani Publishers, New Delhi.

- Parkash, R. (1983). Forest Surveying, International Book Distributor
- Punnia, B.G. (1987). Surveying Vol I. Laxmi Publishers, New Delhi.
- Sahani, P.B. (1979). Text Book of Surveying Vol. I & II. Oxford and IBH, New Delhi.

f) . Soil Biology & Fertility 3(2+1)

Theory

Introduction - forest soils vs. cultivated soils, special features of forest soils, forest soil formation and vegetation development. Pedogenic processes – Podzolization and Laterization. Properties of soils under different forest ecosystems. Forest floor – stratification – types of humus. Essential nutrient elements-occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N, P and K, macro and micronutrient fertilizers and their uses. Forest soil - biology-distribution of various microorganisms in soil ecosystem and their interaction effects. Role of microorganisms in soil fertility. Mineral transformations-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers – their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N2 fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur, and micronutrients. Mycorrhizae: types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllosphere concept. Fertility management of forest soils. Integrated nutrient management in plantation forestry.

Practical

Study of forest soil profile; Estimation of pH and EC –Organic carbon – available N, P, K, Ca, Mg, S and micronutrients – Determination of CEC and exchangeable cations; Interpretation of soil and plant analysis data for fertilizer recommendation. Basic sterilization techniques; culturing and maintenance of micro organism occurring in soil; Staining methods; Study of decomposition of forest litter by CO_2 – evolution method; Estimation of nitrification rate in soil; Isolation of legume bacteria and Azotobacter; Preparation and inoculation techniques for mycorrhizae and biofertilizers.

Suggested Reading

- Brady, NC. The Nature and Properties of Soils. Mac Millan Pub. Comp. New York.
- Burges, A. and Raw, F. 1967. Soil Biology. Acad. Press, New York
- Mengel, K. and Kirkby, A. 1978. Principles of Plant Nutrition. International Potash Institute, Switzerland
- Pritchett and Fisher RF 1987. Properties and Management of Forest Soils. John Wiley, New York.
- Tisdale, L. S. Nelson, L.W. and Beaton, J. D. 1985. Soil Fertility and Fertilisers. Macmillan Publishing Company, New York
- Young, A. 1989. Agroforestry for Soil Conservation. CAB International, U.K.

g). Forest Ecology and Biodiversity 3(2+1)

Theory

Historical development of ecology as a science. Levels of biological organization. Major forest Ecosystem. Forest environment- major abiotic and biotic components and their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology- species interactions, ecological succession, terminology, basic concepts, theories of succession- climax vegetation types, forest management and succession. Island Biogeography. Autecology of important tree species. Perturbation ecology- Biodiversity and conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices. Principles of conservation biology, Ex-situ and In-situ methods of conservation, Genetic and evolutionary principles in conservation. Biosphere concept. Conservation – efforts in India and worldwide.

Practical

Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Study of succession in field and water bodies; Visit to different ecosystems.

Suggested Reading

- Odum EP 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p
- Misra KC 1974. Manual of Plant Ecology. Oxford &IBH Pub Co. New Delhi etc. 491p
- Michael P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi, 404p
- Montagnini, F and Jordan, C.F. 2005. Tropical Forest Ecology: The Basis for Conservation and Management. Springer. 295p.
- Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press. Cambridge. 299p
- Sagwal, S.S. 1995. Forest Ecology of India. Pioneer Publishers, India. 368p

h). Rangeland and Livestock Management 2(1+1)

Theory

Definition, scope and importance – cattle and fodder resources of India, grassland types of India and their distribution – ecological status of Indian grasslands – principles of grassland management for maximizing forage yield and quality. Feeding habit and grazing behavior of range animals. Carrying capacity – definition, method of calculation. Establishment and management of grasslands – selection of species, planting, cultural practices – liming, fertilizer application, burning, weed control, grazing and cutting intensity. Storage of fodder – silage and hay – methods of preparation – hay banks, Fodder trees and shrubs, Forest grazing.

Definition and importance of Livestock management. Important breeds of important livestock eg. Cattle, buffalo, sheep and goat. Breeding and reproductive management for higher productivity. Feeding management – types of feedstuffs available for feeding livestock, methods of feeding. Assessing nutritive value of feed and fodder, estimation of digestible nutrients and energy in feedstuffs. Principles of rationing. Prevention and control of diseases.

Practical

Study of grassland and rangelands in the area. Different tools/instruments used in livestock management; Routine management practices followed on livestock farms; Identification of feedstuffs and their nutritive value; Nutritive requirement animals; Study of housing systems and requirements; Preservation of fodder as hay, silage and leaf meal.

Suggested Reading

- Banerjee, G.C. 2010. A text book on Animal Husbandry, 8th Edition, Oxford and IBH New Delhi.
- Holechek J.L. et al. 1989. Range Management. Prentice Hall, New Jersey
- Sastry, N.S.R. and C.K. Thomas. 2005. Livestock Production Management, Kalyani Publishers, New Delhi.
- Singh R.V. 1982. Fodder trees of India. Oxford and IBH New Delhi.
- Ward H.M. 1980. Grasses. A handbook for use in the field and laboratory, Scientific Pub., Jodhpur

i). Climate Science 3(2+1)

Theory

Agrometeorology – definition, aim and scope. Factors and elements of weather and climate. Composition and structure of atmosphere. Air and soil temperature regimes, atmospheric humidity, types of clouds and precipitation, hails and frost. Cyclones, anticyclones and thunder storms. Solar radiations components and effect on plant growth. Effect of weather and climate on the growth and development of crops. Climatic normals for crops and trees. Agro climatic zones of India . Evaporation and transpiration.

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest. Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on agro-forestry- Climate resilient forestry. Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change. National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer. Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of

sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere.

Suggested Reading

- Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur
- Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi
- Mavi, H.S. (1994) Agrometerology . Oxford &IBH, New Delhi
- Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,
- Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg
- Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR , New Delhi.

j). Forest Laws, Legislation and Policies 2(2+0)

Theory

National forest policies-scope and importance- comparative analysis of all forest policies -Indian judicial system- Legal definitions, application of penal code to forests, general principles of criminal law, legal principles of punishment, criminal procedure code, the law of evidence and the Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act, 1927 general provisions, Code of Civil procedure, 1908. Forest (Conservation) Act, 1980. Brief description about other major forest laws of regional, national and international significance. Detailed study of KFA 1961.Biological Diversity bill 2002-discussion of court verdicts on issues of utmost importance to conservation.

Suggested Readings

- Dutta, R. and Yadav, B. (2012). Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India
- Joy, P. P. (2012). Set up your criminal practice. Swamy Law House, Ernakulam
- Shetty, B. J. (1985), A Manual of Law for Forest Officers, Sharda Press, Mangalore
- Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butterwarths Wadhwa, Nagpur
- Varghese, M. I. (2012). Treatise on Forest Laws of Kerala. Swamy Law house, Ernakulam.

k). Geomatics 3(1+2)

Theory

Remote sensing - classification based on source: Active and passive remote sensing; Aerial and space remote sensing; Interaction of electromagnetic radiation with atmosphere and earth surface; Aerial photographs – types; Photo interpretation - Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Programme; Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery-NDVI; Forest cover monitoring and damage assessment; Microwave remote sensing. Introduction to GIS. Differences between GIS and conventional cartography. Spatial and non-spatial data- Integration of attribute data with spatial data. Spatial

data - Raster and Vector data-Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection-Toposheet and Map reading. Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, GLONASS, QZSS, Compass, IRNSS etc., GAGAN

Practical

Preparation maps; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping. Digital image processing. Introduction to various GIS software – Q-GIS, ERDAS, Arc GIS etc. Exercises in viewing, editing, overlay. Visit to the GIS labs at State level.

Suggested Reading

- Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London
- Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA:ESRI
- Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351
- Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press
- Lillesand, T.M. and Kiefer,W.R.(1994).Remote sensing and Image Interpretation, Fourth edition. John Wiley & Sons, Inc., USA
- Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS & LUP, Nagpur.

I). Recreation & Urban Forestry 2(1+1)

Theory

Forest recreation – Definition and scope – social and environmental aspects of recreation components new approaches in forest recreation. Principles and elements of landscaping -types of landscape designs formal-Persian and Mughal designs, and informal- British and Japanese. Landscape components- plant and other components- lawn, pergolas, hedges, edges, topiary, baloon, arbours, carpet beds, trees, flower beds, annuals, and climbers. Practices of landscaping-Tools and implements for landscaping. Specialised gardens-butterfly, water, bog or marsh, terrace, roof, Sunken, Indoor and rock. Planning and planting programmes in institutional and industrial complexes, roads, bridges, parking area and other structures. Urban forestry – definition and scope – uses of urban forests, Management of urban forest-Arboriculture and its importance in urban forestry.

Practical

Preparation, planning and designing the planting pattern for parks, sanctuaries and industrial complexes – familiarise with the components of landscaping – studies on the features of flowering and foliage trees suitable for avenue planting – visit to landscaped areas, parks tourist spots and centres, national parks and sanctuaries., practice planting methods.

Suggested Reading

- Douglar, J. Hort, R. A and Ranganadhan, S. (1982). Forest Farming. Natraj Publications, Dehradun.
- Gopikumar K. (2008). Arboriculture Principles and Practices. Published by Khanna Bandhu, Dehradun
- Hamm, W.E and Cale, D.N.(1987). Wild Land Recreation, John Wiley and Sons, New York .
- Miller, R.W.(1988). Urban Forestry. Prentice Hall International Ltd. London
- Singh, S.P. (1986). Planting of Trees. B.R. Publishing Corporation, Delhi.
- Urban Forestry and Urban Greening. An International Journal aimed at presenting high-quality research with urban and peri-urban woody and non-woody vegetation and its use, planning, design, Elsevier Publications.

m). Restoration Ecology 2(1+1)

Theory

Degraded lands: Concept, classification, status, extent and causes of degraded lands/ wastelands, different types of degraded lands – physical, chemical and biological land degradation. Soil erosion- types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected soils, causes, extent and their effects on plant growth and afforestation / reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas- explanation, impact on pant growth and Biodrainage techniques. Afforestation and reclamation of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification-definition, impact and causes, prevention and counter measures (shelter belts and wind breaks). Soil pollution- types, effects and control measures through forestry techniques. National and state level programmes on degraded lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development programme.

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation programme.

Suggested Reading:

- Anilkumar and Pandey, RN 1989. Wastelands Management in India. Ashish Publishing House, New Delhi
- Buol, S.W., Kole, F.D. and McGracken, R.J. 1975. Soil Genesis and Classification. Oxford and IBH Publ. New Delhi.
- Butler, B.E. 1980. Soil Classification for Soil Survey. Clerneder Press-Oxford Publ. Co., London.
- Gregersen, H. Draper, S. and Elz. D.(eds.) 1989. People and Trees- The Role of Social Forestry in Sustainable Development EDI Seminar Series, The World Bank, Washington, D. C. 273p

- Hegde NG 1987. Handbook of Wasteland Development. BAIF, Pune 102p.
- Hegde NG and Abhyankar 1986 (eds). The Greening of Wastelands. BAIF, Pune 204p
- IARI 1960. Soil Survey Manuel, IARI. New Delhi.
- ICAR 1977. Desertification and its Control. ICAR, New Delhi 358p.
- National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix,
- Prasad, V. N. 1985. Principles and Practices of Social-Cum-Community Forestry. International Book Distributors, Dehradun, 108p
- Shah, S. A. 1988. Forestry for People. ICAR, New Delhi, 147p
- Sharma, S. C., Chaturvedi R. B and Mishra O. P 1990. Utilization of Wastelands for Sustainable Development In India. Concept Publishing Co. New Delhi-59, 488p

n). Forest Inventory and Yield Prediction 2(1+1)

Theory

Yield - In regular forests-In Irregular forests. Estimation of growth and Yield of stands - Forest Inventory - Point sampling Forest Inventory - Definition-objectives- Kinds of enumeration- Tree assessment techniques- Measurement of wood volume, tree volume & tree volume tables - Kinds of sampling -Sampling design - Kinds of sampling units- Fixed area and point sampling units - Plots, strips, topographical units - sampling intensity- Inventory designs used in India - Sampling errors and non sampling errors.-Organisation of field work and conduct of enumeration - Point sampling- Concept of horizontal point sampling . Estimation of growth and yield prediction in forest stands- Stand structure - Growth of stand - Methods of predicting future growth of stands - Stand density - Canopy density -Crown competition factor- Yield tables- definition- Preparation of yield table - Application and use of yield tables - Stand table-definition and use.

Practical

Study the demarcation and alignment of plots, strips etc. Field exercise on Horizontal Field demonstration of various sampling techniques- Simple, stratified, multi stage, multiphase, non-random sampling techniques. Visit forest areas for forest enumerations- point sampling- use of wedge prism and Relaskop - Field exercise on the determination of site quality -Visit to local forest divisions and study the methods of preparation and use of yield tables. Method demonstration on the use of aerial photographs in forest inventory

Suggested Readings

- Chapman, H.H and Meyer, W.H. (2008).Manual of Forest Mensuration: Methods and Techniques. Asiatic Publishing House, New Delhi, 522p.
- Chaturvedi, A.N and L.S. Khanna. (2011). Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.
- Heindjik, D. (1975). Forest Assessment. International Book Distributors, Dehradun, 349p
- Husch, B., Beers, T.W. and Kershaw,Jr. J.A.(2002). Forest Mensuration (4th edition). John Wiley & Sons, Nature.456 pp.
- Kangas, A. and Maltamo, M. (2006). Forest Inventory: Methodology and Applications. Managing Forest Ecosystems (Vol.10).Springer.340pp.

- Philip, M.S.(1994). Measuring Trees and Forest. AB International, UK,310p
- Scott,C.T and Gove, J.H. (2002). Forest Inventory. Encyclopedia of Environmetrics (Vol 2), John Wiley & Sons. pp 814–820
- Shiver, B.D and Borders, B.E.(1996). Sampling Techniques for Forest Resource Inventory. John Wiley and Sons, New York, 356p
- Spurr, H.S.(1952).Forest Inventory. John Wiley and Sons, New York, 476p.

IV.) Forest Product Utilization (FP)

a). Wood Anatomy 3(2+1)

Theory

Introduction to wood anatomy. Classification of plant kingdom. Gymnosperms versus angiosperms. Kinds of woody plants. The plant body; a tree and its various parts. Meristems; promeristem, primary meristem, secondary meristem. Simple tissues; parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body; typical stems and roots of dicots and monocots. Secondary growth in woody plants. Mechanism of wood formation in general, and with special reference to typical dicot stem. Ray initials and fusiform initials; anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood, sapwood, heartwood, pith, early wood, late wood, growth rings, wood rays, etc. Sapwood versus heart wood, anatomical differences. Transformation of sapwood to heartwood; factors affecting transformation. Microscopic features of wood. Prosenchymatous elements, tracheids, vessels, fibers. Parenchymatous elements, parenchyma and rays, resin canals, gum canals, latex canals, infiltrants in wood. Three dimensional features of wood; transverse, tangential and radial surfaces. Elements of wood cell walls. The structure and arrangement of simple pit, bordered pits. Extractives in wood. Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers; classification into porous and nonporous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood.

Practical

Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Study of infiltration and inclusions in wood. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification. Field identification of important timbers of Kerala.

Suggested Reading

Anoop, E. V., Antony, F., Bhat, K. V. Lisha, D. A. and Babu, L. C. 2005. Anatomical key for the identification of important timbers of Kerala. Kerala Agricultural University, Thrissur and Kerala

State Council for Science, Technology and Environment, Thiruvananthapuram, Kerala, India. 126p.

Hoadley, B. 2000. Identifying wood-Accurate results with simple tools. Taunton Press, Newtown, USA. 223p.

Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.

Rao, R. K. and Juneja, K. B. S. 1992. Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.

b). Wood Products and Utilization 3(2+1)

Theory

Uses of wood. Growth of wood based industry in India, effect of globalization. Importance of forest based industries in relation to Indian economy. Wood as a source of energy and chemicals, wood as raw material for industries like pulp, paper, rayon, composite woods and improved woods. Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes. Structural uses of Timber – bridges and other super structures. Decorative uses of wood. Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.). Primary conversion; sawing and veneering. Composite wood; plywood, laminated wood, core board, sandwich board, fibre board, particle board; manufacturing process, uses and properties. Adhesives used in manufacture of composite wood. Improved wood; compressed wood, impregnated wood etc.; manufacturing process, uses and properties. Nano technology in wood. Manufacture of rayon and match. Wood carving and handicrafts. Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Biochar, technology, bioenergy concepts - short rotation crops as raw materials.

Practical

Estimation of specific gravity and calorific value of wood specimens. Maceration techniques and determination of sizes of fibres, vessels etc. Visits to various wood based industries like, plywood, packing case, match, tannins, furniture, saw mills etc. to study the manufacturing process. Visit to saw mill to study veneering and different kinds of sawing. Handicraft manufacturing unit. Visit to wood distillation unit. Visit to nearby industrial plantations.

Suggested Reading

- Baldwin, R. F. 1981. Plywood manufacturing practices. Revised 2nd Ed. Miller and Freeman Publication, Inc. USA. 388p.
- FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
- Hoadley, B. 2000. Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown, USA. 223p.

c). Ethnobotany, Medicinal and Aromatic Plants 3(2+1)

Theory

Definition and scope of ethnobotany. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic – people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, etc Methods and tools in Ethnobotanical studies. Ethnobotany of tribals in Southern India. Traditional Botanical Knowledge- concepts. Major tribes of Northern, Central, North East and Andaman and Nicobar Islands. Ethnobotany of the plants from the following families. Guttiferae (Clusiaceae), Malvaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae, Thymeliaceae.

Definition - role of medicinal and aromatic plants in Indian economy - Important essential oil yielding plants in India - Detailed study of lemon grass, citronella, palmarosa, vetiver, japanese mint, eucalyptus, jasmine, patchouli and geranium - botany, climate and soil requirements, planting cultural and manorial practices - harvesting, curing and extraction of essential oils. Medicinal plants in India and Kerala - history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants like *Atropa, Cinchona, Rauvolfia, Opium, Sandal, Acorus, Cannabis, Digitalis, Strychnos nux-vomica, Aconitum, Neem, Dioscorea, Costus, Solanum* etc. Cultivation practices of medicinal plants like *Adhathoda zylanica*, *Sida cordifolia, Sterospermum colais*, *Plumbago zylanica*, *Tinosporacordifolia*, *Kaemferia glanga*, *Indigofera tinctoria.* Conservation packages for the medicinal plants collected in wild.

Practical

Field visit to different tribal regions to gain ethnobotanical knowledge and the inter-relation between plant and people- Survey and identification of plants used by the tribals for medicine, food and other social purposes- Collection and preparation of herbarium specimens of the above plants- Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Suggested Reading:

- Atul, C.K. and Kapur, B.K. (1982). Cultivation and utilization of medicinal plants. RRL., CSIR, Jammu-Tawi.
- Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian medicinal plants. CSIR, New Delhi.
- Cunningham, A. 2014. Applied Ethnobotany: "People, Wild Plant Use and Conservation". Taylor & Francis,
- EIRI Board. (2007). Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction
- Ethnobotany. Principles and applications. (1997). C. M. Cotton. John Wiley and Sons Ltd. 424p.

- Gunther, E. (1975). The essential oils. Robert, K Krieger Pub. Co., New York.
- Jain, S.K. 2010. Manual of Ethnobotany (2nd Ed). Scientific Publishers, India, 242p.
- Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672p.

d). Wood Science and Technology 3(2+1)

Theory

Kinds of woods; hardwood, softwood, bamboos and palms, merits and demerits of wood as a raw material, the physical features of wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Wood water relationship; shrinkage, swelling, movement, fibre saturation, equilibrium moisture content. Wood seasoning; merits, principles and types; air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules. Seasoning defects and their control. Classification of timbers based on durability. Wood preservation; principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage. Non-pressure methods; steeping, dipping, soaking open tank process, Boucherie process. Pressure methods; full cell process, empty cell process (Lowry and Rueping). Wood machining. Sawing; techniques, kinds of saws; cross cut, edging, cudless, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Various stages in wood working. Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.

Practical

Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties. Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to wood testing laboratories.

Suggested Reading

- Bowyer J. L., Shmulsky, R. and Haygreen, J. G. 2007. Forest products and wood science: An introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.
- Brown, H. P. 1985. Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.
- FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.
- Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.
- USDA [U.S. Department of Agriculture]. Wood handbook - Wood as an engineered material. 1999. U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p.

e). Logging and Ergonomics 2(1+1)

Theory

Definition and scope of logging, logging plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction. Implements used in logging operation; traditional and improved tools. Felling rules and methods, Work contracts related to felling and removing (contract system, convener systems) etc. Conversion, measurement and description of converted material. Means of transport of timber; carts, dragging, skidding, overhead transport, ropeways, skylines. Transport by road and railways. Transport by water; floating, rafting and concept of booms. Non-destructive sampling methods of wood. Grading and storage of timber in the depots for display and disposal, temporary and final storage. Timber Depots; types, lay out and management. Systems of disposal of timber. Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.

Practical

Equipments and tools used in logging operations and their uses. Instructions regarding maintenance of various records and registers in logging operations; Conversion of felled trees into logs, poles, firewood, pulpwood. Visit to local saw mills to study the equipments used and process of conversion. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to local dumping yard (timber depot) to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Preparation of ergonomic check lists. Familiarize the e-auctioning procedure of State Forest Department. Safety rules and first aids in forestry operations

Suggested Reading

- Brown, N. C. 2002. Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.
- Staaf, K.A.G. and Wiksten, N.A. (1984). Tree Harvesting Techniques. Martinus Nijhoff/DR W. Junk Publishers, Netherlands.
- FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
- GFC. [Guyana Forestry Commission]. 2002. Code of practice for timber harvest. 2nd Ed. Georgetown, Guayana. 42p.
- Hakkila, P. 1989. Utilization of residual forest biomass. Springer-verlag, Berlin. 567p.
- Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.

- Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.

- Mehta, T. 1981. A handbook of forest utilization. IBD Dehradun. 298p.
- Wakermann, A. E. 2002. Harvesting timber crops. Biotech books, Delhi. 433p.

f). Non-Timber Forest Products 3(2 +1)

Theory

Types of markets for timber and non-timber forest produce, market locations of timber and non-timber forest produce and their features. Demand forecasts. Price determination in timber and non-timber forest produce. Economic features of specialized timber markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like pre-commercial thinning, commercial thinning, harvesting, hauling, sawing, transportation, treatment of wood, carpentry, and other processing activities involved in teakwood, rosewood, matchwood, pulpwood, sandalwood, veneers; type and degree of competition in market for services of saw mill and other intermediate wood processing industries, price spreads across different channels of marketing. Economic features of specialized markets in terms of degree and type of competition for bamboo, canes, lac, gums, resins, hides and skins. Economics of gathering medicinal plants from forests, economics of processing medicinal plants. Domestic demand and trade in timber and non-timber forest products. International demand and trade in timber and non-timber forest produce. Market inefficiencies in timber, non-timber forest produce and measures to check in efficiencies, role of cooperative societies in marketing of timber and non-timber forest produce. Economic policy and regulations of international timber trade. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting. International Timber Trade Organization (ITTO) and timber certification.

Practical

Library review of studies on marketing and trade of; timber forest produce (teak, rosewood, *Terminalia* spp. *Pterocarpus* and other important timber of national importance etc.); Non-Timber Forest Produce (NTFP such as bamboo, canes, eucalypts etc.); forest based medicinal plants. Visits to timber produce and NTFP markets to collect price data and quantity sold and to observe auctions and competitions. Analysis of price and quantitative data of timber forest produce, NTFP for examining trend; seasonal, cyclical variations. Visit to markets of forest based medicinal plants. Study of buy back arrangements in forest based medicinal plants trade. Valuation of timber and NTFP (existence value, use and option values, intrinsic value etc). Development of hypotheses to study the marketing of forest produce. Presentation of results on analysis of price and quantity. Economics of processing pulp to paper/poly fiber; wood to plywood/veneers.

Suggested Reading

- Gray, J. W. 1993. Forest resource systems in developing countries. Food and agricultural organization. Rome. 259p.
- ITTO. [International Tropical Timber Organisation]. 1993. The economic linkages between international trade in tropical timber and sustainable management of tropical forests. London environmental economic centre, International Institute for Environment and Development, London, UK. 330p.
- ITTO. [International Tropical Timber Organisation]. 2012. Annual review and assessment of the world timber situation, Yogyakarta, Indonesia. 182p.

- Kula, E. 1996. The economics of forestry: Modern theory and practice. Timber press, Portland, Oregon. 182p.
- Muraleedharan, P. K. Subramanian, K. K., and Pillai, P. P. 1998. Basic readings in forest economics. Kerala Forest Research Institute and Ford Foundation, Thrissur, Kerala. 177p
- Tewari, D. N. 1995. Marketing and trade of forest produce; International Book Distributors (Book Sellers & Publishers), Dehradun, India. 140p.

g). Certification of Forest Products 2(2 +0)

Theory

Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Programme for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

Suggested Readings

- Bass, S. Introducing forest certification. 1996. A report prepared by the Forest Certification Advisory Group (FCAG) for DGVII of the European Commission. European Forest Institute, Discussion Paper 1. 30p. Details available at: http://www.giz.de/Themen/de/dokumente/en-d28-inenpenennt-certification-verification-forest-manage.pdf
- Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.
- Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.
- Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.

V. Basic and Social Science (BS)

a). Information and Communication Technology 2(1+1)

Theory

Introduction to computers, hard ware and soft ware, basic works of computer, operating systems. DOS, WINDOWS commands for managing files. Windows component like icons, desktop, My Computer, recycle bin, My Documents, task bar, start menu options. Familiarizing with MS OFFICE (MS Excel, MS Word, MS PowerPoint). Introductions to FOSS for OS and for work related to word processing, spreadsheet and presentation. Introduction to intra and internet and its application. Introduction to statistical packages and image processing software. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and

criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practical

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Suggested Reading:

- Norton Peter, "DOS Guide", Prentice Hall of India
- Norton Peter, "Introduction to Computers", TMH
- Rajaraman V, "Fundamentals of Computers", PHI

b). Communication Skills and Personality Development 2(1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences. Applied Grammar: Introduction to Word Classes. Structure of the Verb in English. Uses of Tenses. Study of Voice. Use of Conjunctions and Prepositions. Sentence Patterns in English. Spoken English: Conversations of Different Situations in Everyday Life. The Concept of Stress, Stress Shift in Words and Sentences. Words with Silent Letters and their Pronunciations. The Basic Intonation Patterns.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

Suggested Reading

- Carroll, B.J. 1986. English for college, Macmillan India Ltd. New Delhi
- Hahn, "The Internet complete reference", TMH
- Hornby, A.S. 1975. Guide to patterns and usage in English. Oxford University, NewDelhi.
- Qurik, R and Green baum, S 2002. A University grammar

c). Plant Biochemistry 2(1+1)

Theory

Chemistry of carbohyd rates–classification,mono, diandpoly saccharides, anomerism, epimerism, mutarotation, configuration of sugarsandin version. Chemistry of lipids–classification,

simple lipids and phosph or lipids. Fatty acids and fat constants, lipids of chloroplast, membrane lipids. Chemistry amino acids, peptides and proteins, classification, levels of protein structure. Chemistry of nucleic acids–bases, sugars, Nuc nzymes –classification, enzymekinetics, enzyme inhibition, allosteric enzymes, lysozymes, coenzymes. Metabolism of carbohydrates–glycolysis, TCAcycle, HMPshunt, glyoxy licacidcycle, electron transport chain. Lipids metabolism–beta oxidation and fatty acid biosynthesis. Photosynthesis –light reaction, dark reaction, Hill's reaction, photo respiration, C4 pathway, C3 and C4 plants, CO2 fixation, regulation of photosyn thesis. Plant hormones and their mode of action.

Practical

Qualitative tests for carbohydrates, Quantitative estimation of reducing sugars by DNS method, Quantitative test for total carbohydrates by Anthrone reagent, Qualitative tests for lipids,Determination of Saponification number of oils/fats, Determination of Iodine number of fatty acids, Qualitative tests for proteins/amino acids,Estimation of protein by Lowry's method, Determination of Michaelis constant of enzymes, Estimation of RNA.

Suggested Reading

- Conn, E.E. and Stumpf, P.K.(1989). Outlines of Biochemistry, Wiley Eastern Ltd., New Delhi
- Mazur, Aand Harrows, B.(1971). Text book of Biochemistry. W.B. Sanders Publications, New Delhi.
- Robert, C.B.(1983). Modern concepts in Biochemistry. Allyn and Bacon Inc. London
- William, H.E. and Daphne, C.E.(2005). Biochemistry and Molecular Biology, Oxford University Press.

d). Forest Botany/BasicMathematics 2(1+1)

Theory (Forest Botany)

Introduction to Allied and Applied Branches of Botany; General classification of plants – Phanerogams, Cryptogams, Angiosperms and Gymnosperms, Dicotyledons and Monocotyledons; General body organization and characters of Algae (e.g. *Chlamydomonas*), Fungi (*Mucor*), Bryophytes (*Moss*) and Pteridophytes (*Nephrolepis*); Parts of flowering plants- Root system and Shoot system, typical structure of root, stem and leaf; Functions of root, stem and leaves; Basic Structure of Flower- Essential and Non essential parts of flower; Morphology of root, stem and leaves; Morphology of Flower with emphasis on Inflorescence; Types of Phyllotaxy and Venation in leaves, types of placentation and aestivation in flower; Basic types of tissues (Structure and Function) - Dermal, Vascular and Ground tissues; Parenchyma, Sclerenchyma, Collenchyma, Chlorenchyma, Aerenchyma, Cambium, Xylem and Phloem; Types of vascular bundles in flowering plants.

Practical

Morphology of root, stem and leaves with special emphasis on underground and aerial modifications in root and stem; simple and compound leaves; types of phyllotaxy and venation (live specimens); typical structure of bisexual flower; types of inflorescence (live specimens); types of tissues with the aid of permanently mounted slides; Tissue organization in Dicot root, stem and

leaves; Tissue organization in Monocot root, stem and leaves with the aid of permanent slides or study charts.

Suggested reading:

- Ashok Bendre and Ashok Kumar. (1984). *Textbook of Practical Botany*. Vol. I and II. Rastogi Publications. Meerut. India. (Also available on Flipkart and Amazonbooks. Com)
- Ashok Bendre and P. C. Pande. (1996). *Introductory Botany*. Rastogi Publications. Meerut. India.
- Ashok Kumar (2001). *Botany in Forestry and Environment*. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
- Dutta. C. (1998). *Botany for Degree Students*. (1998). Oxford University Press. India
- Dutta. C. (2000). *Class Book of Botany*. Oxford University Press. India
- Gurucharan Singh. (2000). *Plant Systematics*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Pandey S. N. and S. P. Mishra. (2008). *Taxonomy of Angiosperms*. Ane Books India, New Delhi.
- Pandey. P. (2012). *Taxonomy of Angiosperms*. S. Chand and Company Ltd. New Delhi.

Basic Mathematics

Elementary idea of complex number. Arithmetic and Geometric progressions. Elementary idea of permutation and combinations. Matrix of a system of linear equations. Binomial theorem for positive integral index, any index and their applications, addition and subtraction formulae. A, B and C, D formulae. Sine and Cosine formulae. Inverse Trigonometric functions, ratios and their interrelationships. Limit off unctions-differentiations and integrations simple applications-maxima and minima least square techniques- Introduction to matrices and determinants, special type of matrices, addition, subtraction and multiplication of matrices.

Suggested Readings

- Chatterjee S. K. (1970). Mathematical Analysis. Oxford & IBH.
- Frank, A. (1962). Schaum's Outline of Theory and Problems of Matrices. McGraw-Hill
- Frank, A. 1967. Theory and Problems of Differential Equations. McGraw-Hill
- Gentle JE. (2007). Matrix Algebra: Theory, Computations and Applications in Statistics. Springer
- Narayan, S. (1953). A Text Book of Matrices. S. Chand and Company.
- Parameswaran, S. (1976). An introduction to mathematics. Oxford & IBH Publishing Co. 172p.
- Priestley, H.A. (1985). Introduction to Complex Analysis. Clarenton Press
- Walter R. (1976). Principles of Mathematical Analysis. McGraw-Hill.

e). Physical Education–I 1(0+1)

Practical

Concept of Physical Education-Meaning, need & importance, aim & objectives. Conditioning exercises-warmingup, warming down (general & specific), and flexibility exercise. Physical Fitnes sexercises for speed, strength, agility, endurance and coordination. Posture & Concept-Definition, values of good posture, causes & draw backs of bad posture, Common postoral deviation, their

causes and correct exercises, Kyphosis, Scoliosis, Lordosis Knock knee & Bowlegs, Flatfoot. Running ABC'S, walking ABC'S-Major games-Rules and regulations of important games, Skill development in any one of the games-Football, Basketball & Ball badminton. Indoor games - Participation in one of the indoor games - Shuttle badminton & table tennis. Athletic events-Rules & regulations of athletic events, Participation in any of the athletic events–Broad jump, high jump and short put. Conduct of Health Related Physical Fitness Test (TPFP): One mile run/Beep test, Sit-Up60 sec, Sitandr each, Modifiedpull-ups. NOTE: (onetobe selected major games, in door games and Athletic events).

f). NCC/NSS-I 1(0+1)

NCC

Introduction to NCC, defense services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, armsdrill, shoulderarm, orderarm, presentarm, guard of honour, ceremonial drill.

NSS

Aims and objectives of NSS. NSS logo, mottoetc. Orientation of students in national problems, study of philosophy of NSS, funda mentals rights, directive principles of state policy, Village adoption.

g).Statistical Methods & Experimental Designs 3(2+1)

Theory

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data. Construction of frequency distribution, tables –graphicre presentation of data, simple, multiple component and percentage, bardia gram, piedia gram, histogram, frequency polygon and frequency curveave rage and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poissonand normal distributions, sampling, basic concepts, sampling vs. Complete enumeration parameter and static, sampling methods, simple random sampling and stratified and om sampling. Tests of significance: Basic concepts, tests fore quality mean, aninde pendet and pairedt-tests, chisqu are tests for application of attribute sand test for good ness to fitof men dalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of sample linearreg ression, tests of significance of correlation and regressionco-efficient. Introduction to design of experiment- Basic principles of experimental design-replication, randomization and local control. Analys is of variance-assumptions-construction of ANOVA table–conclusions based on ANOVA. Comparisons basedon means-critical difference, DMRT. Transformations of data-square root, logarithmic and angulartrans for mations. Completelyr and omized design-Layout, analysis, advantages and limitations. Rand omised block design-layout, analysis, choice of no. of blocks, advantages and limitations. Latinsquare designs-layout, analysis, applications, advantages and limitations.

Practical

Formation of frequency distribution. Diagrammatic and graphic representation. Calculation of different measures of central tendency. Computation of various measures of dispersion. Calculation of coefficient of variation-coefficients of skewness and kurtosis. Computation of product moment correlate on coefficient-rank correlation, coefficient-and coefficient of concordance. Fitting of linear egression models for prediction. Simple problems on probability-fitting of binomial distribution. Fitting of poisson distribution, problems on normal distribution. Selection of simple random sample – estimation of parameters – sample size determination. Selection of stratified and om sample–equal, proportional and Ney man's allocation in stratified sampling. Large sample tests. Small sample tests, t and F tests, Chi –square test, test of goodness of fit – test of independence of attributes in a contingency table - computation of mean – square contingency. Analysis of variance-construction of ANOVA table of one-way classified data. Analysis of variance-construction of ANOVA table of two-way classified data. Layout and analysis of CRD, Layout and anal ysis of RBD. Analysis of data from 2n factorial experiments in RBD. Formation of Yate's table-calculation of main effects and interaction effects. Layout and analysis of split-plot design.

Suggested Reading

- Anderson, R.L. and Bancroft, T.A.(1952).Statistical Theory in Research. Mc. Graw Hill Book Co., New York.
- Cochran, W.G and Cox, G.M.(1958). Experimental designs. Wiley, New York
- Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi. Federer, W.T.(1955), Experimental Design. Macmillan, New York.
- Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. New York. 680 p.
- Kempthorne, O. (1952). The design and analysis of experiments. Wiley, New York.
- Nigam A.K. and Gupta, V.K.(1979). Hand boo kon Analys is of Agricultural Experiments. IASRI Publication, New Delhi.
- Panse, V. G. and P.V. Sukhatme. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
- Petersen Roger G. (1994) Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.

h). Physical Education–II 1(0+1)

Practical

Concept of Health -Physical health, mental health, social health, spiritual health, spectrum of health. Fitness & wellness-Motor components. Regular exercises. Amount of training, Scientific way of training, Rest and relaxation, conditioning, Good posture, Heredity, Environment, Standard of living, Balance Diet, Stress &tension, Drugs, Intoxication. Means of Fitness Development-Aerobic activities, anaerobic activities, Sports & Games, Yoga, Recreational Activity. Safety Education–Swimming. Yoga-Meaning & importance of Yoga. Role of Yogain life, Teaching of Yoga. Physical Fitness test-TPFP Fitness test: One milerun/ Beep test, Sit-Up 60 sec, Sit and reach, Modified pull-ups. Major games-Rules and regulations of important game, Skill development in

any one of the game- Hockey, Volley ball, Hand ball and Kho Kho. Indoor games-Participation in one of the in door games–(Table Tennis & Badminton). Athletic events-Rules & regulations of athletic events participation in anyone of the athletic events-Triple jump, Discus throw and Javelin throw. NOTE: (one to be selected, major games, in do or games and Athletic events)

i). NCC-II/NSS-II 1(0+1)

NCC-II

Weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush.

NSS-II

Socio-economic structure of Indian society, population problems, brief of Five Year Plan. Functional literacy, non-formal education of rural youth, eradication of social evils, village adoption-continued.

j). Physical Education-III 1(0+1)

Practical

Lifestyle diseases & dietary and lifestyle changes that reduce the incidence of chronic diseases. Obesity, Coronary heart diseases (CAD), is chemic stroke Diabetes Mellitus, Blood pressure, Osteoporosis. Injuries–Injuries in sports. Prevention of sports injuries. First aid training in sports-Sprain, Fractures, Burns, Snakebite, Drowning, Unconscious victim, First aid ABC, First aid CPR, Sling and Splint and carrying techniques. Yoga continuation. Major games, Rules & regulation of important games, Skill development in any one of the game-Cricket, Football, Basket ball, Volley Ball and Net ball. Athletic events-Rules & regulations of athletic events–participation in any one of the athletic events-short & long distance running. Any one to be selected major games and Athletics events. Adventure training-On Land– Trekking, High Altitude Trekking, Rock Climbing, Mountaineering. In water-River Crossing.

k). NCC-III/NSS-III 1(0+1)

NCC-III

Field engineering, map reading, conventionalsigns, grid systems, use of service protractor, prismatic compass and its use, self defence, general principles, precautions and training, attacks and counterattacks, marching and searching, first aid, hygiene and sanitation, civil defence, leadership and NCC song.

NSS-III

Awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition, village adoption- continued.

l). Forest Tribology & Anthropology 2(2+0)

Theory

Meaning, scope and development of Anthropology. Relationships with other disciplines. Main branches of Anthropology, their scope and relevance. Human Evolution and emergence of Man. Phylogenetic status, characteristics and geographical distribution. Principles of Prehistoric Archaeology. Chronology: Relative and Absolute Dating methods. Culture, Society, Marriage, Family, Kinship, Economic and Political Organization, Social Control, Religion, Anthropological theories, Language and Communication, Research Methods in Anthropology. Race and Racism. Applications of Anthropology. Ethno-archaeology in India. Demographic profile of India. The structure and nature of traditional Indian social system. Caste system in India Definition and characteristics of a tribe. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Tribal economy. Tribals and Constitution of India Administration of tribal areas in independent India- appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare.

Suggested reading:

- Furer-Haimendorf, C.V. 1985. Tribes of India - the struggle for survival. OUP. New Delhi
- Hasnain, N. 2007. Tribal India. New Royal Book Company
- Hasnain, N. 2011. Indian Anthropology. Palaka Prakashan
- Sharma, R.N. and Bakshi, S. 1984. Tribes and tribal development. Uppal Publ. House, New Delhi
- Sharma, R. N., Sharma, R.K. 1997. Anthropology. Atlantic Publishers & Distributors.
- Thakur, D. 1986. Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi

m). Study Tour 1(0+1*)

Practical

Study tour of one week duration in the respective States/part of India. To familiarize the students with the fauna, flora and other research activities of SAUs, Research institute, forest industries, Govt. and private organizations of different parts of respective states/ part of India. To expose the students to various national / heritage monuments as part of national integration activity.

n). Forest Extension & Community Forestry 3(2+1)

Theory

Forest Extension: Introduction- human behaviour and psychology. Concept, scope, principles, philosophy and objectives of extension education and forestry extension education. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history.

Forestry extension: process, principles and types of education, Formal, informal non-formal education. People's participation in Forestry programmes. Elements of extension education, man himself man's environment and man's created devices. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Van Vigyan Kendras, Technology Assessment and Refinement Programme (TARP) of ICAR/ ICFRE. Communication: meaning, definition, elements and selected models. Audio-visual aids: importance, classification and selection. Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA). Rural social groups, primary and secondary groups, formal, informal group, temporary, permanent groups, references group, classification of group.

Community Forestry: Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry. Forests and man: Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups. Gender dimensions in Community forest management. Social Forestry- definition, need and purpose, historic development. Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Microplan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co-operative societies.

Practical

Visits to study structure, functions, linkages and extension programmers of KVKs or ICFRE institutes/voluntary organizations/Mahila Mandal/Village Panchayat/Van Panchayat/ State Forest Department (Social forestry wing). Group discussion at farm homesteads. Preparing individual and village level production plans. Preparation of charts, posters and flash cards. Participation in conducting exhibitions and method demonstrations/campaigns at the village level. Familiarization of the use of audio-visual aids. PRA exercises. Visit to village to study the community forestry components- Community reserve, organizational set up and administrative procedures in a social forestry (SF) Range, Microplan preparation-Field visit to a JFM operational area and conduct PRA surveys. Afforestation techniques and social forestry.

Suggested Reading:

- FAO (1984). Forestry extension, making it work, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.
- L.K. Jha and P. K. Sen Sarma, A.P.H. (2008). A Manual of Forestry Extension Education, Published by VEDAMS, P. 386 p.
- D. Sim, H. A. Hilmi (1987), Forestry Extension Methods, FAO Forestry Paper-80, P. 153.
- Jalihal, K.A. Veerabhadraiah, V. (2007), Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.

- Balakathiresan, S. (1986). Essentials of forest management, Nataraj Publishers, Dehradun.
- Bullock, R. C. L. and Hanna, K.S. (2012). Community Forestry Local Values, Conflict and Forest Governance. Cambridge University Press.
- Gunter, J. (Ed.). (1973). The Community Forestry Guidebook (http://www.forrex.org/ sites/ default/ files/ forrex_series/FS15.pdf).
- Ojha, H.R., Timsina, N.P., Kumar, C., Banjade, M.R and Belcher, B. (2007). Communities, Forests and Governance: Policy and Institutional Innovations from Nepal. Adroit Publishers, New Delhi, India.
- Roy, S.B. and Chatterjee, M.(1994). Joint Forest Management. Inter India Publications
- Tiwari, K.M. (1983). Social forestry for rural development. International Book Distributors.
- Vyas, G. P.D. (2006). Community Forestry. Agrobios, India.

o). Entrepreneurship Development & Business Management 2(1+1)

Theory

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to forestry sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of forestry inputs industry. Characteristics of Indian forestry processing and export industry. Social Responsibility of Business.

Practical

SWOT analysis, developing leadership skills, developing managerial skills, problem solving skill, supply chain management and total quality management, project planning formulation and report preparation.

Suggested Reading:

- Maslow, A.H (1970) Motivation and personality. Harper and Row publishers , New York.
- Perelson, B and Steiner, G (1964) Human behaviour. Harcourt Brace Jovanovich , New York.

p). Forest Economics and Marketing 3(2+1)

Theory

Economics- Meaning, definition, subject matter- Divisions of economics - Importance of economics- Forest Economics- Meaning, definition- Basic concepts-Goods, service, utility, value, price, wealth, welfare-Wants-Meaning, characteristics, classifications of wants, importance. The ory of consumption- Law of diminishing marginal utility, meaning, definition, assumption, illustration, limitations, lawofequi-marginal utility. Importance. Consumer surplus- Meaning,

definition, importance. Demand-Meaning, definition, kinds of demand, demand schedule, demand curve, law of Demand, extension and contraction vs increase and decrease in demand. Elasticity of demand- Types of elasticity of demand, degrees of price elasticity of demand, methods of measuring elasticity, factors in fluencing demand, elasticity of dem and, importance of elasticity of demand–supply- meaning, supply function-Law of supply-factors in fluencing supply-Pricing of timber and non-timber products-Economics of timber and non-timber forest products. Forest planning–forest policy and development. Production-Meaning, factors of production-land, labour, capital, organization, entrepreneurship-Distribution-rent, wages, interest, prof it-National Income-definition and concepts-.Public finance- meaning- Public resource-Meaning- sources-Taxation-types-Publicexpenditure-meaning, principles, Money-meaning-evolution-Inflation: definition, types of inflation-Welf are economics-Meaning and basic concepts.

Marketing- definition – Marketing Process – Need for marketing – Role of marketing –– Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

Suggested Readings

- Dewett,K. K.2005.Modern Economic Theory. S. Chand, New Delhi.
- Dewett, K. K.,Verma.2004 Elementary Economic Theory, S. Chand, New Delhi
- Jhingan, M. L. 2012. Macro Economic Theory. Vrindapublishers, New Delhi.
- Reddy, S.S., Raghu Ram,P., Neelakanta Sastry, T.V.,Bhavani, D.I.2004. Agricultural Economics. Oxford and IBH Publishers, New Delhi.

q). All India Study Tour 3(0+3*)

Three weeks' duration

To familiarize the students with the flora , fauna and other research activities of SAUs, research institutes, forest industries, govt. and private organization of different parts of India. To expose the students to various national / heritage monuments as part of national integration activity.

r). Agricultural Informatics 3(2+1)

Theory

Computer Programming, General Concepts, Documentation and Program Maintenance, Debugging programs, Errors. Introduction to Visual Basic, Java, Fortran, C/ C++, etc, concepts and standard input/output operations, Variables and Constants, Operators and Expressions, Flow of control, Inbuilt and User defined functions, programming techniques for agriculture/forestry.

e-Agriculture, concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in agriculture/forestry. ICT for Data Collection, formation of development prorammes, monitoring and evaluation of Programmes. Computer Models in agriculture/forestry: statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information. Decision support systems, taxonomy, components, framework, classification and applications in agriculture/forestry, DSS, Agriculture Information/ Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools.

Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix, Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power point for creating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, art tool, graphics, template & designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system.

Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Introduction of various programming languages such as Visual Basic, Java, Fortran, C, C++, and their components Hands on practice on writing small programmes. Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/CropSyst/ Wofost. Preparation of Inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology, demonstration of generating information important for Agriculture. Hands on practice on preparation of Decision Support System.

VI. Wildlife Sciences (WL)

a). Wildlife Biology 3(2+1)

Theory

History of Wildlife studies in India; Classification of Indian Mammals, Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids; Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity; Animal behavior and adaptation; Habitat Improvement: Food, Water, Shelter improvement.

Practical

Visit to various protected areas and observations on the morphological, behavioral, feeding and reproductive activities of different species of wild animals in India. Various study methods on the wild animals, such as focal animal sampling, Sherman trapping, mist netting, camera trapping, for identification, determination of age and sexing of animals including the small mammals. Faecal analysis of wild animals.

Suggested Reading

- Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.
- Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.
- Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.
- International Zoo Books, Published by New York Zoological Society, New York
- Johnsingh, A.J.T. and N. Manjrekar. 2014. Mammals of South Asia. Vol. I. University Press, 614p
- John singh, A.J.T. and N. Manjrekar. 2015. Mammals of South Asia. II. University Press, 739p
- Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press
- Mathur R. 1985. Animal Behaviour. Oxford University Press
- Menon V. 2014. Indian Mammals: A field guide. Hachette. 528p.
- Mittermeier, RA Rylands, AB and Wilson DE. 2013. Handbook of the Mammals of the World - Volume 3. Lynx Edicions. 952.
- Prater, S.H. (1971). The Book of Indian Animals. Oxford University press, Bombay. 324p.
- Sukumar, R. Asian Elephant. Ecology and Management. Oxford University Press Cambridge.
- Wilson, DE Mittermeier RA. 2009. Handbook of the Mammals of the World - Volume 1. Lynx Edicions. 728.
- Wilson, DE Mittermeier RA. 2011. Handbook of the Mammals of the World - Volume 2. Lynx Edicions. 886.

b). Ornithology & Herpetology 3(2+1)

Theory

Introduction. History of ornithology in India. Origin and ancestry of birds. A brief knowledge of bird anatomy, morphology and physiology, digestive, skeletal, respiratory, excretory systems of birds. Skeleton, feathers, skin, beak and taxidermy. Thermoregulation in birds. Bird ecology and behaviour; migration and territorial behaviour, feeding, song and nests. Eggs and egg laying. Water birds, scavenger birds, frugivorous birds, pest birds, pet birds and pollinator birds. Importance of birds to different ecosystems. Birds and man. Bird watching, Bird conservation and management in India. Important Bird areas of India, Red Data Book birds of India. Wetland conservation, Ramsar sites of India. Classification of Indian birds - birds belonging to the Orders Podicipediformes, Procellariformes, Pelicaniformes, Ciconiformes, Phoenicopteriformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, Caradriformes,Columbiformes,Psi ttaciformes, Cuculiformes, Strigiformes, Caprimulgiformes, Apodiformes, Trogoniformes, Coraciformes, Upupiformes, Piciformes and Passeriformes.

Practical

Field identification of major birds of India. Bird watching and drawings. Study of feathers, beak and leg types of different groups of birds. Study of the nest and eggs of birds. Mist netting and tagging/marking of birds for the bird migration studies. Bird census techniques. Visit to different bird habitats.

Suggested Reading

- Ali, S. and Ripley, D.S. 1990. A compact Handbook of Birds of Indian subcontinent. Oxford University press, Bombay.
- Daniel, J C. 2002. The Book of Indian Reptiles. Bombay Natural History Society, Bombay, 141pp.
- Das, I. 1995. Turtles and Tortoises of India. Oxford University Press. Bombay. 176pp.
- Das, I. 2002. A photographic guide to Snakes and other reptiles of India. New Holland Publishers (UK) Ltd.
- Grimmet, R. Inskipp T and Inskipp, I. 2003. Handbook of Birds of Indian subcontinent. Oxford University press
- Grimmet, R. Inskipp, T and Nameer, P.O. 2007. Birds of southern India, BNHS series.
- Gururaja KV. 2012. Pictorial Guide to frogs and toads of the Western Ghats. IISc. Bangalore.
- Kazmierczak, K. and van Perlo B. 2000. A field guide to the birds of the Indian subcontinent, Yale University Press, New Haven. CT.
- Kentwood D. Wells. 2007. The Ecology and Behavior of Amphibians. Th University of Chicago Press, Chicago.
- Rasmussen P C and John C. Anderton.2012. *Birds of South Asia: The Ripley guide*. Vol. I and II, Smithsonian Institution and Lynx Edicions, Washington DC and Barcelona.
- Wallace GJ and HD Mahan. 2005. An Introduction to Ornithology. 3rd Ed. McMillion publishing company. New York.
- Whitaker, R. and Captain, A. 2004. Snakes of India. The Field Guide. Draco Books. Chengalpattu, Tamil Nadu, xiv+479, pls, text-figs.
- William E. Duellman and Linda Trueb. 1986. Biology of Amphibians. John Hopkins University Press, Maryland.
- Vidyarthi, L.P. and Rai, B.K. 1985. The tribal culture of India. Concept Publ. Co., New Delhi.

c). Wildlife Management 2(1+1)

Theory

Definition, History of wildlife management and conservation in India; values of wildlife - aesthetic, recreational, scientific, educational, commercial, farming, technological and ecological values. Zoogeographic regions of the world – Palearctic region, Nearctic region, Oriental region, Ethiopian region, Neotropical region, Australasian region. Major biomes of the world – polar region, coniferous forests, temperate forests, tropical forests, grasslands, deserts, mountains, inland waters, oceans and oceanic islands. Biogeographic zones of India - trans-Himalayan, Himalayan, Indian desert, semi-arid, Western Ghats, Deccan peninsula, Gangetic plain, North East India, islands, coasts. Habitat requirements of animals. Red Data Book and redlisting, IUCN

revised red list categories – Extinct, Extinct in the wild, Vulnerable, Near Threatened and Least concerned. Wildlife census: Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities, block counts, road side counts, dung counts, pug mark census, water hole census, line transect- statistical analysis. Telemetry- transmitters, receivers, analysis of data, visual tagging and marking. Captive wildlife: Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, CITES. Wildlife Damage - Appraisal, Control and Management. Healthcare, Disease Management and Nutrition in Wild Animals Protected areas concept, wildlife sanctuaries and national parks, biosphere reserves, major protected areas of India.

Practical

Exercise on the census methods - direct method - total count, block count, water hole count, capture - recapture method, point transect, and line transect method – use of soft ware for analysis. Exercise on the census methods - indirect methods, dung count for elephants, pugmark method for larger cats and pellet count for other ungulates. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control: Questionnaire survey. Wildlife photography.

Suggested Reading

- Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.
- International Zoo Books, Published by New York Zoological Society, New York
- Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press
- Lever, C. 1985. Naturalised mammals of the world. John Wiley, London
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- Rajesh, G. 1995. Fundamentals of Wildlife Management, Justice Home, Allahabad.
- Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun
- Wildlife Institute of India (2004) Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun
- Wodroffe, G. 1981. Wildlife conservation and modern zoo. Saiga Publishing Co., England
- Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore

ELU-I Experiential Learning 5(0+5)

- Production and Marketing of high value forest produce (0+5) (FP)
- Raising Quality Planting Materials for forest regeneration (0+5) (SA/FB)
- Apiculture/Sericulture (0+5) (FB/NR/WL)
- Ecotourism (0+5) (BS/WL)
- Wild Animal Health Management (0+5) – WL

1. Production and Marketing of high value forest produce 5(0 + 5)

Project formulation, Market survey and prioritization of species. The species (imported and indigenous) that are currently available in the market has to be surveyed through personal visits to timber markets, saw mills, forest depots etc. Lesser known, but highly utilizable indigenous species of timbers will be given priority. Fast rotation timber species raised under various trials of the University will also be included to the extent possible.

Potential of different species for various end uses will be determined. Timber samples have to be converted into sticks / smaller sizes / macerated through appropriate procedures such as sawing and sizing in a saw mill or maceration in a laboratory. Mechanical tests: Static bending, compressive tests-across and along the grain. Finding out safe working stresses of lesser known or exotic/new species. Wood database currently available in the department will be updated based on the test results. Project report preparation and presentation, final examination. Wood conversion in an integrated saw mill, turnery for handicrafts, joineries and furniture making. Data analysis, project report writing, presentation and final examination.

2. Raising Quality Planting Materials for forest regeneration 5(0+5)

Project for mulation, Identification of species (grasses, trees, medicinal plants & wild fruits) for nursery raising, time of collection of plant material from selected seed sources, quantity of seed/plant material required, nursery area (open and protected), inputs required, Schedule for intercultural operation-seed treatment, sowing, weeding, fertigation, root hardening treatments. Assessment of demand in local/potential markets and institutions. Collection, Handling, Processing and Storage of planting material. Identification of superior seed sources, seed collection, treatment and storage. Vegetative propagati on under controlled and ambient conditions. Collection of vegetative propagules. Treatment and processing of bare root and containerized seedlings. Project Report and Presentation, Final examination

3. Apiculture 5(0+5)

Project for mulation, Apiculture-Scope and importance of beekeeping–Bees classification–Hives –Social organization–extraction of honey and other products. Marketing of honey and bee wax and their value addition. Cost Benefit analysis, Project Report and Presentation, Final examination.

4. Ecotourism 5(0+5)

Socio- economic feasibility analysis for initiating ecotourism projects. Tour planning and site development. Social engineering and natural resource management. Study of environmental and social impacts of ecotourism and mitigation strategies. Potential of ecotourism as a business.

5. Wild Animal Health Management 5(0+5)

Basic concepts of disease and health conditions. Review of major diseases of Indian wild mammals, birds, amphibians and reptiles. Epidemiology of disease. Disease and population dynamics. Disease transmission between domestic and wild populations. Malnutrition, starvation, dehydration as disease syndromes. Condition, health and nutritional assessment in free-ranging

populations. Control of disease planning and management of wildlife health programmes. Zoonoses.

ELU-II Experiential Learning 5(0+5)

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- Raising Quality Planting Materials for forest regeneration (0+5) (SA/FB)
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- Ecotourism (0+5) (BS/WL)
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Student READY- Forestry Work Experience (FOWE) 20(0+20)

The Forestry Work Experience (FOWE) course would have the following modules.

• Orientation (10 days)	0+1
• Forest Range Training Programme (50 days)	0+12
• Industrial placement (20 days)	0+3
• Weapon Training and First-Aid Training (5+3=8 days)	0+1
• Socio-economic Surveys and Village Attachment (20 days)	0+2
• Report writing and presentations (12 days)	0+1

Orientation

Conducting various exercises for exposing the students on the recent trends in the field of forestry, transactional analysis, personality development, soft skills etc and to prepare students for the rigours of professional life after completing B.Sc. Forestry programme.

Forest Range Training Programme

Visit to modern forest nurseries, herbal gardens and watersheds, study the felling and logging operations, timber lots and important industrial products, study working plan, enumeration, volume and yield calculation & compartment history files, study the 'CAT' (Catchment Area Treatment Plan) and FDA (Forest Development Agencies). Use of forestry equipments/ instruments, Study the regeneration and management of important forestry tree species, Sample plots, layout studies, stump analysis, preparation of local volume Tables. Study the working of other Forestry related organizations/industries.

At the Wild life Sanctuaries/National Parks/Tiger Reserves, the students are expected to learn about the aspects related with the preparation of the Management Plans/Conservation Plans, to undertake and familiarize the various wildlife population enumeration techniques and the biodiversity assessment techniques. To undertake pilot studies on the man-animal conflict and other issues in the forest areas etc.

Industrial Placement

Attachment with Forest Based Industries like Wood Workshop, Saw Mills, Wood Seasoning and Preservation Treatment Plants, Pulp and Paper Industries, Aromatic and Medicinal Plant Units including AMPRS, Odakkali, Oushadhi, Kottakkal, KAPL, Aluwa, Ayurdhara, etc. Carpentry, bamboo and reed crafts, other Wood Products Industries, rubber, NWFP etc.Worksto beunder taken includes study the nature of industrial and business organization–structure, raw material–collection and processing of raw-material, hands on practicals, production and management process, marketing and financial management.

Weapon Training and First-Aid Training:

Hands on training in the handling of various kinds of weapons and their operation, limitations and precautions during their use. Getting basic know ledge on different first aid practices which are required in case of field emergencies, like snakebite, animal attack, poachers and accidents. Also to learn about the first aid to be given to wild animals in distress and volunteering in rural health services.

Socio Economic Surveys and Village Attachment:

Data collection, use of PRA techniques with respect to village profile including socio-economic and cultural status, farm technology used, home steads, agro forestry, biodiversity etc., Bench Mark survey of plantre sources (cropping pattern, home steads, agro for estry, biodiversity, yield system etc.),Schedule development, tabulation, analysis and preparing plan of work. Understanding local for estry and other village level institutions(Panchayat,Village Forest Committees, corporations, youth/women groups etc.), People's participation in developmental programmes with special reference to forestry. Exercises on the use of extension methods and teaching aids for Transfer of Technology.

Report Writing and Presentation

Compilation of the work/experience detailing the objectives, places and persons visited, work done, experiences/skills gained and suggestions for improvement of training. Presentation of the report before faculty. The assessment will be based on Project Report evaluation and viva-voce.

PW Project Work & Dissertation 10(0+10)

This course shall provide the B.Sc. (Hons) Forestry students an understanding of the principles and procedures of the experimental design, layout, analysis and interpretation of data and technical writing. Each student shall work on a specific research project to be identified with the help of the supervising teacher. They shall also prepare and present a proposed plan of work (PPW) specifying the objectives and procedures of the study and present the same before an audience consisting of faculty and students. The research work will be conducted leading to the preparation of a project report in the format and style of M.Sc. Thesis. Evaluation will be done based on the quality of work, quality of report and its presntation before an audience consisting of faculty and students.

Minimum Standards for Establishing a College of Forestry

1. **Degree nomenclature:** B. Sc. (Hons) Forestry
2. **Eligibility Criteria** 10+2/Intermediate with PCM/PCMB/Agriculture (P- Physics, C-Chemistry, M-Mathematics, B-Biology) from a recognised Board/university
3. **Medium of Instruction:** English
4. **Minimum Intake:** 50 students per year
5. **Departments**
   1) Silviculture and Agroforestry
   2) Forest Biology and Tree Improvement
   3) Natural Resource Management
   4) Forest Product Utilization
   5) Wild Life Sciences
   6) Basic and Social Sciences

6. Faculty Requirements for Divisions/Section

Department	Professor	Associate Professor	Assistant Professor	Total
Silviculture and Agroforestry	1	2	4	7
Forest Biology and Tree Improvement	1	2	4	7
Natural Resource Management	1	2	4	7
Forest Products and Utilisation	1	2	4	7
Wildlife Sciences	1	2	4	7
Basic and Social Sciences	1	2	6	9
Total	**6**	**12**	**26**	**44**

7. Administrative and Supporting Staff for Divisions/Section

Department	Steno/PA/ Computer Operator	Attendant/ Messenger	Laboratory Assistant / Attendant	Field Staff
Silviculture and Agroforestry	1	1	1	3
Forest Biology and Tree Improvement	1	1	1	3
Natural Resource Management	1	1	1	3
Forest Products and Utilisation	1	1	1	3
Wildlife Sciences	1	1	1	3
Basic and Social Sciences	1	1	1	3
Total	**6**	**6**	**6**	**18**

Note: Security services to be outsourced

8. Manpower Requirements

A. Dean's Office

Manpower	Number
Dean	1
A. Establishment	
PA to Dean	1
Assistant Registrar	1
Accounts Officer	1
Superintendent	1
Computer operator	2
Steno/Assistant	2
Operator (Audio visual)	1
Attendants /Messengers	4
Clerk (LDC)	4
Electrician	1
Storekeeper	1
Driver (office vehicle/student buses/tractors)	4
Security, Sanitation and Landscaping and transportation	To be outsourced
B. Central Research and Teaching Laboratories	
Laboratory Technicians	2
Laboratory Assistant	2
Laboratory Attendant	1
C. Library Staff	
Assistant Librarian	1
Library Assistant	1
Clerk	1
Shelf Assistant	2
D. Students Welfare	To be provided by the Institute/ University as the Central Facility
E. Hostel Staff for two Hostels*	
Warden	1(UG and PG; Men & Women)
Assistant Wardens	2(UG and PG; Men & Women)
Care Taker/Matron	4(UG and PG; Men & Women, Men &Women)
Attendants	8
Security, Sanitation and Landscaping	To be outsourced

9. Land Requirements : 50 ha

- **Main building and Hostels** : 6 ha
- **Field area** : 44 ha
- **Play grounds & indoor stadium** : From common facility of the institute

10. Floor Space Requirement

A. Central Facilities

S. No.	Details	Number of Rooms	Dimensions
1.	Dean office	1	20' x 24'
2.	PA room	1	10' x 12'
3.	Committee room with video conferencing facility	1	20' x 48'
4.	Administrative officer room	1	20' x 12'
5.	Admin. staff rooms	2	20' x 12' each
6.	Examination cell	1	20' x 12'
7.	Placement cell	1	30' x 18'
8.	Smart Lecture rooms	6	Seating capacity -70
9.	Library	1	60' x 140'
10.	Examination hall	1	Seating capacity -150
11.	Laboratories	10	30' x 48' each
12.	Hostels	4	UG and PG Boys & UG and PG Girls
13.	Toxic chemical waste storage/disposal Unit	1	20' x 24'
14.	Canteen	1	20' x 12' (kitchen) & 20 x 36' (seating)
15.	Toilets	2 sets for each floor	
16.	Parking space	As per requirement (APR)	For college and hostels
17.	Vehicles - Dean's car	one	
	Vehicle - for Field trips as part of research- Jeep/SUV with four wheel drive	Two	
	Vehicle - for Students Field trip - 30 seat capacity bus	Two	
	Vehicle - pick up van	One	
18.	Common room for boys and girls	Two	

B. Departments

S. No.	Detail	Number of rooms	Dimensions (ft)
1	Office of Head of the Department	10(one for every Department)	20 x 12 each
2	Administrative Staff	10 (one for every Department)	12 x 10 each
3	Faculty Room	10 (one for every Department)	30 x 30 each and to be partitioned
4	Rooms for Research Scholars	10 (one for every Department)	20 x 24 each
5	Smart Lecture cum seminar room	10 (one for every Department)	Seating capacity – 40 each
6.	Laboratories	20 - Two laboratories (one each for UG and PG) in each departments	20 x 60 (one) 20x 36 (one each for 6 departments)

11. Central/Division/Section Laboratories (as per requirements of the teaching and research work of the college)

12. Common laboratory/facility

Botanical Garden
Natural History Museum
Xylarium
Tree Nursery
GIS and Remote sensing Lab
Computer Lab
Auditorium (optional)
Students Activity Centre (optional)

13. Department wise list of Minimum Equipment/ Instruments in Laboratories

Sl. No.	Name of the Equipment	Number	UG	Department
1.	Soil analysis kit	1	UG	Silviculture(SAF)
2.	Portable soil moisture kit	1	UG	(SAF)
3.	Telescopic tree ladder	1	UG	(SAF)
4.	Seed moister meter	1	UG	(SAF)
5.	Seed/ grain divider	1	UG	(SAF)
6.	Seed precision divider	1	UG	(SAF)
7.	Seed divider	1	UG	(SAF)
8.	Seed grader	1	UG	(SAF)
9.	Seed hand-test sieves	1	UG	(SAF)
10.	Seed sieve shaker	1	UG	(SAF)
11.	Laboratory aspirator	1	UG	(SAF)

12.	Seed blower	1	UG	(SAF)
13.	Illuminated purity work board	1	UG	(SAF)
14.	Hot air seed drier	1	UG	(SAF)
15.	Growth Rooms	3	UG	Forest Biology and Tree Improvement (FBT)
16.	Hot Plates, Magnetic stirrers, Vortex etc.	6	UG	(FBT, WLS)
17.	Laminar Flow	4	UG	(FBT, WLS)
18.	Multiflow Dispenser	2	UG	(FBT, WLS)
19.	Precision Ovens	6	UG	(FBT, WLS)
20.	Plant Imager	2	UG	(FBT)
21.	Shakers (Table Top)	3	UG	(FBT, WLS)
22.	Spectrophotometer	2	UG	(FBT)
23.	Thermocycler	6	UG	(FBT, WLS)
24.	Thermomixer	3	UG	(FBT)
25	Tissue Lyser	3	UG	(FBT)
26.	Vacuum Concentrator	2	UG	(FBT)
27.	Computer for Bioinformatics Section	6	UG	(FBT, WLS)
28.	PAR & LAI Ceptometer /Canopy analyzer	1	UG	(FBT)
29.	Leaf area meter	1	UG	(FBT)
30.	Steady state porometer	1	UG	(FBT)
31.	Leaf wetness sensor	1	UG	(FBT)
32.	Scholanders pressure bomb (Plant water console)	1	UG	(FBT)
33.	Osmometer	1	UG	(FBT)
34.	Compound microscope (Students)	30	UG	(FBT)
35.	Stereo microscopes	5	UG	(FBT)
36	Compound microscopes (Research – binocular / trinocular)	3	UG	(FBT, WLS)
37	Wildlife census equipments (compass, GPS, range finder, bat detectors, mist nets,Sherman traps, tapes etc)	100	UG	Wildlife Sciences (WLS)
38.	Wildlife handling equipments	As per requirement (APR)	UG	(WLS)
39.	Wildlife Field research equipments such as binoculars, telescopes, ultra sonic batdetectors, audio equipments, remotecameras and triggering devises, museumcollection equipments, specimen storagecabinets etc	As per requirement (APR)	UG	(WLS)
40.	SLR digital camera and accessories	5	UG	(WLS)

41.	Spectrophotometer	1	UG	(NRM)
42.	Flame photometer	1	UG	(NRM)
43.	Conductivity meter	1	UG	(NRM)
44.	Water bath	1	UG	(NRM)
45.	incubator	1	UG	(NRM)
46.	Laminar Air flow	1	UG	(NRM)
47.	Bomb calorimeter	1	UG	(NRM)
48.	Incubator	1	UG	(NRM)
49.	Automatic weather station	4	UG	(SAF, WLS)
50.	pyranometer	1	UG	(FBT)
51.	Salinity meter	1	UG	(NRM)
52.	Tensiometers	2	UG	(NRM)
53.	Tree telescope	2	UG	(NRM)
54.	Canopy analyzer	1	UG	(NRM)
55.	Laser Digital caliper	3	UG	(NRM)
56.	Moisture meter	1	UG	(NRM)
57.	Viscometer	1	UG	(NRM)
58.	Digital balance	3	UG	(NRM)
59.	prismatic compass	5	UG	(NRM)
60.	Swedish Bark gauge	3	UG	(NRM)
61.	altimeter	5	UG	(NRM)
62.	Clinometer	5	UG	(NRM)
63.	Hypsometer	APR	UG	(NRM)
64.	Pressler's Increment borers	4	UG	(NRM)
65.	Abney level	10	UG	(NRM)
66.	dumpy level	3	UG	(NRM)
67.	Alidade	3	UG	(NRM)
68.	Christen's hypsometer	APR	UG	(NRM)
69.	Smythie's hypsometer	APR	UG	(NRM)
70.	Improvised calipers	APR	UG	(NRM)
71.	Brandis hypsometer	5	UG	(NRM)
72.	Haga altimeter	5	UG	(NRM)
73.	Blume-Leiss hypsometer	4	UG	(NRM)
74.	Spiegel relaskop	5	UG	(NRM)
75.	Global positioning systems	5	UG	(NRM)
76.	Wheeler's pentaprism	4	UG	(NRM)
77.	Chain (20 or 30 m)	4	UG	(NRM)

78.	Offset	APR	UG	(NRM)
79.	Cross Staff	APR	UG	(NRM)
80.	Plump Bob	APR	UG	(NRM)
81.	Ranging rods	APR	UG	(NRM)
82.	Tape (30 m)	5	UG	(NRM)
83.	Plane table	5	UG	(NRM)
84.	Trough compass	5	UG	(NRM)
85.	U fork	5	UG	(NRM)
86.	Spirit level	5	UG	(NRM)
87.	Digital level	2	UG	(NRM)
88.	Laser level	2	UG	(NRM)
89.	Level staff	5	UG	(NRM)
90.	Microscope- simple microscope, compound microscope and stereo microscope	5 each	UG	Forest Protection (FPU, WLS)
91.	Autoclave- vertical and horizontal	1 each	UG	(FPU)
92.	Pressure cooker (20 L)	2	UG	(FPU)
93.	Hot air oven	1	UG	(FPU)
94.	B O D Incubator	1	UG	(FPU)
95.	Temperature and humidity control chamber	1	UG	(FPU)
96.	pH meter	2	UG	(FPU, FRM)
97.	Water bath- rectangular thermostatic	1	UG	(FPU)
98.	Common balance	2	UG	(FPU)
99.	Bunsen burner	2	UG	(FPU)
100.	Herbarium press	15	UG	(FPU)
101.	Workstation for GIS	10	UG	Basic Sciences (BSS)
102.	Scanner cum plotter/Printer	2	UG	(BSS)
103.	Global positioning systems	10	UG	(BSS)
104.	GIS software - ERDAS/Arc GIS/I GiS Ver.1.1 GIS	2	UG	(BSS)
105.	3D Printer	1	UG	(BSS)
106.	Universal testing machine micro processor based with PC system and printer	1	PG	Forest Products and Utilisation (FPU)
107.	Near Infra Red (NIR) / Fourier Transform Infrared (FT-IR) Spectrophotometers	1	PG	(FPU)
108.	Wiley mill for powdering wood samples (for cellulose and lignin analysis)	1	PG	(FPU)
109.	Nuclear Magnetic Resonance Spectroscopy (NMR)	1	PG	(FPU)
110.	Atomic Absorption Spectrophotometer (AAS)	1	PG	(SAF)

111.	Yoder apparatus	1	PG	(SAF)
112.	Tree radar system	1	PG	(SAF)
113.	CHNS analyzer	1	PG	(SAF)
114.	Mini tractor will tiller/disc facility	1	PG	(SAF)
115.	Radio transmitters and radio telemetry equipments	5	PG	(WLS)
116.	Wildlife marking equipments such as split- rings, bands, tags, ball chain necklace, betalights, cyalume, punch marking and tattooing equipments, fluorescent powder and hand-held ultra-violet lights	As per requirement (APR)	PG	(WLS)
117.	Sequencer - ABI 3730xl	1	PG	(FBT)
118.	Illumina Sequencing Platform	1	PG	(FBT)
119.	Cold room -20 C	1	PG	(FBT)
120.	Cold room 4 C	1	PG	(FBT)
121.	SNP Genotyping Platform	1	PG	(FBT)
122.	HPTLC	1	PG	(FBT)
123.	High Performance Computing Grid	1	PG	(FBT)
124.	Inductively Coupled Plasma (ICP-OES	1	PG	(FBT)
125.	High Speed Centrifuge	4	PG	(FBT)
126.	Water Purification Unit	APR	PG	(FBT)
127.	-20 C Freezer	3	PG	(FBT)
128.	-80 C Freezer	3	PG	(FBT)
129.	Autoclaves	5	PG	(FBT)
130.	Automated Capillary Electrophoresis System	3	PG	(FBT)
131.	Autopipetting System	3	PG	(FBT)
132.	Biolistic Particle Gun	3	PG	(FBT)
133.	Biophotometer	2	PG	(FBT)
134.	Biosafety Cabinet	3	PG	(FBT)
135.	Centrifuge	6	PG	(FBT)
136.	Cryo-cans	6	PG	(FBT)
137.	Dry Baths	6	PG	(FBT)
138.	Electrophoresis Systems and Power Packs	3	PG	(FBT)
139.	Electroporator	4	PG	(FBT)
140.	Environmental Chamber	2	PG	(FBT)
141.	Fermenter	3	PG	(FBT)
142.	Fluorescent Microscope	3	PG	(FBT)
143.	Gel Documentation System	4	PG	(FBT)
144.	Gel Dryers	2	PG	(FBT)

145.	Hybridization Ovens	2	PG	(FBT)
146.	Ice Making Machines	2	PG	(FBT)
147.	Incubator Shakers	4	PG	(FBT)
148.	Incubator	5	PG	(FBT)
149.	Lypholyser	1	PG	(FBT)
150.	Microcentrifuge	6	PG	(FBT)
151.	Microplate Washer	2	PG	(FBT)
152.	Microplate Readers	2	PG	(FBT)
153.	Microwave Digestion Oven	2	PG	(FBT)
154.	Nanodrop for DNA Quantification	2	PG	(FBT)
155.	Plate Centrifuges	3	PG	(FBT)
156.	Real Time PCR	4	PG	(FBT)
157.	Refrigerator 4 C	5	PG	(FBT)
158.	Semi Dry Blotter	2	PG	(FBT)
159.	Ultracentrifuge	2	PG	(FBT)
160.	Ultrasound Sonicator	3	PG	(FBT)
161.	UV Transilluminator	3	PG	(FBT)
162.	UV Stratalinker	2	PG	(FBT)
163.	Water Bath - Shaking	3	PG	(FBT)
164.	Major Softwares-CLC Genomics and other relevant softwares	APR	PG	(FBT)
165.	Portable Ethylene Analyzer	1	PG	(FBT)
166.	Programmable LED Experimentation System	1	PG	(FBT)
167.	Leaf Spectrometer	1	PG	(FBT)
168.	Root Image Analysis System	1	PG	(FBT)
169.	In Situ Root Imager	1	PG	(FBT)
170.	UV to Near Infrared Range Spectroradiometer	1	PG	(FBT)
171.	HemiView - Forest Canopy Image Analysis System	1	PG	(FBT)
172.	IRGA Photosynthesis System	1	PG	(FBT)
173.	Chlorophyll Fluorimeter	1	PG	(FBT)
174.	Sap flow meter	1	PG	(FBT)
175.	Infra red thermometer	1	PG	(FBT)
176.	Eddy covariance CO2/H2O flux measurement system	1	PG	(FBT)
177.	Soil CO2 flux system	1	PG	(FBT)
178.	UV-Bio Radiometer with Recorder	1	PG	(FBT)
179.	Florescence microscope	1	PG	(FBT)

180.	Dissection microscopes	20	PG	(FBT)
181.	Microtome	1	PG	(FBT)
182.	Vacuum oven with vacuum pump	1	PG	(NRM)
183.	Microwave oven	2	PG	(NRM)
184.	Melting point apparatus	1	PG	(NRM)
185.	Bark separator	2	PG	(NRM)
186.	Topo Abney	5	PG	(NRM)
187.	CHN Analyzer	1	PG	(NRM)
188.	Ravi multimeter	5	PG	(NRM)
189.	Vertex digital hypsometer (Haglof)	3	PG	(NRM)
190.	Micrometer- stage and ocular	4 each	PG	(FPU)
191.	Colony counter	1	PG	(FPU)
192.	Inoculation chamber (Laminar airflow chamber)	2	PG	(FPU)
193.	Ultra violet lamps	APR	PG	(FPU)
194.	centrifuge	2	PG	(FPU)
195.	Electronic monopan balance	2	PG	(FPU)
196.	Spectrophotometer or colorimeter	1	PG	(FPU)
197	Haemocytometer/ Petroff-Hausser counting chamber	1	PG	(FPU)
198.	Filters-Seitz filter	1	PG	(FPU)
199.	Orbital incubator / hot palte stirrer	1	PG	(FPU)
200.	Rotary flask shaker	1	PG	(FPU)
201.	Inoculation needle	APR	PG	(FPU)
202.	ICP (OES)	1	PG	(BSS)
203.	Microwave digester	1	PG	(BSS)
204.	Infrared thermometer	1	PG	(BSS)
205.	Air weather monitoring system	1	PG	(BSS)
206.	Manual and automatic agrometeorology	1	PG	(BSS)
207.	Solar radiation assessment system	1	PG	(BSS)
208.	Soxhlet apparatus	1	PG	(NRM)

COMMUNITY SCIENCE (HOME SCIENCE)

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i). UG degree:

- B.Sc. (Hons) Community Science
- B.Sc. (Hons) Food Nutrition and Dietetics.

ii). PG degrees: M.Sc. and Ph. D (Community Science)

PG in following streams:

S. No.	Specialization in M.Sc. and Ph.D.
1	Food Science and Nutrition
2	Textiles and Apparel Designing
3	Family Resource Management
4	Human Development and Family Studies
5	Extension Education and Community Management

Restructuring of UG programmes for increased practical and practice contents

Basic supporting courses of Science and Humanities:	32 credits
Core courses for three years for all students:	95 credits
Student READY programme:	40 credits
	Grand Total 167 Credits

Department – wise distribution of core courses	No. of credits
*Department of Apparel Design	09
*Department of Textile Science and Design	10
Department of Food Science and Nutrition	15
Department of Food Policy and Public Health Nutrition	10
*Department of Family Resource Management and Consumer Science	18
*Department of Human Development and Family Studies	17
Department of Extension Education and Communication Management	16
Total	**95**

***Departments were bifurcated into two each**

Student READY programme module – I 36 weeks

Student READY programme module – II 36 weeks

List of Basic Supporting, Core and Student READY module courses

I. Basic Supporting Courses	
General English	2(1+1)
Technical Writing (English)	2(1+1)
Elementary Statistics	3(2+1)
Agricultural Informatics	3(1+2)
Principles of Biochemistry	3(2+1)
Environmental Studies and Disaster Management	3(2+1)
Elementary Human Physiology	3(2+1)
Fundamentals of Food Microbiology	3(2+1)
Communication Skills and Personality Development	3(2+1)
Economics and Marketing	3(2+1)
Introduction to Rural Sociology	2(2+0)
National ServiceScheme	2(0+2)
Total	**32(19+13)**
1. List of Core courses	
Course Title	**Credit Hours.**
Department of Textile Science and Design Textile Courses	
Textile Science and Fabric Care	3(2+1)
Techniques of Fabric Construction	3(1+2)
Textile Finishes	2(1+1)
Retailing and Merchandising-Textiles and Apparel	2(2+0)
Total	**10(6+4)**
Department of Apparel Design Textile Courses	
Fundamentals of Clothing Construction	3(1+2)
Garment and Accessory Designing	3(0+3)
Traditional Textiles and Costumes of India	3(2+1)
Total	**9(3+6)**
Department of Extension Education and Communication Management Courses	
Women in Agriculture	2(2+0)
Extension and Rural Development	2(2+0)
Information and Communication Technology	3(1+2)

Diffusion and Adoption of Homestead Technologies	3(2+1)
Programme Development for Rural Families OR Project Management	3(1+2)
Extension Training Management	3(1+2)
Total	**16(9+7)**
Department of Food Science and Nutrition	
Principles of Human Nutrition	3(3+0)
Food Science and Processing	3(2+1)
Normal and Therapeutic Nutrition	3(2+1)
Clinical Nutrition and Dietetics	3(2+1)
Food Analysis	3(1+2)
Total	**15(10+5)**
Department of Food Policy and Public Health Nutrition	
Community Nutrition and Education	3(2+1)
Food and Nutrition Policy and Agriculture	2(2+0)
Food Hygiene and Sanitation	2(1+1)
Food Standards and Quality control	3(2+1)
Total	**10(7+3)**
Department of Family Resource Management and Consumer Science	
System Dynamics and Management of Resources	2(1+1)
Financial Management and Consumer Education	2(2+0)
Ergonomics and Appropriate Technologies	2(1+1)
Entrepreneurship Development and Business Management	3(2+1)
Fundamentals of Art and Design	3(2+1)
Residential and Commercial Space Design	3(2+1)
Housing and Space Management	3(2+1)
Total	**18(12+6)**
Department of Human Development and Family Studies	
Fundamentals of Human Development	2(2+0)
Developmental Challenges in Children	3(2+1)
Life-Span Development	3(2+1)
Marriage and Family Dynamics	3(2+1)
Family Counseling and Child Welfare	3(2+1)
Education Psychology and Early Childhood Education	3(2+1)
Total	**17(12+5)**
Grand Total	**127(78+49)**

Student READY Programme

Module 1- Product Development and Entrepreneurship

Objective

This module aims to grant practical knowledge to students regarding product development and entrepreneurship, covering all aspects related to income generation through production and sale of clothing and textile and interior decoration products and also the management of their entrepreneurial ventures.

Course Title	Credit Hours
Apparel Designing Technique-Flat Pattern and Draping	3(0+3)
Principles of Textile Designing	3(0+3)
Fashion Illustrations	3(0+3)
Computer Aided Designing-Pattern Designing	4(0+2)
Retailing and Merchandising- Textiles and Apparel	2(0+2)
Instructional Video Production	3(0+3)
Print and Electronic Journalism	3(0+3)
Web designing and Multimedia production marketing	4(0+4)
Public Relations and Social Marketing	3(0+3)
Seminar	1 (1+0)
Event Management	3(0+3)
Interior Design and Decoration	3(0+3)
Computer Aided Interior Designing	4(0+4)
Minimum of 20 credits to be studied	**37**
In-plant Training/Internship/Hands on Training/ RAWE	**20**

Student READY programme

Module 2 - Community Nutrition and Welfare

Objective

This module aims to impart practical knowledge to students regarding community welfare encompassing all the aspects viz. diet counseling, food preservation, food service and hospitality management, nutraceuticals and health foods, early childhood care, education and counseling for parents and community and multimedia and video production. Students would be ready to conduct and manage community welfare programs independently.

Course Title	Credit Hours
Print and Electronic Journalism	3(0+3)
Web designing and Multimedia production marketing	4(0+4)
Instructional Video Production	3(0+3)

Diet and Nutrition Counseling	3(0+3)
Food Preservation and Storage	3(0+3)
Food Service and Hospitality Management	3(0+3)
Nutraceuticals and Health Foods	3(0+3)
Methodsand Materialsfor Teaching YoungChildren	4(0+4)
Education and CounselingforParentsandCommunity	2(0+2)
EarlyChildhood Care, Education andManagement	4(0+4)
Developmental Assessment ofYoungChildren	3(0+3)
Seminar	1(1+0)
Minimum of 20 credits to be studied Total	**36**
In-plant Training/Internship/ RAWE	**(10+10) =20**

A. Distribution of credits as per the Experiential Learning/ internship

EL Activity	No. Of Credits
Orientation	
Developing a Business Plan/ Project proposal	1
Identification of the product to be manufactured, Market Survey, Analysis of the existing status of the identified product and targeted market and customer, Innovativeness and Creativity, Preparation of the project proposal with supply chain of inputs, personnel plan, production plan, finance plan etc. And its preparation	
Plan for the Production	
Organization of resources, Organizing Utility, Sequential grouping of activities, Packaging and storage, Product pricing physical inputs, man hours, depreciation etc.	1
Production	5
Regularity in production, Adhering to production plan, Product quality assessment, Maintenance of production records, Team work	
Sales	2
Sales strategy, sales strategy, sales volumes, assessment of sales performance, profit generated including C/B ratio, payback period, etc.	
Documentation and Report Presentation and Evaluation	1
Total Credit	**10**

Internship Credit Hours 10

B. Semester wise courses B.Sc. (Honours) Community Science

Course Title	Credit Hours
I SEMESTER	
General English – I	2 (1+1)
Extension and Rural Development	2(2+0)
Textile Science and Fabric Care	3(2+1)

Principles of Human Nutrition	3(3+0)
Fundamentals of Art and Design	3(2+1)
Fundamentals of Human Development	2(2+0)
Environmental Studies and Disaster Management	3(2+1)
National Services Scheme	2(0+2)
TOTAL	**20 (14+6)**
II SEMESTER	
Technical Writing (English)	2 (1+1)
Women in Agriculture	2(2+0)
Fundamentals of Clothing Construction	3(1+2)
Food Science and Processing	3(2+1)
System Dynamics and Management of Resources	2(1+1)
Life-Span Development	3(2+1)
Principles of Biochemistry	3(2+1)
Agricultural Informatics	3(1+2)
TOTAL	**21 (12+9)**
III SEMESTER	
Project Management	3(1+2)
Techniques of Fabric Construction	3(1+2)
Community Nutrition and Education	3(2+1)
Financial Management and Consumer Education	2(2+0)
Marriage and Family Dynamics	3(2+1)
Elementary Statistics	3(2+1)
Fundamentals of Food Microbiology	3(2+1)
Food and Nutrition Policy and Agriculture	2 (2+0)
TOTAL	**22(14+8)**
IV SEMESTER	
Housing and Space Management	3(2+1)
Textiles Finishes	2(1+1)
Normal and Therapeutic Nutrition	3(2+1)
Communication Skills and Personality Development	3(2+1)
Developmental Challenges in Children	3(2+1)
Food Standards and Quality Control	3(2+1)
Extension Training Management	3(1+2)
Ergonomics and Appropriate Technologies	2(1+1)
TOTAL	**22(13+9)**

V SEMESTER	
Economics and Marketing	3(2+1)
Garment and Accessory Designing	3(0+3)
Food Hygiene and Sanitation	2(1+1)
Introduction to Rural Sociology	2(2+0)
Family Counseling and Child Welfare	3(2+1)
Elementary Human Physiology	3(2+1)
Residential and Commercial Space Design	3(2+1)
Retailing and Merchandizing- Textiles and Apparel	2(2+0)
TOTAL	**21(13+8)**
VI SEMESTER	
Clinical Nutrition and Dietetics	3(2+1)
Traditional Textiles and Costumes of India	3(2+1)
Food Analysis	3(1+2)
Entrepreneurship Development and Business Management	3(2+1)
Educational Psychology and Early Childhood Education	3(2+1)
Information and Communication Technology	3(1+2)
Diffusion and Adoption of Homestead Technologies	3(2+1)
TOTAL	**21(12+9)**

Student Ready Programme – Module -1 Product Development and Entrepreneurship

SEMESTER VII		**SEMESTER VIII**	
Apparel Designing Technique-Flat Pattern and Draping	3 (0+3)	In-plant training / Internship / RAWE	20
Retailing and Merchandising-Textiles and Apparel	2(0+2)		
Fashion Illustrations	3(0+3)		
Computer Aided Designing-Pattern Designing	2 (0+2)		
Print and Electronic Journalism	3(0+3)		
Instructional Video Production	3(0+3)		
Web designing and Multimedia production	4(0+4)		
Public Relation and Social Marketing	3(0+3)		
Seminar	1(1+0)		
Tourism and Hospitality management	3(0+3)		
Event Management	3(0+3)		
Interior Design and Decoration	3(0+3)		
Computer Aided Interior Designing	4(0+4)		
Minimum of 20 credits to be studiedt	**30**		

Student READY programme (Module 2) - Community Nutrition and Welfare

SEMESTER – I		SEMESTER II	
Print and Electronic Journalism	3(0+3)	In-plant training/ Internship/ RAWE	20
Web designing and Multimedia production marketing	4(0+4) 4(0+		
Instructional Video Production	3(0+3)		
Diet and Nutrition Counseling	3(0+3)		
Food Preservation and Storage	3(0+3)		
Food Service and Hospitality Management	3(0+3)		
Nutraceuticals and Health Foods	3(0+3)		
Methods and Materials for Teaching Young Children	4(0+4)		
Education and Counseling for Parents and Community	2(0+2)		
Early Childhood Care, Education and Management	4(0+4)		
Developmental Assessment of Young Children	3(0+3)		
Seminar	1(1+0)		
Minimum of 20 credits to be studied **Total**	**36**		

Course syllabus

B.Sc. (Honours) Community Science

I. Department of Extension Education and Communication Management

Core Courses

1. Extension and Rural Development 2 (2+0)

Theory

Extension Education- concept and importance, philosophy, principles and objectives. Evolution of extension education- glimpses of pre- and post-independence era. Community: Meaning and definition, types of communities, community and science, community mobilisation-leadership, participation-PRA. Community development programmes- concept, objectives, organization, activities, achievement and failures. Sociology and Rural Sociology- meaning, scope, importance, concepts-structural and functional, differences between rural, urban and tribal societies. Rural development- concept, need, meaning, aim and functions of extension education for rural development. Panchayati Raj Institutions- concept, structure and function. Five year plans. Current rural development programmes/ Organisations- SGSY, MGNREGA, IAY, ICDS, Total sanitation schemes/ campaigns etc., DWMA, ATMA, ITDA, DRDA, KGMV. Role of ICAR, SAUs, KVKs, DAATTCs and NGOs in rural development.

Suggested Readings

- Ray, G.L. (2003), Extension Communication and Management. Kalyani Publishers. Fifth revised and enlarged edition.
- Dahama, O.P. and Bhatnagar, O.P. (2003). Education and Communication for Development. Oxford and IBH Publishing Co. Pvt. Ltd.
- Sandhu, A.S. (1993) Textbook on Agricultural Communication: Process and Methods. Oxford and IBH Publishing Co. Pvt. Ltd.
- Chitambar, J.B. (2008). Introductory Rural Sociology. New Age International (P) Limited.
- Sachdeva, D. R. and Bhushan, V (2007). An Introduction to Sociology. KitabMahal Agency.

2. Project Management 3(1+2)

Theory

Project management: Overview. Project - meaning, concept, types, elements of management. Project proposal- concept, designing, project initiation, resource allocation framework. Market and demand analysis. Environmental appraisal of projects, Environmental impact analysis, Technical analysis, Financial analysis. Budgeting Terminology of networks. Project management techniques.

Practical

Collection and screening of case studies on project management and report writing, Visit to project - Technology generation project. Visit to Project - Transfer of Technology (ToT). Visit to Project- Women entrepreneurship. Visit to state level and international level funding agencies. Visit to International funded projects. Visit to women and child development project. Visit to agriculture development project, Visit to rural development projects. Designing, planning and preparation of a mini project proposal. Working on project management techniques: PERT. Working on project management : CPM. Working on project management techniques: WBS. Report writing

3. Extension Training Management 3(1+2)

Theory

Training: Concept, need, definition, importance. Identification of training need. Types of Training. training process, different phases of training and its management. Qualities of a good trainer- communications skills, training skills, motivational skills and handling difficult situations. Adult learning, characteristics of adult learner. Facilitation skills in training, problem and prospects of training. Designing training module: Basic guidelines, steps in module designing. Training methods. Training evaluation: Objectives, principle, steps and indicators of training evaluation. Important training institutions in India

Practical

Visit to state level training institutes, report writing and presentation, Visit to vocational training institutes, report writing and presentation, Hands-on-experience with training need analysis. Writing training objectives. Hands-on-experience on training methods, Familiarization

with monitoring and evaluation tools of training, Familiarization with offline and online training module. Preparation of training module, Designing, conducting and evaluation of training pogramme, Analysis of HRD programmes of academic and corporate institutions. Interaction with HRD professionals. Presentation of reports.

Suggested Readings

- Gupta, C.B. (2001). Human Resource Management. Sultan Chand and Sons.
- Dahama, O.P. and Bhatnagar, O.P. (2003). Education and Communication for Development. Oxford and IBH Publishing Co. Pvt. Ltd.
- Lynton, R.P. and Pareek, V. (2008). Training for Development. Vistaar Publications.
- Narwani, G.S. (2002). Training for Rural Development. Rawat Publication.
- Saxena, J.P. and Kakkar, A.T. (2000). Training and Development.

4. Diffusion and adoption of Homestead Technologies 3(2+1)

Theory

Concept and elements of diffusion process. Innovation–decision process, types of innovation–decision, consequences of innovations. adoption: meaning, definition, adoption process, factor affecting adoption and innovation – decision process and constraints. Different terms used in diffusion of innovation and adoption process: Rate of adoption, overadoption, innovativeness, dissonance, rejection, discontinuance. Adopter categories: concept and types. Homestead technology: concept and its relevance to innovation – decision process different channels of communication and their characteristics. Social change: concept, theories, dimensions and factors. Change agents and opinion leader; change proneness – acceptance and resistance to social change. Different homestead technologies with special reference to Home Science.

Practical

Collection of homestead technologies. Adoption in localities- Observation, visit to different entrepreneurs with adopted home stead technologies for business enterprise. Visit to different successful SHGs, Categories of adopters among SHG members. Analysis and presentation of report. Identification of change agents in a locality, Presentation of report

Suggested Readings

- Ray, G.L. (2003) Extension Communication and Management. Kalyani Publishers. Fifth revised and enlarge edition.
- Dahama, O.P. and Bhatnagar, O.P. (2003). education and communication for development. Oxford and IBH Publishing Co. Pvt. Ltd.
- Sandhu, A.S. (1993) Textbook on Agricultural Communication: Process and Methods". Oxford and IBH Publishing Co. Pvt. Ltd.
- Chitambar, J.B. (2008) Introductory Rural Sociology. New Age International (P) Ltd.
- Sachdeva, D. R. and Bhushan, V. (2007) An Introduction to Sociology. Kitab Mahal Agency.

5. Programme Development for Rural Families 3(1+2)

Theory

Planning: nature of planning. Extension programme planning: concept, definition, objectives, principles relevant terms used in programme planning : situation, aims, objectives, problem, solution, project, plan, plan of work, calendar of work etc. Steps in extension programme planning: elaborate discussion. Critical analysis of few major development programmes under five-year plans. Leader and leadership: meaning, definition, identification of leader execution of programme: Environment and rapport building, role of local leader, involvement of local leaders, involvement of local bodies, organizations and extension agencies. Implementation of programme and constraints associated with it. Monitoring and evaluation: concept, meaning, definition.

Practical

Establishing rapport with rural families and identification of leader. Conducting baseline survey of village and household and analysis of information. Different PRA tools, its applications in programme development and exercises. Triangulation of information from conventional and PRA method. Preparation of detailed plan of work for small need based programme. Implementation of programme Evaluation of programme Documentation Presentation of findings of programme

Suggested Readings

- Sandhu, A.S (2003), Extension Programme Planning, New Delhi : Oxford IBH
- Ray, G.L. (2004), Extension Communication and Management. New Delhi : Kalyani Publishers.
- Reddy, A.A (2001), Extension Education, Baptala: Sri Lakshmi Press.
- Dahama, O.P and Bhatnagar, O.P (2003). Education and Communication for Development. New Delhi : Oxfords IBH
- Sehgal, S. and Raghuvanshi, R.S. (2007) Text Book of Community Nutrition. ICAR: New Delhi.

6. Information and Communication Technology 3(1+2)

Theory

IT and its importance, IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practical

Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Handling of audio-visual equipments. Organization of an audio-visual programme. Exercises on

MS Word; MS Excel; MS Power Point; Internet applications- Web browsing, creation and operation of email account; analysis of data using MS Excel. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Introduction of various programming languages such as Visual Basic, Java, Fortran, C, C++, and their components. Hands on practice on writing small programmes.

7. Women in Agriculture 2(2+0)

Theory

Evolution of agriculture in India, General agricultural production activities, Agricultural and allied sectors in rural India, role of women in agricultural and allied sectors, status of farm women -Social, economic and health status of women in agriculture, Women friendly tools and implements, Gender issues, Women in agriculture Policy, Programmes (government and non-government)and institutions for women in agriculture, Women empowerment in agriculture, Agripreneurship and training to farmwomen. Courses for Student Ready Programme

Courses for Student Ready Programme

1. Print and Electronic Journalism 3(0+3)

Practical

Visit to print and electronic stations for familiarization with equipments, Interaction with personnel of print and electronic media. Report writing on observations and presentation. Planning a press note/ press release for print media, Screening of radio news programmes. Screening of TV news programmes. Exercises on writing different types of reports for radio. Exercises on writing different types of reports - television formats, Hands-on experience with editing. Planning a press note/ press release for electronic media, Writing and presentation of radio and television news, Orientation to photography and photographic equipment. Hands on training with different types of professional cameras, Writing captions for photographs. Writing and editing photo features for selected photographs and presentation. Familiarization with different online articles. Content creation for online journal. Creating a blog.

Suggested Readings:

- Arvind Kumar (1999). The Electronic Media. Anmol Publications, New Delhi.
- Bhatt, S.C. (1993) Broadcast Journalism. Basic Principles Har Anand Publications, Delhi
- Bhatnagar, R. (2001). Print Media and Broadcast Journalism. Indian Publisher Distributors, Delhi
- Katyal, V.P (2007). Fundamentals of Media Ethics. Cyber Tech Publishers, New Delhi.

2. Public Relation and Social Marketing 3(0+3)

Practical

Visit to Institution under government sector for analyzing the public relations institution. Oientation to different models of PR. Designing PR models. Analysis of the situation to find out the social problems in a community,. Assessment and analysis of the problems. Preparation of report on collected information. Planning for social marketing strategy based on the identified problems. Execution of social marketing programme, Planning for publicity campaign, Execution of publicity campaign. Evaluation of programme and reporting.

Suggested Readings

- Yadava, J.S and Mathur, P. (1998). Issues in Mass Communication: the basic concepts. Volumes 1 and 2. Indian Institute of Mass Communication, New Delhi.
- Douglas, S. (1989). A Social Marketing Perspective on Communication Campaigns in Public Opinion Campaigns. Sage publications, New Delhi.

3. Instructional Video Production 3(0+3)

Practical

Familiarization with instructional video, Writing instructions for instructional video. Familiarization with script. Hands-on-experience with script writing, Familiarization with video and audio formats. Preparation of amateur instructional video. Familiarization with video camera and operation. Hands-on-training with video camera. Production of video – pre-production, production and post production. Projection and evaluation.

Suggested Readings

- Zettl, H. (2005) Television Production Handbook**.** Thomson Learning, USA.
- Millerson, G. and Owens, J. (2008) A Hand book of Video Production. Butterworth-Heinemann, Oxford.
- Millerson, G. and Owens, J. (2009) Television Production. Focal Press, London.
- Zettle, H. (2010). Video Basics. Wadsworth Publishing, Belmont, California.
- Millerson, G. and Owens, J. (2011), Video Production Handbook. 5th ed.
- Vasuki, B. (2013). Video Production. 2nd edition. Oxford University Press.

4. Web designing and Multimedia production 4(0+4)

Practical

Familiarization with different types of websites

Hands-on-experience with Adobe photoshop for designing of website, Hands-on-experience with HTML 4.01 writing for construction of website. Hands-on-experience with Dreamweaver for construction of website. Hands-on-experience with flash for animations of website,

Familiarization with cascading sheet styles. Familiarization with web analytics, Practical orientation to Multimedia application. Exposure to multimedia hardware and maintenance-parts and connection, peripheral. Handling multimedia-parts, connections and peripheral. Scanning, retrieval, capturing and navigating skills. Planning and Production of multimedia package, Multimedia authoring tools - CD and DVD writing techniques, Presentation of the prepared Multimedia kit by using LCD Projector.

5. Seminar 1(1+0)

Theory

A power point presentation on any topic chosen from the subjects studied from vocational package to be prepared and delivered to the group of staff and students of department.

Organization of topic. Presentation of data. Oral presentation. Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

II. Department of Textile Science and Design Core Courses

1. Textile Science and Fabric Care 3(2+1)

Theory

Textile: definition, forms of textile, importance of textile industry in national economy Classification of textile fibres Properties of textile fibres; primary and secondary properties Molecular structure of textile fibres: Monomers, polymers and their types, polymerization and its types, degree of polymerization and orientation Cotton: Fibre production, fibre varieties and their grading, fibre morphology, physical, chemical and biological properties and end-uses Bastfibres: Flax, jute, hemp and ramie; Fibre production, fibre morphology, physical, chemical and biological properties and end-uses Other bastfibres (ramie, jute, hemp): Fibre production, fibre morphology and physical, chemical and biological properties and end-uses Wool: Fibre production, classification of wool and their labeling, fibre morphology, physical, chemical and biological properties and end-uses Silk: Fibre production and classification, fibre morphology, physical, chemical and biological properties and end-uses Chemical spinning: Wet, melt and dry spinning and common properties of man-made fibres Rayons: Viscose, cupramonium and High Wet Modulus rayons; fibre manufacturing, microscopic structure, physical, chemical and biological properties and end-uses Modified cellulosic fibres: Diacetate and triacetate; fibre manufacturing, fibre microscopic structure, physical, chemical and biological properties and end-uses Synthetic fibres: Nylon, polyester and acrylic; fibre manufacturing, fibre microscopic structure, physical, chemical and biological properties and end-uses Mechanical spinning: Ring spinning method Classification of yarn on the basis of structure- simple and novelty yarns, twist direction, twist amount, fibre length and end-uses Methods of fabric construction: Weaving, knitting, braiding, tufting, net, lace making, crocheting, macramé, stitch through fabrics, quilted fabrics, laminated fabrics, bonded fabrics, felt, nonwoven and films Stain removal: Classification of stains and methods of removing different stains Laundry: Definition, principles, equipments, laundry methods and dry cleaning Laundry agents: Water, soap, laundry auxiliary, stiffening agents, bleaches and blues Care of textiles: Labeling and labeling Act Labels and tags used in textiles Storage of clothes: Requirements of short term and long term storage, folding and packaging of clothes

Practical

Testing of textile fibres Microscopic view Burning test Solubility test Visual test Study and identification of different types of yarns in the market Study and identification of fabric samples of different construction in the market and thread count Removal of different stains from fabric surface Washing and finishing of garments made of following fibres: Cotton, Wool, Silk, Blends/ synthetic Visit to textile industry.

Suggested Readings

- Cowan, M. L. and Jungerman, M. E. 1969. Introduction to textiles. 6th ed. New York. Appleton-Century – Crofts.325 p.

- Dantyagi, S. 1959. Fundamentals of textiles and their Care. New Delhi. Orient Longman Limited.
- Deulkar, D. and Tarabai.1967. Household textiles and laundry Work. 3rd ed. Delhi.Atma Ram and Sons Ltd.
- Hall, A.J. 1969. A Students Textbook of Textile Science. London. Allman and Son Ltd
- Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
- Joseph, M. L. 1986. Introductory textile science. 5th ed. New York. CBS College
- Publishing.
- Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd
- Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.
- Stout, E.E. 1970. Introduction to textiles. 3rd ed. New York. John Wiley and Sons, Inc.
- Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
- Vilensky, L. D. and Gohl, E. P.G. Textile Science. Delhi. CBS Publishers and Distributors.
- Wingate, I. B. 1970. Textile Fabrics and their selection.6th ed. New Jersey. Prentice Hall Inc.
- Wynne, A. 1997. Textiles. London, Macmillan Education Ltd. 310 p.
- Vatsala, R. 2003. Textbook of Textiles and Clothing. New Delhi. Indian Council of Agriculture Research.

2. Techniques of Fabric Construction 3(1+2)

Theory

History of weaving and looms Woven fabrics; simple woven structures and compound woven structures and characteristics of woven fabric Classification of looms on basis of mechanics, means of running loom, structure and means of weft insertion Parts of loom and loom accessories and their function Mechanism of weaving: primary, secondary and tertiary motions Basic weaves: Plain, twill and satin and their variations Complex weaves: extra yarn fabrics, pile fabrics, leno, damask and jacquard Knitting: Terminology and principle of knitting Knitting machine: Parts and their function and types of knitting machine Knitting stitches:plain, rib and purl and types of knit fabrics Macrame and crochet: Tools and materials. Manufacturing process of felt, properties and end uses

Practical

Observation of fabric structures under magnifying glass Graphical representation of woven design Handloom and its parts Weaving calculations and yarn preparation for plain weave Setting of loom and weaving of plain weave fabric Knitting machine and its parts Sample preparation of different fabric constructions hand knitting; plain, rib, purl knots of macramé stitches of crochet manual felting

Suggested Readings

- Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
- Joseph, M. L. 1986. Introductory Textile Science. 5th ed. New York. CBS College Publishing.
- Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd
- Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.

- Stout, E.E. 1970. Introduction to textiles. 3rd ed. New York. John Wiley and Sons, Inc.
- Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
- Vilensky, L. D. and Gohl, E. P.G. Textile Science. Delhi. CBS Publishers and Distributors.
- Wynne, A. 1997. Textiles. London. Macmillan Education Ltd. 310 p.
- Vatsala, R. (2003), Textbook of Textiles and Clothing.New Delhi. Indian Council of Agriculture Research.

3. Textile Finishes 2(1+1)

Theory

Textile finishing: Definition and its importance Classification of textile finishes: Chemical, mechanical, temporary, permanent, durable, renewable, semi permanent, reactive and additive finishes Processes of removing impurities from fabrics: Scouring, desizing, degumming, carbonizing, souring Basic finishes that alter hand or texture: Fulling/milling, felting, singeing, stiffening, decatizing Surface finishes: Bleaching, delustering, calendering, beetling, napping, flocking, burnt out design, acid design, plisse design, tentering, shearing and brushing Functional finishes: Water proof and water repellent finish, shrinkage control, wrinkle resistance, anti-static finish, anti-microbial finish, durable press and flame retardant finish Dyes and pigments, classification of dyes Application of dyes: direct, acid, basic, vat, azoic, mordant, sulphur, reactive and disperse dyes Dyeing techniques and equipment: Solution dyeing, fibre dyeing; tow and stock dyeing, yarn dyeing; skein and package dyeing and piece dyeing Styles of printing: Direct, discharge and resist printing Printing methods and equipment: Block, screen, stencil, roller, heat transfer printing, tie and dye and batik

Practical

Finishing of cotton fabric Scouring Bleaching Mercerization Tying and dyeing of cotton fabric with direct dye Fabric designing by batik technique with napthol dye Printing of cotton fabric using different methods Block Stencil Screen Heat transfer

Suggested Readings

- Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
- Joseph, M. L. 1986. Introductory textile science. 5th ed. New York. CBS College Publishing.
- Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd.
- Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.
- Stout, E.E. 1970. Introduction to textiles. 3rd ed. New York. John Wiley and Sons, Inc.
- Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
- Vilensky, L. D. and Gohl, E. P.G. Textile Science. Delhi. CBS Publishers and Distributors.
- Wingate, I. B. 1970. Textile Fabrics and their selection. 6th ed. New Jersey.Prentice Hall Inc.
- Wynne, A. 1997. Textiles. London. Macmillan Education Ltd. 310 p.
- Koushik, C.V and Josico, A.I. 2003. Chemical processing of textiles: Preparatory processes and dyeing.NCUTE. New Delhi.
- Vankar, P.D. 2006. Handbook on natural dyes for industrial applications. New Delhi. National Institute of Industrial Research.

- Shenai, V.A. (2000) Chemistry of dyes and principles of dyeing. Mumbai Sevak Publications.

4. Retailing and Merchandising –Textiles and Apparel 2(2+0)

Theory

Retailing and merchandizing- Terminology, concept and principles Factors affecting merchandizing Role and responsibilities of merchandiser Merchandizing for buying house, departmental stores and export houses. Evolution of retail and retail formats marketing research: Meaning, scope and classification, steps in marketing research Role of marketing research in product planning Sale promotion and promotion mix: advertizing, sale promotion technique, personal selling and publicity

Pricing methods and pricing of textile Export and Import: Channels of distribution, starting of export and import business and its procedure Organizations involved in export promotion in India WTO and its impact on retailing and merchandizing in textile and apparel industry

Suggested Readings

- Cooklin, G. 1991. Introduction to clothing manufacture. London. Blackwell Science Ltd.
- Easey, M. 1995. Fashion marketing. Oxford (U.K.) Wiley-Blackwell.
- Kotler, P. and Keller, K.L. 2006. Marketing management. 12th ed. New Delhi. Prentice Hall of India Pvt. Ltd.
- Nickles, W.G. 1982. Marketing principles. II ed. New Jersey. Prenctice Hall Inc. Eaglewood Cliffs.
- Phillips, C.F and Duncan, D.J. 1956. Marketing principles and methods. II ed.U.S.A.
- Richard D. Irwin Inc.
- Pradhan, S. 2009. Retailing management. 3rd ed. New Delhi. Tata McGraw-Hill Publishing Company Ltd.
- Ramaswamy, V.S. and Namakumari, S. 2004. Marketing management- Planning, Implementation and Control. 4th ed. New Delhi. Mcmillan India Pvt. Ltd.

III. Department of Apparel Designing

1. Fundamentals of Clothing Construction 3(1+2)

Theory

Terminology related to clothing construction Sewing tools and equipments required for measuring, drafting, cutting and stitching Selection and preparation of fabric for garment construction Layout of paper pattern, marking, cutting and stay stitching Unit construction method Importance and function of clothes Socio- economic and psychological factors affecting clothing choices Consumer behaviour and motivation Clothing requirements of different age groups: infant, toddler, pre-schooler, school age children, teenager, adolescent, adult and senior citizen Application of elements and principles of art in apparel designing

Practical

Demonstration on: Sewing equipments and tools, sewing machine and its care. Preparation of samples: Hand stitches; basting, slip-stitching, hemming, smocking, over casting, attaching

fastener and button holing, mending and patching Machine stitches; seam and seam finishes, pleats, gathers and tucks, stay stitch, under stitching, placket opening Demonstration on taking body measurements Preparation of fabric for cutting, and layout of paper pattern on different fabrics patterns including plain, print, lines, plaid and check. Drafting, cutting and stitching of different garments:

i. Baby frock
ii. Panty
iii. Bloomer
iv. Blouse

Suggested Readings

- Carson, B. 1969. How You Look and Dress. 4th ed. New York. Webster Division, McGraw-Hill Book Company.
- Doongaji, S. and Deshpande, R. Basic Processes and Clothing Construction. 2nd ed. New Delhi. New Raj Book Depot.
- Erwin, M.D. *et.al*. 1979. Clothing for Moderns. 6th ed. New York. Macmillan Publishing Co.
- Gawna, E.J. and Qerke, B.V. 1969. Dress 3rd ed. Illinois. Peoria Chas Bennett Co. Inc.
- Kefgen, M. and Phyllis, T.S. 1971. Individuality in Clothing Selection and Personal Appearance. New York. The Macmillan Company.
- Lewis, V.S. 1979. Comparative Clothing Construction Techniques. Minnesota. Burgess Publishing Company.
- Mansfield, E.A. and Lucas, E.L. 1974. Clothing Construction. 2nd ed. London. Houghton Mifflin Company.
- Sodhia, M. 2004. Advanced drafting and draping. New Delhi. Kalyani Publisher.
- Rosencranz, M.I. 1972. Clothing Concepts- A Social and Psychological Approach. New York. The Macmillan Company Ltd.
- Tate, M.T. and Glisson, O. 1961. Family Clothing. New York. John Wiley and Sons.
- Sannapapamma, K.J. and Jahan, S. TXAD111-Fundamentals of Clothing Construction. ecourse.iasri.res.in.

2. Garment and Accessory Designing 3(0+3)

Practical

Selection of figure template for men, women and children Designing of garments for women using different construction features: collar, sleeve, neckline men using different construction features: shoulder yoke, collar, sleeve, cuff children using different construction features: Yoke, gather, pleats, tucks, shirring, smocking, trimmings Drafting and construction of following garments for women, men and children fancy frock salwar/ pyjama/pyjami kurta (gents)/kameez (ladies) night dress/ gown Accessories: introduction and classification; footwear, hand bags, belt, jewelery, gloves, hats, scarves and umbrella Designing of accessories for women, men and children Selection of designs for construction of accessories Construction of one accessory each for women, men and children

Suggested Readings

- Goldstein, H. and Goldstein, V. 1954. Art in Everyday life. 4th ed. New York. Macmillan Publishing Co., Inc. pp – 515.
- Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh. India. Abhishek Publications. 41-43 pp.
- Graves, M. 1951. Art of Colour and design. 2nd ed. New York. McGraw- Hill Company. pp – 438.
- Beitler, E. J. and Lockhart, B. 1961. Design for you. 2nd ed.
- Peacock, J. 2000. Fashion accessories- The complete 20th century source book. London. Thames and Hudson.
- Meadows, C. S. 2003. Know your fashion accessories. NewYork. Fairchild books.

3. Traditional Textiles and Costumes of India 3(2+1)

Theory

Traditional woven textiles of Indi History of woven textiles: Dacca muslin, Brocades, Calico Printing Traditional sareesof India Jamdani, Baluchari, Pochampalli, Patola and Ikat, Kanjivaram, Chanderi, Maheshwari, Bomkai, Sambhalpuri, Vichitrapuri, Paithani, Kota Doria, Gadwal, Irkal, Venkatagiri, Narayanpet, Kasavu, Tanchoi and Brocade Sarees. Traditional woven and embroidered shawls of India: Shawls of Kashmir, Himachal Pradesh, Gujarat, North Eastern States and other states. Printed and painted textiles Printed textiles Block printed textiles: Dabuprinting, Bagruprinting, Sanganeriprinting, Bagh printing Tie and dyed textiles of Rajasthan and Gujarat. Painted textiles: Kalamkari, Madhubani, Warli, Patchitra, Phad and Pichhavai. Embroideries of different states of India: Kashida of Kashmir, Chamba Rumal, Chikankari and Zari work of Uttar Pradesh, Phulkari and Bagh of Punjab, Embroideries of Gujarat, Kantha of Bengal, Manipuri Embroidery, Kasuti of Karnataka, Embroidery and Rabari work of Bihar, Pipli work of Orissa Importance of traditional textiles in textile and apparel industry Importance and market scenario of traditional Indian textiles and their impact on modern textiles industry. Geographical Indications obtained for traditional Indian textiles

Practical

Documentation of motifs of traditional Indian embroideries. Sample preparation of traditional Indian embroideries Documentation of woven textiles of India. Creative projects in the adaptation of traditional motifs and designs in contemporary textiles through collection of samples, sketches and development of scrap book Visit to museum and art galleries

Suggested Readings

- Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh, Abhishek Publication.
- Chattopadhyay, K. 1977. Indian Embroidery. New Delhi, Wiley Eastern Limited
- Harney, J. 1997. Traditional Textiles of Central Asia. London.Thomesand Hudson Ltd.
- Krishna, R A. 1966. Banaras Brocades. New Delhi. Crafts museum.
- Lubell, C. 1976. Textile Collection of the World. Vol. 2. London. United States publication.
- Mehta, R J. 1970. Master Piece of Indian Textiles. D. B. Taraporevale Sons and Co. Private Ltd.
- Treasure of Indian Textiles. 1980. Calico Museum. Ahmedabad.Marg Publication Bombay.

Courses for Student Ready Programme

1. Apparel Designing Techniques- Flat Pattern and Draping 3(0+3)

Practical

Designing and styling using flat pattern technique Moving, dividing and combining darts: Pivot and slash method Converting darts into seam lines Adding fullness by gathers, pleats and tuck Construction of different types of yokes collars: full roll collar, convertible collar, sailor collar, chines collar, polo collar sleeves: set-in sleeve and its variations, raglan sleeve, kimono sleeve skirts: 'A' line, pleated and gathered Preparation of basic block using draping techniques Construction of formal dress for teenager using draping technique Development of commercial pattern for a prepared dress: pattern envelope, patterns and instructions for use. Visit to fashion institute.

Suggested Readings

- Bane, A. 1972. Flat Pattern Design. New York. McGraw Hill Book.
- Bray, N. 1986. Dress Pattern Designing. The Basic Principles of Cut and Fit. 5th ed. USA. Blackwell Science Inc.
- Helen, I.B. 1965. The Theory of Fashion Design. New York. John Wiley and Sons.
- Erwin, M.D. 1970. Practical dress design: Principles of Fitting and Pattern and Marking.
- USA. The Macmillan Company.
- Hollen, N.R. 1975. Pattern Making by the Flat-Pattern method. 4th ed. Minnesota Burgess Publishing Company.
- Pepin, H. 1942. Modern Pattern Designs. New York. Funk and Wagnalls Company Inc.
- Warden, J.A. Golding, M.A. and Stam, J.Y. 1969. Principles for Creative Clothing. New York. John Wiley and Sons.
- Helen, J.A. 2009. Pattern making for Fashion Design. New Delhi. Dorling Kindersley India Pvt. Ltd.

2. Principles of Textiles Designing 3(0+3)

Practical

Motif and its geometry Motif as basic unit of design: selection of components of motif, motif development, symmetrical and asymmetrical motifs and their arrangements Patter arrangement with motif in different repeats Geometry involved in basic textile designing- translation, rotation, reflection and glide reflection Geometrical motifs Developing geometrical motifs Use of monochromatic, analogous and complementary colour scheme in developed motif Arrangement of patterns with developed geometrical motifs Abstract motifs Developing abstract motifs Use of monochromatic, analogous and complementary colour scheme in developed motif Arrangement of patterns with developed abstract motifs Stylized motifs Developing stylized motifs Use of monochromatic, analogous and complementary colour scheme in developed motif Arrangement of patterns with developed stylized motif Natural motifs Developing natural motifs Use of monochromatic, analogous and complementary colour scheme in developed moti Arrangement of patterns with developed natural motifs Ethnic and Traditional motifs Using ethnic and

traditional motifs for creating designs Application of suitable colour schemes in the developed designs Sketching and rendering of different types of border patterns Sketching and rendering of patterns for apparels Sketching and rendering of patterns for home textiles Preparation of swatch book of fabric samples of different types of structural and decorative designs Field visit to printing and textile design centre

Suggested Readings

- Goldstein, H. and Goldstein, V. 1954. Art in Everyday life. 4th ed. New York. Macmillan Publishing Co., Inc. pp – 515.
- Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh, India. Abhishek Publications. 41-43 pp.
- Graves, M. 1951. Art of Colour and design. 2nd ed. New York. McGraw- Hill Company. pp – 438.
- Beitler, E. J. and Lockhart, B. 1961. Design for you. 2nd ed. New York. Johan Wiley and Sons, Inc. pp – 247.
- Wilson, J. 2001. Hand Book of Textile Design: Principles, Processes and Practice. CRC Press, Cambridge. Woodhead Publishing Limited. Pp.152.
- Evans, H. M. and Dumesnil, C. D. 1982. An Invitation to Design. New York. Macmillan Publishing Co., Inc. pp – 358.
- Miller, J. 2003. The style sourcebook. London. Octopus Publishing. pp 92-108.

3. Fashion Illustrations 3(0+3)

Practical

Drawing eight head figure using geometric body shape Proportion: proportion of body parts, proportion of head, face and feet according different age group, sketching figures of different age group based on head theory Facial expression in illustration-eyes, nose and lips Basics of drawing legs, hands and arms of children, men and women's hand Front, ¾ and profile faces of adult and child (Male and Female) Adult and child (Male and Female)figures in different poses Sketching of garment features: collars, neckline, fasteners, sleeves, pockets, cuffs and hemline Sketching of added fullness: frills, flounce, gathers, pleats Sketching of accessories: hats, shoes, boots, belts and purses Designing of garments for adult and child -Male and Female Illustration of fabric design and texture using different media -water colour, pencil colour, collage, poster colour and crayon colour

Suggested Readings

- Greenwood, M. and Murphy, M.F. 1978. Fashion innovation and marketing. New York, Macmilan Publishing Company.
- Stone, E. and Sample, J.A. 1985. Fashion merchandising- An Introduction. IV Ed., New York, MacGraw-Hill Book Company.
- Bina, A. 2012. Fashion Sketchbook. IV Ed. New York. Fairchild books.
- Ireland, P.J. 1970. Fashion Design Drawing. London. B.T. Batsford Ltd.
- Ireland, P.J. 1980. Basic Fashion Design. London. B.T. Batsford Ltd.
- Ireland, P.J. 1974. Fashion Drawing for Advertising. London. B.T. Batsford Ltd.

- Kathryn, K.C. and Munslow, J. 1997. Illustrating Fashion. Oxford. Blackwell Science.
- Riegelman, N. 2009. 9 heads: A guide to drawing fashion. Boston. Pearson education.

4. Computer Aided Designing- Pattern Designing 2(0+2)

Practical

Introduction to pattern making software Basics of pattern making tools Standard tool bar Piece tool bar Seam tool bar Edit tool bar Tool kit Rotate tool bar Internals Segment tool bar Grading tool bar Darts/Pleats Fabric and Stripes Basics of pattern making menus File menu Edit menu Piece menu Grading menu Point menu Segment menu Dart menu Pleat men Seam menu Walk menu Tool menu Help menu Creating and grading basic patterns Bodice front and back Sleeve Skirt front and back

Suggested Readings

- Manual of Pattern Making Software

IV. Department of Family Resource Management and Consumer Science Core Courses

1. System Dynamics and Management of Resources 2(1+1)

Theory

Systems approach to management. Motivating factors of management- valueas, goals and standards, origin, classification and role , Resources – definition, types , guidelines for use of resources and factors affecting, management of household resources and situation, Management process- planning - importance, types, characteristics and techniques, organizing; controlling- definition, phases and factors, evaluating- definition and types of evaluating. Time - tools of time management, and process of time management. Decision making process - types, steps in decision making and factors affecting decion making. Money - management process, types and sources of income, steps in making budget, controlling budget and evaluation of budget.

Practicals

Identification of individual and family values, identification of immediate, short term and long term goals of individual and family. Standards for individual and family goals. Decision making by individuals and families. Applying decision making process, group work presentation on types of decision and decision making process. Listing out human and non – human resources, listing community resources. Application of management process to organize an event – planning, organization, evaluation. Management of personal time record for a week. Presentation of personal time record.

Suggested Readings:

- Mann, M.K. (2004). Home Management for Indian Families, Kalyani Publisher Ludhiana
- Nickell, P. and Dorsey, J.M. (1970). Management of Family Living. Wiley Eastern, New Delhi
- Vargeese, M.N. Ogale, N.N. and Srinivasan, K. (1992). Home Management, Wiley Eastern, New Delhi.

- Krishna Oberoi (2006). Resource Management for Better Homes. R.K. Offset, Delhi.
- Bhargava, Bela. (2005). Family Resource Management and Interior Decoration. Apple Printer and V. R. Printers, Jaipur.

2. Fundamentals of Art and Design 3(2+1)

Theory

Introduction and objectives of interior decoration. Elements of art and their importance in interior decoration. Principles of design and their application to enrich the interiors Colour: sources of colour, properties of colour, emotional effect of colour, colour schemes, colour theories, colour plans for interiors Furniture – types of furniture, materials and finishes of furniture, factors affecting the selection of furniture, care and maintenance of furniture, furniture arrangement, paints to be considered while selecting the furniture. Wall – classification, types of building walls,functional characteristics of walls, types of wall treatments, exterior and interior wall finishes. Floor importance, types of floor covering, care, maintenance and selection of floor covering. Windows – importance, its functional and decorative treatments. Accessories – classification, application of principles of design and decoration in the selection/development of accessories, and their placement.

Lighting – importance, types of lighting and its application. Flower arrangement – materials used, principles involved, types, practical utility and care. Table setting – linens, tableware etc. required for table setting, table etiquettes.

Practical

Learning elements of art and principles of design. Development of motif and design through art principles. Colour – colour schemes, values and intensity scale, colour wheel. Furniture – care and arrangement of furniture. Accessories – preparation and placements of accessories. Flower arrangement. Learning different types of table setting and napkin folding. Window treatment. Lighting, fixtures and then utility. Market survey – different types of wall and floor coverings.

Suggested Readings

- Dorothi, *et al.,* (1980). Introduction to Interior Design. New York: Mc Millan.
- Faulkner and Faulkner. (1975). Inside Today's Home. New York: Holt, Rinehart and Winston.
- Gewther, M. (1970). The Home, its Furnishings and Equipment U.S.A. Mc. Graw Hill.
- Mike, L. (1986). The Complete Interior Decoration. United Kingdom: Mc Donald.
- Ruth, M. (1975). The Home and its Furnishings, U.S.A.: Mc. Graw Hill.
- Seetharaman P. and Sethi M. (2002). Interior Design and Decoration. CBS Publishers and Distributors. New Delhi.

3. Financial Management and Consumer Education 2(2+-0)

Theory

Concepts, importance, objectives and major aspects of family finance. Income concepts: productive income, hidden income, money income, real income, psychic income. Family – as income producing and utilizing unit, factors affecting in the use of family income. Analyzing

income: income profile, methods of handling income, account keeping. Family budget: steps of budget making, factors influence on budget making, advantages of budget making, Engel's law of consumption, standard of living. Credit- needs types, use and source, planning for financial security of families, credit institution. Savings and Investment- types of savings / investment, Saving institution and its importance, criteria for judging family investments. Taxation- objectives, characteristics and classification. Consumer – definition and role, concept of consumer and consumer economics. Market and merchandising – types of market, definition and importance of merchandising. Consumer problems in rural and urban areas: unfair trade practices, adulteration, faulty weights and measures. Consumer rights and responsibilities. Consumerism and consumer protection- history of consumer movement in the developed and developing countries, growth of consumerism, consumer protection Act and Govt. legislation and order, NGO's for consumer protection and welfare. Standard and standardization and legislative measures for regulating quality. Sources of consumer information – advertisements, labels, packaging etc. Consumer and environment.

Suggested Readings

- Bhargava, Bela. (2005). Family Resource Management and Interior Decoration. Univ. book home Pvt. Ltd. Jaipur.
- Khetarpaul, N and Grover, I. (2004). Consumer Guide for Home Maker – Udaipur: Agratech Pub Academy.
- Maneesha Shukul and Veena Gandotra. (2006). Home Management and Family Finance. Dominant Publishers and Distributors, New Delhi.
- Mann, M.K. (2004) Home Management for Indian Families. Kalyani Publishers, New Delhi.
- Rice, Nickel and Tucker. (1976). Management in Family Finance. John Wiley and Sons., New York
- Seetharaman P. Sethi M. (2002). Consumerism Strategies and Tactics. CBS Publishers and Distributors. New Delhi.
- Tiwari, O.P. (2000). Consumer Protection Act Allahabad: Allahabad Law Agency.
- Verghese, M.N. Ugale, W. N. and Srinivasan, K. (1997). Home Management, New Delhi: New Age International.

4. Housing and Space Management 3(2+1)

Theory

Housing and its importance, characteristics and effect of insufficient housing. Factors to be considered in selection of family housing, selection of site, housing needs at different stages of family life cycle. Housing problems – rural and urban housing problems in India. Housing legislation and regulation - Building Act 1984, Defective Premises Act 1972, Disability Discrimination Act 1995, Environment Protection Act etc. Housing policies - government and non-government housing policies and housing schemes. Housing standards – sanitary facility, food preparation and refuse disposal, space and security, thermal environment, illumination and electricity, structure and material, interior air quality, water supply, lead based paints, access, site and neighbourhood, sanitary condition and smoke detectors. Types of house planning – floor plan, site plan, cross sectional plan, perspective plan, elevation plan and landscape plan. Housing finance - government

and non- government finance institutes. Advantages and disadvantages of renting and owning a house. Technology in housing – advance technology in housing construction, low cost building technology, low cost building materials. Economy in housing construction – principles of house planning (orientation, privacy, grouping, roominess, sanitation, ventilation, flexibility, circulation, economy, furniture requirement). Ergonomics and housing - space management and Interior types based on functional needs – interior for youth, elderly and other special needs, functional design of areas in interior .

Practical

Learning architectural symbols. Drawing of house plans for different income levels and activity groups. House plan for renovation according to needs of residents. Designing of kitchen, bathroom etc. for special needs. Market survey to study the available building materials in the local market.

Suggested Readings

- Cherunilam, F. and Heggade, O. (1987). Housing in India. Mumbai: Himalaya Publishing.
- Dorothy Stepat – Devan, Kathryn Camp Logan, Darlene M. Kness, Laura Szekely. Macmillan Publishing Co., Inc, New York.
- Faulkner, R. and Faulkner, S. (1975). Inside Today's Home. New York: Rinehart and Winston.
- Mathur, G.C. (1993). Low Cost Housing in Developing Countries. New Delhi: Mohan Primlani, Oxford and IBH.
- Tessis Agan, M.S. (1970). The House. New Delhi: Oxford and IBH

5. Ergonomics and Appropriate Technologies 2(1+1)

Theory

Work-worker and workplace relationship, work simplification techniques, principles of ergonomics, Household drudgery- definition, Drudgery reduction. Household equipment-introduction, definition, classification and base materials used in construction. Impact of household equipments on work, worker and environment, equipment design and its effect on body posture. Energy – definition, classification and sources, causes of energy crisis and solutions, status of energy crises in India and abroad. Renewable and non renewable energy saving technologies, ways and methods in the reduction of energy consumption in household, farm and community.

Practical

Use and care of common household appliances- refrigerator, washing machine, vacuum cleaner, oven etc. Demonstration of solar household technologies, biogas, zero energy cool chamber etc. Motion Studies – process chart, operational chart etc.

Suggested Readings

- Grandjean, E. (1981). Ergonomics of the Home Taylor and Francis Ltd. New York.
- Grandjean, E. and Kroemer, K.H.E. (1999). Fitting the Task to the Human a Text Book of Occupational Ergonomics. Taylor and Francis, New York.

- Peet, I.J and Arnold, M.G. (1993). Household Equipment. John Wiley, New York.
- Science and Technology for Women. (1993). Complied by Center of Science for Village. Waradha. Department of Science and Technology, New Delhi.
- Singh, S. (2007). Ergonomics Integration for Health and Productivity. Himanshu Publication, Udaipur, New Delhi.
- Steidle, Roze and Bratton. (1968). Work in the Home. John Wiley and Sons Inc. New York.
- Swanson, Bettye. (1983). Introduction to Home Management Macmillan Publishing Co. Inc. New York.
- Varghese, M.N., Ogale, N.N. and Srinivasan, K. (1992). Home Management. Wiley Eastern, New Delhi.

6. Entrepreneurship Development and Business Management 3(2+1)

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes / competencies. Concept, need and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning – spotting of opportunity-scanning of environment – identification of product / service – starting a project; factors influencing sensing the opportunities.

Infrastructure and support systems- Good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries. Interaction with successful entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies

Suggested Readings

- Vasant Desai. (2011). Entrepreneurial Development Potential beyond Boundaries; Himalaya Publishing House.

7. Residential and Commercial Space Design 3(2+1)

Theory

Design and space organization analysis of independent house of different income groups. Design and space organization analysis of apartments and flats. Understanding on building bye laws, regulations and specifications essential for building, and service management. Selecting materials and finishing scheme for interiors. Estimation of cost of fittings, fixtures, furniture, lighting and materials for interior finishing. Estimation of cost of fittings, fixtures, furniture, lighting and materials for commercial buildings. Appraisal on space needs in commercial buildings. Study of commercial interiors for business establishments, hotels/restaurants, hospitals, educational buildings, public service buildings Specifications writing-writing detailed clause by clause specification for materials pre and post execution, tests, mode of measurements, manufacturers details and specifications etc.

Practical

Develop conceptual drawings and floor plans for various income groups. Develop layouts of furniture, lighting, electrical and plumbing for various income groups. Practical applications of design and space organization of apartments and flats and analysis. Cost estimation for designing interiors of various income groups. Planning of ergonomic work layout for a small project (1000 sq.ft.). Planning of ergonomic work layout for hills areas and commercial areas. Evolving interior decoration details with material sample for the small project. Evolving interior decoration details with material sample for hills areas. Evolving interior decoration details with material sample for the a large commercial area. Presentation of the detailed work done for small projects. Presentation of the detailed work done for hill areas. Presentation of the detailed work done for large commercial projects.

Suggested Readings

- Bonda P. and Sonsnowchik K. (2007). Sustainable Commercial Interiors. John Wiley and Sons Publication.
- Carol Simpson, Estimation for Interior Designers, Watson Guptill, Rev. Sub edition, 2001.
- Crafti. (2004). The office – Designing for Success. 2004. Images Publication
- Francis, D. (1997). The New Office. Conran Octopus Publication
- Harmon. S and Kennon, K. The Codes guidebook for Interiors. Fifth Edition. John Wiley and Sons Publication.
- Leibing W. Ralph(1999). Architectural Working Drawings ,4th edition John Wiley and sons, New York .
- Piotrowski, C. and Rogers, E. (1999). Designing Commercial Interiors. Second Edition. John Wiley and Sons Publication.

Courses for student READY programme

I. Event Management 3(0+3)

Practical

Identifying practical situations for event management, conceptualizing goal and objectives,Overall show management. Exhibit sales and promotion. Attendance promotion.

Contract negotiations. Festivals (diwali, religious ceremonies). Social gathering. Conference/ workshop/seminar/congress programming. SWOT analysis of event. Portfolio preparation; presentation and projection for work. Project report on visit to different types of organizational settings like hotel, guest house, hostel, small offices, clubs, fast food centres for management and organization of events. Project planning.

Programme planning and execution. Project development. Event accountancy. Event communication and sponsorship. Event marketing and advertising. Live event management. Visit to different organizations/hotels etc. Project preparation and report presentation.

Suggested Readings and Visits

- Aditya, Suvarna. (2003). Event Management Development Institute. I.E.S. Management College. 4th Floor, 791, S.K.Marg, Opp. Lilavati Hospital, Bandra (W), Mumbai - 400 050.
- Kit, Potions, H.P. Bhuson. (1998). Festival and Special Event Management. . IBM Cooperation, 60 Renfrew Drive, Suite 105, Markham, Ontario, Canada L3R0E1.
- National Institute of Event Management. Ground Floor, Nandavan Building, Corner of Vallabhbhai Road and Ansari Road, Vile Parle (W), Mumbai.
- Sulekha, Narayna. (2001). International Institute of Event Management. SNDT Women's University, Juhu Campus, Juhu Tara Road, Santacruz (W), Mumbai - 400 049.

2.Interior Design and Decoration 3(0+3)

Practical

Application of elements and principles of interior design and Decoration Preparation of utility and decoration articles by using various painting/printing techniques Calligraphy Use of floor decoration in interiors Flower arrangement and decoration for different areas and occasions Stationery designs; cover designs for books, magazines, illustrations, lettering construction etc. Accessories; various types, materials and techniques; pottery, collage, handicrafts, utility articles, paper mache items, paper sculpture, poster making, greeting cards, fabric painting, glass painting, gift wrapping etc.

Suggested Readings

- Dorothi, S. *et al.* (1980). Introduction to Interior Design. New York: Mc Millan.
- Faulkner and Faulkner. (1975). Inside Today's Home. New York: Holt, Rinehart and Winston.
- Gewther, M. (1970). The Home, its Furnishings and Equipment U.S.A. Mc. Graw Hill.
- Mike, L. (1986). The Complete Interior Decoration. United Kingdom: Mc Donald.
- Ruth, M. (1975). The Home and its Furnishings, U.S.A.: Mc. Graw Hill.
- Seetharaman P. Sethi M. (2002). Interior Design and Decoration. CBS Publishers and Distributors. New Delhi.

3. Computer Aided Interior Designing 4(0+4)

Practical

Use of computer in daily sphere and interior decoration. Basic knowledge to start: Installation Explore Auto CAD window. Concepts of Auto CAD window. Opening auto cad through keyboard,

mouse and getting acquainted with main screen, tool bars, dialog box, cancel command, handling files. Drafting settings and setting preferences. Co-ordinate system and input methods, concept of isometrics .Function and toggle keys, command prompt. Draw commands – lines, multiline and pool lines. Draw commands – arc, circle and ellipse. Edit commands – trim, extend, stretch. Edit commands – rotate, mirror, break, offset. Edit commands – object properties, colour. Edit commands polyline filleting, chamfering. Layers – new, name, line weight, line type and style, changing properties. Text style and editing. Dimensioning style and editing. Hatching concept, inquiry tools, introduction to dimension style. Creation of 2d floor plan line, offset, trim, erase. Add on to the floor plan – stretch, extend, mirror, copy, move, rectangle, circle, arc, fillet, chamfer. Get organized with layers – creation of new layers, layer names, colours to layers, line types, weight, freeze. Introduction to 3d modelling – co-ordinate systems, primitive solids objects – slice, revolve, rotate, aligning, filleting, chamfering, perspective view editing. Rendering – material, light effects, backgrounds, fog, landscapes, image creation. Render the images and save them with different image files in BMP, TGA and JPEG. Camera animation of walk through, seeing the preview files and then converting the same to a movie file as AVI, editing movies files and uniting to single file.

Suggested Readings

- Aptech, Ltd. (2002). Auto CAD – A Beginners Companion. Tata Mc Graw-Hill Series, New Delhi.
- Frey, D. (2002). Auto CAD-2000. BPB Publications, Conaught Place, New Delhi.
- Srivastava, P. and Pushker, R. (2003). Multimedia an Education Tool. Advanced Publishing Concept, New Delhi.

V. Department of Food Science and Nutrition

Core Courses

1. Principles of Human Nutrition 3(3+0)

Theory

Historical development of nutrition. Relationship of nutrition to health, growth and human welfare; Definitions of terms used in nutrition- Recommended dietary allowances; balanced diet; health; functional food; phytochemicals; nutraceuticals; dietary supplements. Energy- Units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food, BMR- methods of measurement, factors affecting BMR. Digestion and absorption of carbohydrates, fats and proteins. Carbohydrates- Types, functions, sources, requirement, health conditions affected by carbohydrates, significance of dietary fibre. Lipids- Types, functions, sources, requirement, health problems associated with lipids Proteins- types, functions, sources, requirement, quality evaluation, improvement, deficiency disorders and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of the following- (i) Fat soluble vitamins-A, D, E, K; (ii) Water soluble vitamins – C, B Complex (thiamine, riboflavin, niacin, B2, B3 and folic acid). Minerals- Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc; bioavailability and factors affecting calcium and iron. Water, Functions, sources, distribution in body,water and electrolight balance.

Suggested Readings

- Agarwal, A and Udipi, S. (2014). Text Book of Human Nutrition. Jaypee Medical Publication, Delhi.
- Sehgal, S. and Raghuvanshi, R.S. (2007). Text Book of Community Nutrition. ICAR Publication.

2. Food Science and Processing 3(2+1)

Theory

Food groups, food guide pyramid and its importance, foods as a source of nutrients Objectives of cooking, processing, preservation, methods of cooking with their merits and demerits. Effect of cooking and heat on nutritive value of foods. Cereals, millets and pulses: Composition and nutritive value, types, storage, processing. Cereal cookery. Gluten and factors affecting the gluten formation, cereal starch, gelatinization, dextrinisation. Pulse cookery. Effect of cooking, factors affecting cooking quality, toxic constituents in pulses. Nuts and oilseeds- Composition and nutritive value, types, storage, oil extraction, processing, toxic constituents and role in cookery. Milk and milk products: Composition and nutritive value, properties, processing and packaging, effect of heat, acid, enzymes, microbes, processed and indigenous milk products and their quality, role in cookery.

Eggs- Structure, composition and nutritive value, storage, evaluation of quality of egg, role of egg in cookery. Flesh foods- Structure, composition and nutritive value, types, storage, evaluation of quality and selection of meat, fish and poultry, methods of cooking, brief description of ageing, tenderization and curing. Vegetables and fruits. Composition and nutritive value, types, storage, selection, post-harvest changes, effect of processing, preservation and cooking on different pigments of both fruits and vegetables. Sugar and its products: Composition and nutritive value, type, function, properties, stages in sugar cookery, role of sugar in cookery. Fat and oils. Composition, nutritive value, types, role in cookery and importance in daily diet. Spices and herbs. Types and its use. Beverages and appetizers. Classification, use in everyday lives with special reference to tea, coffee, cocoa and alcoholic drinks. Leavening agents, classification and functions. Processed and convenience foods. Ready to eat foods, frozen foods, dehydrated foods, instant food mixes.

Practical

Laboratory conduct and responsibilities; knowledge of different food stuffs in English, Hindi and local language. Terms used in cookery, weights and measures; identification and use of different kitchen items and equipments. Identification and listing of various food groups; market survey of processed and preserved foods. Cereal cookery. Preparation of plain rice (open and pressure cook), lime-rice, pulao, paratha, chapatti, upma and halwa. Pulse cookery. Preparation of plain dal, dal with green, pakoras, sambar. Preparation of cereal and pulse combined recipes- Idlis, adai. Nuts and oilseeds. Preparation of chikki, til ladoos, thandai, fish in mustard paste Milk cookery. Preparation of curd and paneer. Egg cookery. Selection of egg, preparation of boiled egg, scrambled egg, poached egg. Meat and fish cookery. Preparation of meat and fish based items. Fruits and vegetables cookery: Preparation of sauces, pickles, squash, chips. Sabjis and salad Sugar cookery. Preparation of fudge and fondent. Process of caramalization; demonstration of

1-thread and 2-thread consistency. Fats and oils. Preparation puris, cakes and biscuits. Appetizers. Preparation of red tea, white tea, coffee, egg nog.Visit of food industries.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
- Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
- Khadder V., (1999), Text book of Food, Storage and Preservation. Kalyani Publishers, New Dehi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
- Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.

3. Normal and Therapeutic Nutrition 3(2+1)

Theory

Determination of nutritional requirements: recommended dietary allowance, calorie consumption unit, food exchange list method. Maternal nutrition. Physiological changes and nutritional requirements during pregnancy and lactation. Infancy. Growth, development and nutritional requirement, importance of breast feeding, weaning and supplementary foods. Pre-school children. Growth and development, food habits and nutritional requirements. School age child and adolescents. Growth and development, food habits and nutritional requirements. Geriatric nutrition. Physiological and psychological changes during old age, nutritional requirements and consideration for diet planning. Importance and modification of normal diet to therapeutic diets, Methods of feeding. Normal and artificial. Aetiology, symptoms and dietary management in acute and chronic fevers. Typhoid, influenza, tuberculosis. Aetiology, symptoms and dietary management in gastrointestinal disorders. Diarrhoea, constipation, peptic ulcer. Aetiology, symptoms and dietary management in liver diseases. Hepatitis, jaundice, cirrhosis of liver. Aetiology, symptoms and dietary management in cardiovascular disease. Atherosclerosis and hypertension. Aetiology, symptoms and dietary management in diabetes mellitus Problems of weight control. Overweight and obesity, dietetic management and prevention.

Practical

Standardization of serving size portions. Planning and preparation of diets for different age groups-Infancy, preschool age, school age, adolescent, adult, old age. Planning and preparation of diets for pregnant and lactating women. Planning and preparation of diets for special occasion. Birthdays, festivals, packed lunches. Planning and preparation of diets for following diseased condition- diarrhea, constipation, hepatitis, hypertension, diabetes, mellitus, overweight/ obesity.

Suggested Readings

- Raghuvanshi, R.S. and Mittal, M. (2014). Food Nutrition and Diet Therapy. Westvills Publication Delhi.
- Agarwal, A and Udipi, S. (2014). Text Book of Human Nutrition. Jaypee Medical Publication Delhi.

4. Clinical Nutrition and Dietetics 3(2+1)

Theory

Clinical Nutrition- Introduction, nutritional status and disease, common deficiency diseases, pathogenesis of nutritional deficiency diseases - macronutrient and Micronutrient, protein calorie malnutrition, vitamin A deficiency, anemia, iodine deficiency disorders, gastro intestinal tract diseases- Introduction, different organs and diseases, diagnostic procedure, diseases of mouth and oesophagus, diseases of stomach and duodenum, diseases of small and large intestine, diverticulitis, malabsorptive syndrome and tropical sprue Diarrhoea- Symptoms of diarrhea pathogenesis and diagnosis of constipation, diseases of liver, pancreatitis, chronic obstructive pulmonary disease, diabetes mellitus cardio vascular disease: risk factors, lipo and apo proteins, role of nutrients in preventing atherosclerosis, major enzymes used for diagnosis, congestive heart failure, hypertension. renal disease. Functions of the kidney, nephritis, urinary calculi, types of renal failure, dialysis. Cancer. Causes of cancer cell development, impact of tumor on host metabolism, systematic effects of cancer. Burns. Physical destruction of skin, metabolic aberrations, alteration in nutritional requirement, interaction between nutrients, infection and drugs.

Practical

Estimation of albumin, glucose, ketone bodies, creatinine and creatine in urin.e Determination of bile pigments in urine Analysis of bile salts in urine Analysis of blood glucose level. Estimation of total protein, albumin, haemoglobin. Estimation of blood urea. Estimation of total cholesterol, HDL, LDL, TG in blood. Assignment and presentation.

Suggested Readings

- ICCIDD/UNICEF/WHO. (2001). Assessment of IDD and monitoring their elimination. A guide for programme managers.
- Bamji, S.M., Rao, P.N., and Reddy, V. (2003). Textbook of Human Nutrition. Oxford and IBH Publishing Co Pvt Ltd.
- Bhavana, S. (1999). Nutrition and clinical care. New Delhi Commonwealth Publishers.
- Gibney M.J, Margetts BM, Kearney J.M and Arab L. (2004). Public Health Nutrition. Publishers Blackwell Science.
- Jean-FZ. (2005). Clinical Nutrition. UK Blackwell Publishing Company.
- Jim M. and Stewant TA (2007). Essentials of Human Nutrition. 3rd edn. New York, Oxford University Press.
- Miguel, A.G. and Eduard, C. (2005). Clinical Nutrition. UK, Blackwell Publishing Company.
- Weinsier and Butterworth (1981). Hand Book of Clinical Nutrition. London, C V Mosby Company.

5. Food Analysis 3(1+2)

Theory

Sampling and sampling techniques. Proximate analysis- Moisture, ash, crude fat, crude fibre, crude protein and carbohydrates by difference. Principles and methods of food analysis. Basic principles: Refractometry, polarimetry, densitometry, HPLC, GLC, spectrophotometry,

electrophoresis, automatic amino acid analyzer. Determination of starch. Test for unsaturation of fats, rancidity of fats. Quantitative analysis of protein by Biuret method, Ninhydrin method, Lowry's method and Dye-binding methodBioassays for protein quality of grainsChemical, microbiological, flurometric and colorimetric methods of analysis of fat soluble and water soluble vitaminsPrinciples and methods for estimation of minerals: Atomic absorption spectroscopy, colorimetric, titrimetric and gravimetric methodsMethods for determining physical and rheological properties of food.

Practical

Proximate analysis: Moisture, ash, crude fat, crude fibre, crude protein and carbohydrate by difference. Demonstration of kjelplus, fibreplus, sox-plus. Estimation of sugar content of fruit and reducing and non-reducing sugars in cereals. Estimation of starch content of cerealsDetermination of iodine value and saponification number of fatsEstimation of minerals, iron, calcium and phosphorus Estimation of vitamins. Ascorbic acid, thiamine, beta-carotene. Protein quality analysis, in-vitro method Physical test for grain quality and rheological properties of foods.

Suggested Readings

- AOAC. (2000). Association of Official Analytical Chemists. Washington, DC.
- Pearson, D. (1973. Laboratory Techniques in Food Analysis. Butterworths and Co., London
- Pomeranz and Yeshajahu. (1987). Food Analysis Theory and Practice. 2nd ed. AVI Publ. Company, Westport.
- Joslyn, M.A. (1970). Methods in Food Analysis: Physical, Chemical and Instrumental Methods of Analysis. Academic Press. New York
- NIN. (2003). A Manual of Laboratory Techniques.

VI. Department of Food Policy and Public Health Nutrition

Core Courses

1. Community Nutrition and Education 3 (2+1)

Theory

Malnutrition- Definition and causes, PEM, Marasmus, Kwasiorkor, vicious cycle of malnutrition. Assessment of nutritional status. Clinical signs and symptoms, nutritional anthropometry, biochemical tests, biophysical tests, diet survey methods. Major nutritional problems prevalent in India and the state of Protein energy malnutrition, anaemia, vitamin A deficiency, iodine deficiency disorders, obesity, hypertension, atherosclerosis, diabetes mellitus. National programmes and role of national and international agencies. In improving nutritional status of the community. Integrated Child Development Service (ICDS), supplementary Nutrition Program (SNP), Applied Nutrition Program (ANP), Mid Day Meal Program (MDMP), Vitamin A Prophylaxis Program, Anaemia Prophylaxis Programme. Food and Agricultural Organization (FAO), World Health Organization (WHO), United Nations Children's Fund (UNICEF), UNDP, CARE and other Voluntary and Government Agencies. Nutrition education- Objectives and methods, principles.

Practical

Assessment of nutritional status of an individual/community using anthropometry and dietary survey. A) Preparation of schedule B) Survey work C) Analysis of data D) Writing of report. Visit to local health centre to identify clinical signs and symptoms of nutritional problems. Identification of adulterants in common foods. Visit to an ICDS Block. Development of audio visual aids- radio script; popular article; chart/posters leaflets etc. Planning, implementation and evaluation of nutrition education for a target group.

Suggested Readings

- Sehgal, S. and Raghuvanshi, R.S. (2007) Text Book of Community Nutrition. ICAR, New Delhi.

2. Food and Nutrition Policy and Agriculture 2(2+0)

Theory

Food situation in India and in the world, food production and consumption trends, food balance sheets. Role of nutrition in agricultural planning and national development. Linkages between agricultural practices, Food production, food distribution and nutritional status. Food crop failure and malnutrition, poverty and vicious cycle of low food production. Agricultural development and its effect on food availability. Effect of food production and economic policies on food availability. impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post harvest processing of foods on food and nutrition situation. Food distribution systems. Food security. Concepts and definitions agriculture and food security, nutrition and health urbanisation and food security, food systems and food security, macroeconomic policies Employment and cash income, markets and food prices. Effect of urban agriculture on the nutritional status of vulnerable groups Innovative approaches to enhance local food production and improve food distribution systems. Innovative and effective approaches to manage health risks of urban agriculture. Implications for urban policies and programmes. Food and nutrition security at national and household level; nutrition policy implementation; nutritional impact of agricultural programmes, food price control and consumer subsidy; contribution of national and international organization for agricultural development.

Suggested Readings

- Bhatia MS. (1991). Agricultural Statistics at a Glance. Ministry of Agriculture, Govt. of India, New Delhi.
- Census (1981, 1991, 2001).
- India (2001). A Reference Annual. Publication Division, Ministry of Information about Broad casting, Govt. of India.
- UNICEF (1999). The State of World's Children. Oxford University Press.

3. Food Hygiene and Sanitation 2(1+1)

Theory

Meaning and Principle of food hygiene. Water Requirement and use, sources of water supply, water pollution, purification of water, portable water and its quality-Criteria and standards,

hardness of water and its treatment, defluoridation of water. Food hygiene: Contamination of foods from various sources. Green plants and fruits, animals, sewage, soil, air and water and their health hazards. Food spoilage. Perishable, semi perishable and non perishable foods. Sanitary procedures for preparation, handling and storage of foods. Food poisoning caused by bacteria: *Salmonella, Staphylococcal poisoning, Botulinum, Clostridium perfringens and B.cerus*. Sources, incubation period, mechanism of action. Investigation of Food Poisoning, prevention and control. Food Poisoning caused by agents other than microorganism. Poisonous plants, animals, chemicals, metals and pesticides etc.

Practical

Identification of micro organism, preparation of slides, preparation of media. Collection of water samples. Testing of water for: (i) Physical quality (ii) Bacteriological quality. Survey of hygienic and sanitary condition in food shops/food vendors. Report writing.

Suggested Readings

- Adams M.K. and Moss M.O. (2000). Food Microbiology, New Delhi: Panima Corp.
- Longree K.L. and Blaker G.C. (1982). Sanitary Techniques in Food Service. New York: John Wiley and Sons.
- Park, K. (1997). Textbook of Preventive and Social Medicine. 1st Ed. Jabalpur: Banarsidas Bhanot.

4. Food Standards and Quality Control 3(2+1)

Theory

Importance of quality control and assurance. Food laws and regulations. Prevention of Food Adulteration Act, Fruit Product Order, Agmark, Essential Commodity Act, Consumer Protection Act, Bureau of Indian Standards, Codex Standards. Specifications and application of food standards for raw materials and food products Food additives. Preservatives, coloring agents, antioxidants, emulsifying agents, leavening agents and stabilizing agents Various methods for the assessment of quality of different foods Selection of sensory panel and sensory evaluation of food products. Food safety, risks and hazards Assessment and prevention of food adulteration. Food packaging and packaging material.

Practical

Sensory and nutritional evaluation of some finished products. Detection of adulterants and preservatives in products.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company Inc., Westport, Connecticut.
- Jellinek, G. (1985). Sensory Evaluation of Foods: Theory and Practice. Ellis Honwood Ltd. Chichester, England.
- Manual of Food Standards and Quality Control. (2014). Dept. of Foods and Nutrition, CCS HAU, Hisar.

- Swaminathan, M. (1999. Food Science, Chemistry and Experimental Foods. 2nd ed. The Banglore Printing and Publishing Co., Bangalore.
- Many, N.S. and Shadaksharswamy, M. (1996). Food Facts and Principles. 2nd ed. New Age International Pvt. Limited, New Delhi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised edn. Kalyani Publishers, New Delhi.

Courses for Students READY Programme

1. Diet and Nutrition Counseling 3(0+3)

Practical

Planning and preparation of diets using exchange lists. Processes and technique of counseling Diet planning in fever and infection Diet planning in GI disorders Diarrhea, constipation, gastritis, ulcerative colitis Diet planning in liver disease. Diet formulation in diabetes millitus. Diet planning in heart diseases. Diet planning in kidney diseases Diet planning in food allergies and gout Diet modification for prevention and treatment of cancer Diet in trauma and burns. Diet in obesity and underweight. Diet for old age people. Setting up a unit for nutrition counseling. Role play exercises for counseling. Supervised counseling of patients/clients. Visit to hospitals with therapeutic kitchen setup.

Suggested Reading:

- Antia, P. (1986). Clinical dietetics and nutrition. Oxford Univ. Bombay
- Moris, E.S. (1994). Modern Nutrition in Health and disease. Leaned Febiger, USA
- Aronson. V. (1986). Effective Nutrition Counselling. Van Nostrand Reinfold, New York.
- Bamji, M.S. (2003). Textbook of Human Nutrition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Mahan and Stump. (2003). Kraus's Food Nutrition and Diet Therapy. 11th ed. Saunders Publishing.
- Mahan L.K. and Raymond, J. L. (2011). Krause's Food and the Nutrition Care Process. 13th ed. Saunders Publishing.
- Sardesai, V. (2011). Introduction to Clinical Nutrition. CRC Press.

2. Food Preservation and Storage 3(0+3)

Practical

Market survey of raw and preserved foods. Preparation of preserved products. Squash, cordial, crush, jams, jellies, marmalade, candy, preserves, murabbas, pickles with and without oil, chutneys, ketchup, sauces, candies, toffees, cheese and syrup. Shelf life and sensory evaluation of developed products Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Visits to food processing and preservation units, canning and bottling units, grain storage institute dairy plant and FCI godown.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.

- Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
- Vijay K., (1999), Text book of Food, Storage and Preservation, Kalyani Publishers, New Dehi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
- Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.

3. Food Service and Hospitality Management 3(0+3)

Practical

Contribution of food service institutions in meeting socioeconomic and dietary needs. Menu planning for industrial canteen, hospital canteen, cafeteria, snack bar, residential hostel. Standardization of recipes suitable for fast food outlet, industrial canteen, hospitals, college hostel. Multiplication of standard recipes for quantity food production, quantity food management, portioning and fixing of cost. Visit to canteen attached to hospital and dietary department cafeteria, 3 star hotel/restaurant, 5 star hotel / restaurant, industrial canteen. Presentation of report on hospital canteen, cafeteria, 3 star hotel / restaurant, 5 star hotel / restaurant in terms of organizational set up, production, preparation and service. Practical exercise on planning, preparation and service in a cafeteria, snack, bar fast food outlet. Management of cafeteria – preparation, costing and fixing of price for meal items. Evaluation of management process and report presentation.

Suggested readings

- Sethi and Malhan. (1993) Catering Management: An Integrated Approach. Wiley Eastern.
- West, Wood and Hanger.
- Food Service in Institutions. John Willey.

4. Nutraceuticals and Health Foods 3(0+3)

Practical

Market survey for dietetic foods. Planning, preparation, nutrient calculation and acceptability of dietetic foods with preference to locally available food stuff. High/low energy, high/low protein high/low fibre low sodiumlow cholesterollow dycemic index low fluid, high fibre and low fat.RUTF (Ready to use therapeutic foods) for under nutrition in preschool and school age children. Food for sports person in intensive activities and endurance activities. celiac disease, Food for lactose intolerance Food for senior citizens (with dental problem, with flatulence, digestive disorders, physical and nervous diseases.

Suggested Reading

- Brigelius-F., J. and Joost HG. (2006). Nutritional Genomics: Impact on Health and Disease. Wiley VCH.
- Cupp, J. and Tracy, T.S. (2003). Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press.

- Gibson, G.R. and William CM. (2000). Functional Foods - Concept to Product.
- Goldberg I. (1994). Functional Foods: Designer Foods, Pharma Foods. 1st ed. Springer US
- Losso, J.N. (2007). Angi-angiogenic Functional and Medicinal Foods. CRC Press.
- Manson, P.(2001). Dietary Supplements. 2nd ed. Pharmaceutical Press.
- Campbell J.E. and Summers JL. (2004). Dietary Supplement Labelling Compliance.
- Neeser, J.R. and German BJ. (2004). Bioprocesses and Biotechnology for Nutraceuticals. Chapman and Hall.
- Robert, E.C. (2006). Handbook of Nutraceuticals and Functional Foods. 2nd edn. Wildman.
- Shi J. (2006). Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC Press.
- Webb, GP. (2006). Dietary Supplements and Functional Foods. Blackwell Publ.
- Robert. E.C. (2002). Hand book of Neutraceuticals and Functional Foods, CRC, Press.
- Goldber, I. (1999). Functional foods: Designer foods, Pharma foods and Nutraceuticals, An Aspen Publications.
- Ghosh, D., Baghchi Debasis and Konishi Tetsuya. 2014. Clinical Aspects of Functional Foods, CRC Press.
- Swaminathan, M. (2004). Essential of Foods and Nutrition. Vol.I and II BAPCO, Bangalore.
- Srilakshmi B. (2002). Dietetics. New Age International, New Delhi.

Department of Human Development and Family Studies

Core Courses

1. Fundamentals of Human Development 2(2+0)

Theory

Human development as a field of study. History of study of human development, scope and importance of study of human development from a life-span perspective. Relationship of the discipline of human development with other disciplines of study. Latest issues in human development. Growth and Development. Definition of growth and development difference between growth and development, determinants of human growth and development; principles of human growth and development Genetic basis and concepts associated with human life; stages of human development; domains of human development and its characteristics. Theories of human development: naturalism. environmentalism, maturational, need, ecological, ethological, cognitive, social, psychoanalytical, language and moral research involving humans. Definition of ethics and research, practical and e**thical principles and concerns in research with human subjects. Ethical trends and challenges**. Origins of scientific inquiry, research designs and methods of data collection- their merits and demerits, variables, hypothesis, sampling, operational definitions.

Suggested Readings :

- Berk, E. L. (2013). Exploring life span development.3rded. McGraw Hill, New York.
- Santrock, J. (2012). Life span development. 14thed. McGraw Hill, New York.
- David, M.T., Garavan, L. and Dooley, M. 2012. Fundamentals of human eesource development. *SAGE Publications Ltd*

- James, M. and Nelson. (2009). Fundamentals of human development, religion, and spirituality. Oxford Higher Education.
- Papalia, D.E. and Olds, SW. (2008). Human development. 11th ed. McGraw Hill. New York.
- Harris, J.R. and Liebert, R.M. (1987). The child. Prentice Hall, Inc.
- Parke, R.D. (Ed). (1984). Review of child development research. Volume 7: The family. University of Chicago Press, Chicago.
- Garbarino, J. (1982). Children and families in the Social Environment. Aldine, New York.
- Bronfenbrenner, V. (1979). The ecology of human development. Cambridge, Harvard Univ. Press.
- Hall, Calvin S and Lindzey. G. (1978). Theories of personality. John Wiley and Sons.
- Munsinger, H. (1971). Fundamentals of child development. Holt, Reinhart and Winston, Inc.

2. Life-Span Development 3 (2+1)

Theory

Prenatal, perinatal and postnatal stages- Issues and scientific concepts associated with conception, pregnancy, prenatal development, labour/ birth, postnatal life infancy- physical, motor, social, emotional, cognitive and language characteristcs. Antecedent influences for infancy growth and development. Early Childhood- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for early years growth and development, Stimulating approaches for optimising development. Middle childhood- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during middle childhood, Adolescence- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during adolescence. Adulthood- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during adulthood. Stimulating approaches for optimising development. Old age- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during old age. Stimulating approaches for optimising development. Recent issues in growth and development from infancy to old age.

Practicals

Observational visits to well baby clinic to observe full term and preterm babies. Case study of individuals in different stages of development- Infancy, early childhood, school age, adolescence, adulthood and old age. Critical analysis of case study reports; preparation of resource files.

Suggested Readings:

- Laura, B.E. (2013). Exploring life span development. 3rd ed. McGraw Hill, New York.
- Santrock, J. (2012). Life span development. 14th ed. McGraw Hill, New York.
- Papalia, D.E. and Olds, S. W. (2008). Human development. 11th ed. McGraw Hill, New York.
- Grinder, R.E. (1993). Adolescence. John Wiley and Sons, New York.
- Schaimberg, L.B. (1988). Child and adolescent development. Macmillan publishing company, New York.

- Papalia, D.E. and Olds, S.W. (1978). Human Development. McGraw-Hill, New York.
- Gordon, K.J. (1975). Human development: A transactional perspective. Harper and Row Publishers, New York.

3. Marriage and Family Dynamics 3 (2+1)

Theory

Marriage- Definition, goals/functions, types/forms of marriage in India, rituals and ceremonies of marriage in different religions of India readiness for marriage– Definition, importance, areas of readiness for marriage. Identifying characteristics of readiness for marriage Mate selection-meaning, mode/methods of mate selection. Field of mate selection. Theories of mate selection. Ways of mate selection in tribal India. Factors responsible for wrong mate selection. Guidelines for mate selection, engagement and its importance. Marital roles and behaviours- Definition and importance of marital roles, marriage as status and role transition, determinants of marital role behaviour, concept related to gender roles, changing gender roles, factors responsible for change in gender roles, role conflict marital adjustment- definition, Areas of marital adjustment, factors influencing marital adjustment, types of marital relations and adjustments, marital adjustment over the family life cycle, obstacles in marital adjustment, Improving marital adjustment, marital adjustment techniques, general techniques of resolving differences, marital success, criteria of marital success marital dissolution: definition, types (Voluntary and Involuntary), factors responsible for an increase in the rate of legal marital dissolution, factors responsible for refraining from divorce after marriage failure, social process of marital failure and divorce, separation distress and factors affecting it, no-fault divorce, consequences of divorce, children's response to divorce, children as weapon against divorce, adjustment to divorce family. Definition, functions, forms/types of family. Family structure and relationships in India- Pattern of changes in family structure and relationships in India, familial (education and employment of women) and Extra Familial Factors (technology, peer group, society) responsible for the changes and consequences of these changes on the family life and society. Family life cycle- Definition, importance of studying family life cycle, developemntal tasks, stages of family life cycle, developmental tasks of stages of family life cycle, typical and alternative forms of families- Charactetristcs of Single parent families, female headed families, childless families, adoptive families, dual earner families, reasons behind alternative form of family and its merits and demerits, alternatives to marriage-singlehood, heterosexual cohabitation/ consensual union, homesxual union, reasons behind it and its merits and demerits family stress – Definition, types/ categories of stressors, variables affecting family's response to stress, Hill ABCX Model/ theory of family stress, causes of family stress, effects/ impact of family stress, manifestations/ recognising symptoms of family stress, stress coping strategies, correlates of family stress. Family crises- Definition, when does stress becomes a crisis, hill's ABCX. Theory of family crisis, conditions for crisis, what happens in a crisis? Stages of a crisis, characteristics of crisis events, effects of crises, factors which affect meeting the crises, adjustment to crises, general things to do in times of crises. Laws and acts regarding marriage, adoption, divorce and inheritance in India. Counselling (premarital, marital and family)- objectives, importance, areas of counselling, types, process and effects.

Practicals

Study on motives of marriage, selection of partner; visit to marriage bureau and family counselling center. Comparative study on nuclear and joint families, atypical families and alternative forms of families. Marital roles and adjustments, family crisis and coping; Roles across family life cycle.

Suggested Readings:

- Benokraitis.V.N. (2014). Marriage and families. 8th ed. Pearson publication.
- Ahuja, R. (2005). Indian social system. Rawat publication. New Delhi.
- Kumar, R. (2000). Violence against women. Anmol publication pvt ltd., New Delhi.
- Goode, W.J. (1989). The family. New Delhi: Prentice Hall of India Private Limited.
- Adams B.N. (1980). The family: A sociological interpretation. 3rd ed. Rand McNally College Publishing Company, Chicago.
- Nye, I. (1973). The family: Its structure and interaction. MacMillan Publishing Company, New York.
- Kenkel, W.F. (1973). The family in perspective. Meredith Corporation, New York.
- Gordon Michael (ed). (1972). The nuclear family in crises. The search for an alternative. New York: Harper and Row Publishers.
- Hate, C.A. (1969). Changing status of woman. Allied publishers, New Delhi.
- Kapadia. K.M. (1966). Mariage and family in India. 3rd ed. Oxford university press, Kolkata.

4. Educational Psychology and Early Childhood Education 3(2+1)

Theory

Educational psychology- Meaning, nature, scope and importance of educational psychology, history of its evolution, abroad and in India, recent trends and challenges in educational psychology concept of learning- definition, essential features, types of learning, laws of learning, principles of learning learning traits- sensation, perception, imagination, attention and memory, remembering and forgetting, intelligence-reasoning and thinking, temperament, problem solving, information processing learning environment- reinforcement- definition, types of reinforcements, schedules of reinforcement, importance of reinforcement in learning, punishment- meaning, functions, types, essentials of good punishment, effect of punishment on learning, motivation- definition, types, modes of motivation (contingency contract, token economy) relationship of motivation with learning and performance discipline- meaning, social attitudes towards it, need for discipline, wholesome and unwholesome functions of it, essentials in discipline, techniques of discipline, factors influencing choice of disciplinary techniques, evaluation of disciplinary techniques, theories for classroom teaching and its applicability – learning theories of jerome bruner, robert gagne, jean piaget, erik erikson, lev vygotsky, lawrence lohlberg performance evaluation – meaning of evaluation/ testing, eays of evaluation of student's performance. Types of tests used in classroom evaluation. Advantages and abuses of testing and tests. Meaning, characteristics and significance of early childhood years. Programme planning in ECE- Steps and types of programme planning, activities to promote all round development of preschool children- cognitive, language, socio-emotional and motor development, role, qualities and responsibilities of an early childhood personnel.

Practicals

Analysing effect of reinforcement, motivation, discipline on learning. Application of theories of classroom teaching. Application of different methods of evaluating performance and interpretation. Observation and recording of activities in ECE center. Developing and conducting activities to promote all round development- Gross and fine motor skills, cognitive skills, language skills, creativity and socio emotional skills. Preparation of suitable teaching learning material used for preschool children.

Suggested Readings

- Mertens, M.D. (2014), Research and evaluation in education and psychology. Sage publication.
- Papalia, D.E. and Olds, S. W. (2008). Human development. 11thed. McGraw Hill. New York.
- Mazur, J.E. (1989). Learning and behaviour. Prentice Hall, New Delhi.
- Klausmier, H.J. (1985). Educational psychology. Harper and Row, New York.
- Dubious, N.F. (1979). Educational psychology and instructional decisions. Dorsey press

5. Family Counseling and Child Welfare 3(2+1)

Theory

Concept, nature, scope, principles and need of family counselling, trust areas in family counselling- educational, vocational, social, personal, premarital and marital, problems in family counselling, methods of handling problems, approaches to evaluate family counselling, counselor's self-awareness and growth. Situation analysis of child, women, youth, elderly, disabled and reserved category in India and in the world- Census, Issues and challenged, determining factors for the present status, impact of present status on the family and society at large. Child welfare- definition, need, constitutional, provisions for children, legislations pertaining to children, schemes/projects and policies for children, other activities of child welfare, women welfare- definition, need, constitutional, provisions for women, legislations pertaining to women, schemes/projects and policies for women youth welfare- definition, need, constitutional provisions for youth, legislations pertaining to youth, schemes/projects and policies for youth elderly welfare- definition, need, constitutional, provisions for elderly, legislations pertaining to elderly, schemes/projects and policies for elderly disabled/ exceptional pupil welfare- definition, need, constitutional, provisions for disabled, legislations pertaining to disabled, schemes/projects and policies for disabled reserved category welfare- definition, need, constitutional provisions for reserved category, legislations pertaining to reserved category, schemes/projects and policies for reserved category national and international organizations and agencies working for child, women, youth, elderly and disabled welfare: UNICEF, WHO, CARE, DWACRA, NIPCCD, CIF etc.

Practicals

Visits to organisations offering counseling to families. studying the areas of family counseling, identifying the families which are in need of counseling, conducting counseling sessions to families, presentation of reports. Visits to various government and non government organisations working for the welfare of the children, Presentation of reports.

Suggested Readings

- NIPCCD. (1994). Child in India: A statistical profile. NIPCCD, New Delhi.
- Randhawa, M.S. (1991). The Rural and urban aged. National Book Organization, Unit IX, New Delhi.
- Saraswathi, S. (1991). Youth in India. ICSSR, Govt. of India, New Delhi.
- TISS (1994). Enhancing the role of family as agency for social and economic development. TISS Bombay. Vol. II, Part II.
- UNICEF. (1990). Children and women in India: A situation analysis. Unit VI, VII.
- Marasimhan, S. (2001). Employment of women. Sage publication. New Delhi.
- Boraian, P.M (2008). Employment of rural women. Concept publishing company. New Delhi.
- Mehta, L.P and Jaiswal, S.S. (2001). Child labour and the laws. Deep and Deep publication. New Delhi.
- Devi, L. (1998). Child and family welfare. Anmol publication. New Delhi.
- Devaisia, L. (1991). Girl child in India. Ashish publishing house. New Delhi.
- Down, W.S. (2006). Child welfare and family services.8thedi. Pearson education publishers.
- Pecora, J.P. (2009). The child welfare challenge: Policy, practice and research. Aldine transaction publisher.

6. Developmental Challenges in Children 3(2+1)

Theory

Special needs and special education: Definition of special needs children and special education, terminologies for children with special needs, history of special education, current trends and issues in special education, legislation and litigations of special education labelling-definition and its effects. Mainstreaming- definition, models of mainstreaming, problems in implementing mainstreaming, effect of mainstreaming on children with special needs mental retardation-definition, classification, prevalence, causes and measurement of mental ritardafoon, their psychological and behavioral characteristics and educational considerations for MR children, managing child in school learning disabilities- definition, prevalence, causes and measurement of LD, psychological and behavioural characteristics of LD children, educational considerations for LD children, managing child in school emotional disorders- definition, classification, prevalence, causes and identification of ED, psychological and behavioural characteristics of ED children, educational considerations for ED children, managing child in school communication disorders- definition, speech production, speech disorders, language disorders, multiple disorders (disorders associated with cerebral palsy, hearing impairment, cleft palate or cleft lip, MR, ED and LD), prevalence, Causes of CD, identification, psychological and behavioural characteristics of CD children, educational considerations for CD children, managing child in school hearing impairment- definition, anatomy and physiology of ear, classification, prevalence causes, measurement of HI children, psychological and behavioural characteristics of HI children, educational considerations for HI children, managing child in school visual impairment-definition, classification, prevalence, anatomy and physiology of eye, causesand measurement of VI children, psychological and behavioural characteristics of VI children, educational considerations for VI children, managing child in school physical impairment- definition, classification, prevalence, neurological impairments, musculoskeletal conditions, congenital malformations, accidents,

diseases and other conditions, psychological and behavioural characteristics of PI children, educational considerations for PI children, managing child in school giftedness- definition, prevalence, Origins of giftedness, Screening and identification of giftedness, Psychological and behavioural characteristics of gifted children, attitudes towards gifted children, educational considerations for gifted children, managing child in school. Rights and provisions for children with special needs in India. Intervention- concept, methods, steps and process, intervention strategies for children with special needs, role of professionals, need and importance of family centered intervention.

Practicals

Observational visits to institutes for children with special needs. Identification of children with special needs in the local community. Developing educational material on identification of children with special needs, organising education programmes for families of children with special needs, planning, recreational and vocational activities for children with special needs; Presentation of case study reports.

Suggested Readings

- Berdine, W.H. and Blackhurst, A.E. (1985). An introduction to special education. 2nd ed. Harper Collins, Lexington.
- Hallahan, D.P. and Kauffman, J.M. (1991). Introduction to exceptional children. 5th ed. Allyn and Bacon, Boston.
- Loring, J. and Burn, G. (Eds.). (1978). Integration of handicapped children in society. Routledge and Kegan Paul, London.
- Werner, D. (1994). Disabled Village Children (Indian edition). Voluntary Health Association of India, New Delhi.
- Philip, M. and Duckworth, D. (1985). Children with disabilities and their families: A review of research. Berks: NFER-NELSON Publishing Co., Windsor.
- Achenbach, T.M. (1982). Developmental psychopathology. 2nd ed. John Wiley, New York.
- Tinberger, N. and Tinberger, E.A. (1983). Autistic children: New hope for a cure. Allen and Unwin, London.
- Hegarty, S. (2002). Education and children with special need. Sage publication. New Delhi.
- Rozario, J. and Karanth, P. (2003). Learning diability in India. Sage publication. New Delhi.
- Prasad, J. and Prakash, R. (1996). Eduaction of handicapped children, problems and solution. Kanishka publication distribution. New Delhi.

Courses for student READY programme

1. Methods and Materials for Teaching Young Children 4(0+4)

Practicals

Orientation on different methods and materials used for teaching young children. Survey of available different kinds of literature appropriate for infancy through early childhood. Visit to Organization and Children's libraries for development of literature, Reporting on different kinds of literature appropriate for infants and preschool children. Developing stories appropriate for

infancy through early childhood- A Folk tale, A Fairy tales, A Personal story etc., Carry out discussions on developed stories, Collection and Observation of different techniques of story telling. Identifying and analyzing the different techniques of story telling, Practicing techniques of effective story telling, Identifying methods of development of creativity -Analyzing situations/ conditions that foster creativity-Preparation of art file with different forms of paintings and printing appropriate for infancy through early childhood- Preparation of collage, murals and models appropriate for infancy through early childhood -Art activities (Painting and graphics, Tearing, cutting, pasting and collage, murals, modeling, printing, blocks, sand and mud, water)- preparation of each medium of art activity for young child's development, types/variations in art activities, identification of different types of creative expressions in young children- creatingsongs with music and rhythm movements appropriate for infancy through early childhood- making simple musical instruments with indigenous material- preparation of different types of puppets -practicing musical activities- learning basic manipulation skills: use of music, voice modulation and sound effects. Making sets and backgrounds- Identifying different types of creative dramas- Scripting for short puppet show and creative dramas, planning and implementing activities to promote creative expressions among young children through a variety of media i.e. painting, printing, modelling, cutting, pasting, blocks, puppetry, music movement, drama and language, Developing resource file, Organising an Exhibition and evaluation of materials developed.

Suggested Readings

- Blackie, Pamela. (1972). Drama. Macmillan, London.
- Contractor, M. (1984). Creative drama and puppetry in education. National Book Trust of India, Delhi.
- Currell, D. (1985). The complete book of puppet. A and C. Black, London.
- Garretson, R. (1966). Music in childhood education. Meredith Publishing Company, New York.
- Hendrick, J. (1980). Total Learning for the Whole Child. The C V Mosby, St. Louis.
- Kaul, V. (1991). Early childhood education programme. NCERT, New Delhi.
- Kaul, V. and Bhatnagar, R. (1992). Early childhood education: A trainer's handbook, NCERT, New Delhi.
- Lacper, S., Witherspoon, R. and Day, B. (1984). Good schools for young children. Mac Millan, New York.
- Maxim, G. (1985). The very young. Wadsworth Publishing Company, Belmount, California.
- Murlidharan, R. and Asthana, S. (1991). Stimulation activities for young children. NCERT, New Delhi.
- Robinson, H. (1983). Exploring teaching. Allyn and Bacon, London.
- Swaminathan, M. (1984). Play activities for young children, UNICEF, New Delhi.

2. Education and Counseling of Parents and Community 2(0+2)

Practicals

Orientation on need and importance of parent and community education. Understanding recent issues and challenges. Parent-Child Relationships and its impact on children. Studying various methods of parent and community education. Visit of local community to identify parents

of normal and exceptional children, rapport building, identifying families with problems and conducting case studies, acquiring familiarization with the tests and techniques used for the assessment of troubled families, identification of areas and issues for parent education, developing parent education programmes, Planning, conducting and evaluating parenting education programmes, wisconsin model of community education, study on communication barriers-differences between men and women, conducting sessions in the community on communication skills and effective human communication, studying on various approaches and techniques of counselling, organising counseling sessions for individuals,couples, parents and families of normal and exceptional children by using appropriate therapies – cognitive behavioural therapy (CBT), rational emotive behavioural therapy (REBT), client centered and existential therapies etc, establishing and managing the resource centre for parents and local community, implementing and evaluating the programmmes developed.

Suggested Readings

- Epstein, L.J. (2010). School, family and community Partnership: Preparing educators and Improving School, Westview press.
- Tett, L. (2006). Community education: Lifelong learning and social inclusion (Policy and practice in education). Dunedin Academic Press.
- Cempbell, D. (2003). Group parent education: Promoting parents learning and support. Sage publication.

3. Early Childhood Care, Education and Management 4(0+4)

Practicals

Visits to nursery schools/ ECCE centers for observation of material, space, personnel, finance, documentation, orientation on areas of development during early childhood period- – planning and implementing activities for physical and motor development, language development, cognitive development, socio-emotional development and creativity , planning theme based developmentally appropriate programmes for crèche, Nursery, LKG and UKG children, preparing yearly and weekly plans for pre-primary education programmes, implementation of prepared plans, visit to different types of ECE centers - based on funds and resources and philosophy and function styles, observation of records and reports maintained in ECE center, organizing parent teacher conferences/ meetings, planning parental participation in ECE programme, celebration of annual day of ECCD center, orientation on management of ECCE programmes - planning, organizing, staffing, leading, monitoring and controlling for quality, designing the activity corners in ECE center- arranging and equipping the classroom – block center, language and art center, creative art and construction center, science and collection center, math and manipulative material center, pretend and play center, sand and water center, outdoor nature center, preparing ECCE project proposal, budget preparation for ECE center, preparation of brochures, leaflets, communication documents for parents and public, evaluation of daily, weekly and monthly schedule of activities prepared, reporting on monitoring and evaluation of classroom arrangements, cleanliness, record keeping etc, planning and organizing field trips, identification of preprimary children with mild behavioural problems – planning and execution of strategies of children with mild behavioural problems, evaluation of strategies planned for children with mild behavioural problems. Presentation of reports.

Suggested Readings

- Hildebrand, V. (2014). Management of child development centers. 8thed. McMillan publishing. New York.
- Mohanty, J. and Mohanty, B. (2007). Early childhood care and education (ECCE). Deep and Deep publishing pvt ltd.
- Agarwal, C.J. (2007). History and philosophy of pre-primary and nursery education. DOABA house, New Delhi.
- Singh, B. (2004). Preschool education. APH publishing corporation, New Delhi.
- Rao, K.V.and Islam-ul-Khurshid. (1997). Early childhood care and education. Ajay Verma for Common Wealth publishers, New Delhi.
- Gill, S. (1993). Child care programmes in India: Changing trends. In Saraswathi, S.S. and Kaur, B. Sage Publication. Unit II, New Delhi.
- Roopnarine, J.L. and Johnson, J.E. (1993): Approaches to early childhood education. Macmillan Publishing Co., New York.
- Beaty, J.J. (1992). Skills for preschool teachers. Macmillan Publishing Co.
- Kaul, V. (1991). Early childhood education programme. National Council for Educational Research and Training, New Delhi.
- Bamahas, A.S., Anandlakshmy, S., Chandra and Bose, A. (1988). Profile of the Child in India. Ministry of Social Welfare, New Delhi.
- Lawton, J.T. (1988). Introduction to child care and early Childhood Education. Oxford and IBH, Calcutta.
- Bose, A. (1987). Encyclopaedia of social work in india. Ministry of Welfare, Government of India, New Delhi.
- Cole, Luella. (1987). A History of education. Holt: Rinehart and Winston, New York.
- National policy on education. (1986). Ministry of Human Resource Development, New Delhi.
- Dutta, Vrinda (1985). Home away from home. M.S. Swaminathan Foundation, Madras.
- Dass, J.R. and Carg, V.C. (1985). Impact of pre-primary education: Dropout, stagnation and academic performance. Education Department, Municipal Corporation, New Delhi.
- Pareek, U. et al. (1985). Behavioural processes in organizations. Oxford Publications, New Delhi.
- Raja, Moonis and Nangia, S. (1985). Atlas of the child India. Concept publishing company, New Delhi.
- Decker, C.A. and Decker, J.R. (1984). Planning and administering early childhood programmes. Charles E. Merrill, Columbus.
- Spodak, Bernard (1982). Handbook of research in early childhood education. The Free Press, New York.
- Leeper, S.H. Skipper, S.D. and Witherspoon, R.L. (1979). Good schools for children. Macmillan Publishing House, New York.
- Naik, Chitra (1978). Growing up. Kosbad Hill. Gram BalShikshan Kendra, Thane.
- Boegehold, B., Harriet, K., Hook, U. and Klopt. G. (1977). Education before five. Bank Street College of Education, New York.

- Indian association for preschool education (1976). New approaches to child education: Children in rural and tribal settings. 12th annual conference of IAPE.
- Sri Ram, R. (1974). Social support services for women delivery systems. In Barooah, R. capturing complexity. Sage Publication, New Delhi.
- Shirley, M.G. and Kilmer, S. (1973). Contemporary pre-school education. John Wiley and sons Inc., New York.
- Spodek, Bernard. (1972). Teaching in the early years. Prentice Hall of India Pvt limited, New Delhi.
- Read, K. (1966). Nursery school: A human relations laboratory. Oxford IBH Calcutta.

4. Developmental Assessment of Young Children 3(0+3)

Practicals

Orientation on Screening and developmental assessment of young children for various developments through different tools and techniques. Exploring existing areas, approaches and tools in developmental screening; Orientation on formal and informal measures in assessment, special considerations and ethical issues in assessing various areas of developments of Toddlers, Infants, Preschoolers and Pre-Primary school children. Conducting tests for Neonatal assessment – APGAR and Gestational age, Neonatal Behavioural Assessment Scale (BNBAS), Conducting tests for Infant and Toodler hood assessment - Anthropometry, Developmental Screening Test, Bayley's Scale of Infant Development (BSID), Vineland social Maturity scale etc. Screening and assessment of preschool and Preprimary school children- Stanford Binet Intelligence Scale, Weschler Scale of Intelligence for Preschool and Primary School Children, Vineland Social Maturity Scale, Adaptive Behaviour Scale; DAS II; Thematic Apperception Test (TAT), Children's Apperception Test (CAT), Raven's Coloured Progressive Matrices (RCPM); Pea body Picture Vocabulary test, PramilaPathak's Mental and Motor Growth of Indian babies; Ecological assessment of Preschool and Preprimary school children- HOME Inventory; Informal measures like Time sampling, event sampling, sociogram, Anectodtal records, Case studies etc; Assessment of readiness skills of pre-primary school children- Auditory perception, Visual perception skills, Writing skills, reading skills, arithematic skills, discriminatory skills, tests for preschool children; Presentation of reports; Conducting education programmes for parents on the developmental status of their children. Identifying the intervention needs of developmentally delayed child; Planning and implementation of intervention programmes and preparation of material; Evaluation of effectiveness of intervention program planned for developmentally delayed child. Presentation of reports.

Suggested Readings

- Minds, L. (2014). Assessing young children. 5thed. Pearson publication.
- Losardo, A. (2011). Alternative approaches to assessing young children. 2nded. Brooker publishing.
- Anastasi, A. (1997). Psychological testing.7thed. Pearson publishers.

BASIC SUPPORTING COURSES

1. General English 2(1+1)

Theory

Word-Formation Prepositions Idiomatic Expressions Conditional Sentences and Modal Verbs Synthesis and Transformation Essay Writing (5 topics to be discussed) Precise writing Study of Prose and short stories from BRIGHTER ENGLISH book of short stories, plays, poems and essays by C.E. Eckersley, Orient Llongman, New Delhi, 1984) The Bachelor of Arts by R.K. Narayan Pre-final examination

Practical

Based on Lectures Language work : the prescribed lessons having a bearing on the topics covered in lectures. Identification of phonetic sounds and symbols Stress and Intonation Listening Comprehension Conversation Practice

Suggested Readings:

- Allen, W. Standard. 1962 Living English Structure, Orient Longmans, London.
- Jones, Daniel. 1993. Everyman's English Pronouncing Dictionary, University Book Stall, New Delhi.
- Jones, Daniel. 1970. An Outline of English Phonetics, Arnold, London.
- George, H.V. 1970. Common Errors in English Learning, M/s Newbury House, London.
- Sharma, S.D. 1984. A textbook of Spoken and Written English, Vikas, Delhi.

2. Technical Writing (English) 2(1+1)

Theory

Nature of technical style vs. general style, writing process (prewriting, drafting, rewriting and editing). Effect of diction, sentence- structure and paragraphs on style; manuscript form, numbers, abbreviation, hyphenation of compound terms, decimal system of numbering headings, equations, documentation, sentence correction. Paragraph writing- Definition, requirements of a good paragraph (Unity, coherence and emphasis), topic sentence, various orders to develop a paragraph (Inductive, deductive, question to answer, exposition, time order, comparison and contrast, enumeration, space order). Report writing- Definition and cardinal characteristics of report, analyzing the report. Report formats- Blank form, letter form, memorandum form and general survey report. Technical correspondence- General principles of technical correspondence, parts of a letter (Heading, address, salutation, body, complimentary closing, signature), type of letters (letters giving instructions, inquiries and answers to inquiries, complaints and adjustments, letter urging action, applications and resumes). Proposal writing- Definition and kinds of proposal, division of formal proposal (Front matter, letter of transmittal, title page, summary or abstract, table of contents, statement of request and body). Writing scientific and semi-technical articles- Source material, topic selection, literature review, tables, figures, footnotes, bibliography.

Practical

Exercise on identification of phonetic sounds, symbols, consonants, pyre vowels, diphthongs, organs of speech, place of articulation and manner of articulation (Voiceless and voiced sounds).

Writing of a technical report, paragraph, formal correspondence, proposal and scientific and semi-technical articles.

Suggested Readings

- Strunk, Jr.; William and White, E.B. (1967). The elements of style. New York: Macmillan.
- Leegget, G. C.; Mead, D. and Charvat, W. (1988). Essentials of grammar and composition. New Delhi: Prentice- Hall (Indian reprint).
- Sherman, T.A. and Simon, S. J. (1990). Modern technical writing. New Jersey: Prentice-Hall.
- Alvarez, J.A. (1980). The elements of technical writing. New York: Harcourt.
- Connor, J.D. (1992). Better English pronunciation. New Delhi, University Book Stall.
- Jones, D. and Glimson, A.C. (1997). English pronouncing dictionary, London.
- Bansal, R.K. and Harrison, J.B. (1983). Spoken English, Orient Longman, New Delhi.
- Krishnamohan and Banerjee, M. (1990). Developing Communication Skills. MacMillan India Ltd, New Delhi.

3. Elementary Statistics 3(2+1)

Theory

Introduction to statistics; definitions, functions, uses and limitations Classification and tabulation of data; qualitative and quantitative classification, discrete and continuous variables, frequency tables, grouped and ungrouped data. Diagrammatic representation of data; One, Two and Three dimensional diagrams with applications. Graphical representation of data; Histogram, frequency polygon, frequency curve, ogives. Measures of central tendency; Introduction to basic concepts of logarithms, AM, GM, HM, median. mode with merits, demerits and uses, relationship between AM, GM and HM, quartile deviation, mean deviation from AM, median and mode, variance, standard deviation, coefficient of variation. Measures of dispersion; range coefficients, inter quartile range, quartile deviation, coefficient of quartile deviation, mean deviation from AM, median and mode, variance, standard deviation, coefficient variation. Moments; Raw moments, Central moments for grouped and ungrouped data, relationship between raw moments and central moments. Measures of skewness and kurtosis; definitions of symmetrical distribution, skewness and kurtosis, relationship between mean, median and mode and between quartiles for symmetrical and skewed distributions. Probability theory; introduction to simple problems of permutations and combinations, definition of random experiment sample space, events, mutually exclusive and equally likely events. Definition of probability, simple problems based on probability, addition and multiplication theorem of probability, conditional events and independent events, Correlation and linear regression analysis; definition of correlation its types, scatter diagrams, Karl Pearson's formula of correlation coefficients, properties of correlation coefficient, definition of regression, regression equations of Y on X and of X on Y, relationship between correlation coefficient and regression coefficients. Problems based on correlation and regression. Tests of significance; basic definitions, hypothesis, null and alternative hypothesis, tests statistic, testing of hypothesis, one sample t-test and two sample fisher's t-test. Chi-square test of goodness of fit and Chi-square test of independence of attributes. Discrete and continuous probability distributions; definition of random variable, discrete and continuous random variables probability distribution of random variable, concepts of discrete and continuous probability distribution, basic concept

of binomial theorem, binomial distribution, Poisson distribution, normal distribution and applications. Analysis of variance; definition of analysis of variance, assignable and nonassignable factors, analysis of one way classified data. Introduction to sampling methods; definition of population, random sample, sampling versus complete enumeration, use of random number table for selecting a simple random sample, simple random sampling with and without replacements.

Practicals

Graphical representation of data Diagrammatic representation of data Measures of central tendency (Ungrouped data) with calculation of quartiles, deciles and percentiles Measures of central tendency (Grouped data) with calculation of quartiles, deciles and percentiles Measures of dispersion (Ungrouped data) Measures of dispersion (Grouped data) Moments, measures of skewness and kurtosis (Ungrouped data) Moments, measures of skewness and kurtosis (Grouped data) Correlation and regression analysis Application of one sample t-test Application of two sample Fisher's t-test Chi-square test of goodness of fit Chi-square test of independence of attributes Analysis of variance one way classification Selection of random sample using simple random sampling

Suggested Readings:

- Elhance, D. N. — Fundamentals of Statistics
- Agarwal, B. L. — Basic Statistics
- Kapoor and Saxena — Mathematical Statistics
- Singh and Verma — Agricultural Statistics
- Hall and Knight — Higher Algebra

4. Agricultural Informatics 3(1+2)

Theory

Introduction to computers, anatomy of computers, memory concepts, units of memory, operating system, definition and types. Application of MS-Office for creating, editing and formatting a document, data presentation, tabulation and graph creation, statistical analysis, mathematical expressions. Database- Concepts and types, creating database, uses of DBMS in health and nutrition. Internet and World Wide Web (WWW)- Concepts, components and creation of web, HTML, XML coding.

Practical

Study of computer components, accessories, practice of important DOS commands. Introduction of different operating systems such as windows, Unix, Linux, creating files and folders, file management. Use of MS-WORD and MS Powerpoint for creating, editing and presenting a scientific document, handling of tabular data, animation, video tools, art tool, graphics, template and designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating database, preparing queries and reports. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management of health information through web.

Use of smart phones and other devices for health warning signs and dietary management. Hands on practice on preparation of decision support system.

5. Principles of Biochemistry 3(2+1)

Theory

Recapitulation of basic chemistry and biology Water, pH and buffers, Acid-base balance Cellular constituents, Structure and function : Amino acid and proteins Carbohydrates Lipids and bio membranes Nucleic acids Dissolved molecules – Vitamins and minerals Enzymes, function, properties, mechanism Metabolism of cellular constituents Basic concepts of Bioenergetics Carbohydrates metabolism Glycolysis and glycogenolysim HMP pathway TCA Cycle Electron transport chain Photosynthesis Gluconeogenesis Lipids metabolism Beta-oxidation Ketone bodies Fatty acid synthesis Amino acid metabolism General reactions of nitrogen assimilation and excretion Biosynthesis of DNA, RNA and Protein Replication Transcription Translation and genetic code Regulation of gene expression

Practicals

Preparation of buffers and pH determination; Preparation of colloids Qualitative and quantitative tests of carbohydrates, lipids and proteins Tests of enzyme action; Experiments on potato oxidase, urease, salivary amylase Paper chromatography of amino acids or carbohydrates ascending and descending Determination of starch, sugar; analysis of proximate constituents in food.

Suggested Readings:

- Conn, EE and Stumpf, PK. 1987. Outlines of Biochemistry. John Wiley.
- Nelson, DL and Cox, MM. 2004. Lehninger Principles of Biochemistry. 4th Edn. MacMillan.
- Voet D, Voet JG and Pratt, CW. 2007. Fundamentals of Biochemistry. John Wiley
- Jayaram. T. 1981. Laboratory manual in biochemistry, New Delhi: Wiley Estern Ltd.
- Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
- Hames B.D., Hooper N.M. and Houghton J.D. 1997. Instant Notes in Biochemistry. BIOS Scientific Publishers.

6. Environmental Studies and Disaster Management 3(2+1)

Theory

Multidisciplinary nature of environmental studies- Definition, scope and importance. Natural resources- Renewable and non-renewable resources and their associated problems. Forest resources- Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forest and tribal people. Water resources- Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources- Use and exploitation, environmental effects of extracting and using mineral resources. Food resources- World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources-

Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources- Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

Ecosystems- Concept, structure and function of an ecosystem. Producers, consumers and decomposers, energy flow in the ecosystem, ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of forest, grassland, desert and aquatic ecosystems. Biodiversity and its conservation- Introduction, definition, genetic, species, ecosystem diversity and biogeographical classification of India. Value of biodiversity- Consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity- Habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India. In-situ and Ex-situ conservation of biodiversity.

Environmental pollution- Definition, cause, effects and control measures of air, water, soil, marine, noise and thermal pollution and nuclear hazards. Solid waste management- Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

Social issues and the environment- Unsustainable to sustainable development, urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics- Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection acts- Air (Prevention and control of pollution) act, water (Prevention and control of pollution) act, wildlife protection act, forest conservation act, Issues involved in enforcement of environmental legislation, public awareness. Human population and the environment- Population growth, variation among nations, population explosion. Role of Information Technology in environment and human health.

Natural disasters- Meaning and nature, types (floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves, global warming, sea level rise, ozone depletion) and effects. Man-made disasters- Nuclear, chemical, and biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. Disaster management- International strategy for disaster reduction at national and global levels; National disaster management framework- Financial arrangements, role of NGOs, community–based organizations and media, central, state, district and local administration, armed forces in disaster response, police and other organizations. Feeding the people struck by the disaster, managing house and dress need during disaster.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/rural/industrial/agricultural. Study of common plants, insects, birds and study of simple ecosystems i.e. pond, river, hill slopes, etc. Case-studies.

Suggested Readings:

- Bharucha, E. (2005). Text book of environmental studies. University Grants Commission, University Press, New Delhi.
- Kapur, A. (2005). Disasters in India: Studies of grim reality. Rawat publication, Jaipur.
- Chauhan, B.C. (2008). Environmental studies. University Science Press, New Delhi.
- De, A.K. (2010). Environmental chemistry. Willey Eastern ltd. New Delhi.
- Singh, S. and Singh, J. (2013). Disaster Management. Pravilika Publication Allahabad.

7. Fundamentals of Food Microbiology 3(2+1)

Theory

Major groups of microorganisms associated with food Sources of microbial contamination in food factors effecting growth and survival of m.o. in foods Physical methods to control microorganisms. Chemical methods to control microorganisms Food Fermentations Traditional fermented foods of India and other Asian countries Probiotics, prebiotics and synbiotics Fermented foods based on milk Fermented foods based on meat Fermented foods based on grains Fermented foods based on fruits and vegetables Fermented beverages Role of microorganisms and food spoilage Spoilage organisms of milk Spoilage organisms of meat Spoilage organisms of grains Spoilage organisms of fruits and vegetables Principles of food preservation. Food poisoning and food borne infections Microbial toxins Indicator organisms Rapid methods for detection of microorganisms.

Practical

Microscopic examination of bacteria, and yeast and molds Preparation of media Methods of sterilization Isolation of microorganisms. Purification of microorganisms Maintenance of microorganisms Detection of faecal coliform, MPN of coli forms Microbiological examination of milk Microbiological examination of grains Microbiological examination of fruit and vegetables

Suggested Readings:

- Stanier Ingraham and Wheels and Painter. 1992. General Microbiology. 5th ed.
- Kapoor, T. and Yadav. 1991. An Introduction to Microbiology.
- Pelczar, *et al.* 1996. Microbiology, 5th edn.

8. Elementary Human Physiology 3(2+1)

Theory

Physiological process, structural and functional basis of human body, skeletal system, joints and muscular system Functions of brain and spinal cord. nerve impulse reflex action and sense organs Composition and functions of blood and lymph, heart and course of blood circulation, blood pressure, pulse and heart sounds. Respiratory apparatus, mechanism of respiration, respiratory rates, volume and transport of gases Physiology of kidney and skin Physiology of digestion, digestive enzymes and their functions, functions of liver, absorption from the intestine. The location, secretions and function of various endocrine glands Male reproductive organs and their functions Female reproductive organs and their functions Pregnancy, persecution and milk secretion Pre-Final Examinations

Practicals

Skeletal system of mammal (rabbit) Hematology- R.B.C., W.B.C., T.L.C., D.L.C. and estimation of hemoglobin in mammalian blood Heart beat and heart sound, blood pressure measurement Respiratory quaotient, inspiration, expiration and measurement of O_2 and CO_2 at various partial pressure in lungs. Reproductive cycle-menstruation and estrous cycles, mating behavior and fertility test

Suggested Readings:

- Arthur J. Vanders. Human Physiology- The mechanisms of body function, Tata McGraw Hill Publishing Company, New Delhi.
- Samson Wright. Applied Physiology. 10th edn. Revised by Keele, C.A. and Neil, B. Oxford University Press, New York.
- C. Guyton. Text Book of Medical Physiology. 5th ed. W.B. Saunders Company- Philadelphia, London.

9. Communication Skills and Personality Development 3(2+1)

Theory

Communication skills- Process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Role of ICT in communication. Recent advances in communication- Print and electronic, internet, e-mail, fax, mobile, interactive video and teleconferencing, computer, e-governance.

Meaning and definition of personality; Theoretical perspectives on personality- Behavioural trait and humanistic personality pattern; moulding the personality patterns. Personality development- Self perception, self concept, self esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family). Aspirations, achievements and fulfillment. Dressing for formal and informal occasions.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations. Developing questionnaire to study impact of physique, educational institutions, aspirations on personality; developing questionnaire to study social prescriptions, gender and family on personality, aspirations and achievements. Collecting data through the questionnaires on small samples. Report writing and presentation. Case study of an individual suffering with personality disorders.

10. Economics and Marketing 3(2+1)

Theory

Terms and definitions in Economics; Consumption, demand and supply. Factors affecting production. Gross Domestic Product (GDP) – Role of poultry sector in National GDP. Marketing-Definition, marketing process, need for marketing, role of marketing, marketing functions, classification of markets, marketing of various channels, price spread, marketing efficiency, integration, constraints in marketing of agricultural produce, market intelligence, bank norms, insurance, SWOT analysis, crisis management. Techno-economic parameters for preparation of projects and basic guidelines for preparation of project report.

Practical

Techno-economic parameters for preparation of project. Preparation of bankable projects for various agricultural products and its value added products. Identification of marketing channel, calculation of price spread, identification of market structure and visit to different markets.

11. Introduction to Rural Sociology 2(2+0)

Theory

Rural sociology- Meaning, scope and significance. Structural differentiation in terms of difference and characteristics of rural and urban societies. Planned social change - Approaches to rural planning, improvement and transformation and their shortcomings. Indian rural development programs (IRDPs). Indian rural social stratification: Castes- Basic notions, changes and its role in economy and policy, difference between caste and class, backward classes and implementations of constitutional provisions. Indian rural institutions: Social- Family and marriage (Nature, forms and changes), Economic-political: Land relations and changes; rural poverty: its manifestations and causes. Socio-religious: Functional significance of beliefs, traditions and customs. Rural social changes - Processes and factors of transformation. Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. ed.
Doshi, S.L. (2007). Rural sociology. Delhi Rawat Publishers.
Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers.
Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers.

12. National Service Scheme 2(0+2)

The course aims at evoking social consciousness among students through various activities viz. working together, constructive and creative social work, increasing knowledge about self and community, contribution in solving social problems, to be skillful in executing democratic leadership, developing skill in programme development, to be able for self employment, reducing gap between educated and uneducated, arousing desire to help weaker sections of society.

B.SC. (HONS) FOOD NUTRITION AND DIETETICS

1. **Degree duration:** 4 years
2. **Eligibility criteria**: 10+2 with PCB. PCM, PCBM (P -Physics, C - Chemistry, B- Biology, M – Mathematics) from a recognized board/University
3. **Number of students:** 40 students per year

Detailed course programme of B.Sc. Food Nutrition and Dietetics is as follows:

Basic supporting Courses

Course Title	Credit Hours
General English	2(1+1)
Technical Writing (English)	2(1+1)
Elementary Statistics	3(2+1)
Agricultural Informatics	3(1+2)
Nutritional Biochemistry – I	3(2+1)
Nutritional Biochemistry – II	3(3+0)
Environmental Studies and Disaster Management	3(2+1)
Elementary Human Physiology	3(2+1)
Nutrigenomics	3(3+0)
Communication Skills and Personality Development	3(2+1)
Economics and Marketing	3(2+1)
Introduction to Rural Sociology	2(2+0)
National Service Scheme	2(0+2)
Total	**35(23+12)**

Core Courses

S.N.	Course Title	Credit Hours
1	Fundamentals of Food Science	3(2+1)
2	Principles of Human Nutrition	3(3+0)
3	Normal Nutrition and Meal Planning	3(2+1)
4	Therapeutic Nutrition – I	4(2+2)
5	Therapeutic Nutrition –II	3(2+1)
6	Food Analysis	4(2+2)
7	Food Chemistry	4(3+1)
8	Food Microbiology	3(2+1)

S.N.	Course Title	Credit Hours
9	Methods of Cookery	3(2+1)
10	Food Processing and Packaging	4(3+1)
11	Food Preservation and Storage	4(2+2)
12	Introduction to Clinical Nutrition	4(3+1)
13	Community Nutrition	4(2+2)
14	Nutrition Education	3(1+2)
15	Food Hygiene and Sanitation	4(2+2)
16	Food Standards and Quality Control	4(2+2)
17	Pulses and Oilseeds: Preparation and Utilization	3(2+1)
18	Special Cookery/Bakery and Confectionary	4(2+2)
19	Nutraceuticals and Health Foods	3(3+0)
20	Public Health Nutrition	4(3+1)
21	Sports Nutrition and Physical Fitness	3(2+1)
22	Nutrition in Emergencies	2(2+0)
23	Nutrition Through Life Cycle	3(2+1)
24	Milk and Milk Products: Preparation and Utilization	4(2+2)
25	Cereals and Millets: Preparation and Utilization	3(2+1)
26	Meat and Meat Products: Preparation and Utilization	3(2+1)
27	Food Product Development and Formulations	2(1+1)
28	Food Toxicology	2(2+0)
29	Fruits and Vegetables: Preparation and Utilization – I	2(1+1)
30	Food Service Management – I	2(2+0)
	Total	**97 (63+34)**

Student READY Programme

Hands on Training to develop competence, capability, capacity building, acquiring skill, expertise and confidence to start their own enterprise and turn job creators instead of job seekers.

S.N.	Course Title	Credit Hours
1	Fruits and Vegetables: Preparation and Utilization – II	2(0+2)
2	Nutritional Status Assessment Methods	3(0+3)
3	Food Service Management – II	3(0+3)
4	Diet and Nutrition Counseling	2(0+2)
5	Special Project	5(0+5)

S.N.	Course Title	Credit Hours
6	Entrepreneurship Development and Business Management	4(0+4)
7	Seminar	1(0+1)
8	In-Plant Training/ experiential learning	10+10=20
	Total	**40 (0+40)**

SEMESTER WISE COURSES

Course Title	Credit Hours
I SEMESTER	
General English – I	2 (1+1)
Agricultural Informatics	3 (1+2)
Environmental Studies and Disaster Management	3 (2+1)
Elementary Human Physiology	3 (2+1)
Nutritional Bio chemistry - I	3 (2+1)
Principles of Human Nutrition	3 (3+0)
Fundamentals of Food science	3 (2+1)
NSS	2 (0+2)
Total	**22(13+9)**
II SEMESTER	
Technical Writing (English)	2 (1+1)
Nutritional Biochemistry- II	3 (3+0)
Methods of Cookery	3 (2+1)
Economics and Marketing	3 (2+1)
Introduction to Rural Sociology	2 (2+0)
Food Analysis	4 (2+2)
Food Preservation and Storage	4 (2+2)
TOTAL	**21(14+7)**

III SEMESTER	
Elementary Statistics	3 (2+1)
Food Microbiology	3 (2+1)
Food Service Management - I	2 (2+0)
Introduction to Clinical Nutrition	4 (3+1)
Nutrition Through Life Cycle	3 (2+1)

Community Nutrition	4 (2+2)
Cereals and Millets: Preparation and Utilization	3 (2+1)
Total	**22(15+7)**

IV SEMESTER	
Communication Skills and Personality development	3(2+1)
Food Product Development and Formulations	2(1+1)
Fruits and Vegetables: Preparation and Utilization - I	2 (1+1)
Normal Nutrition and Meal Planning	3 (2+1)
Milk and Milk Products: Preparation and Utilization	4 (2+2)
Public Health Nutrition	4 (3+1)
Food Chemistry	4 (3+1)
Total	**22(14+8)**
V SEMESTER	
Therapeutic Nutrition - I	4 (2+2)
Food Hygiene and Sanitation	4 (2+2)
Food Standards and Quality Control	4 (2+2)
Sport Nutrition and Physical Fitness	3 (2+1)
Nutrition in Emergencies	2 (2+0)
Nutrition Education	3 (1+2)
Nutrigenomics	3 (3+0)
Total	**23(14+9)**
VI SEMESTER	
Therapeutic Nutrition - II	3 (2+1)
Food Processing and Packaging	4 (3+1)
Pulses and Oilseeds: Preparation and Utilization	3 (2+1)
Nutraceuticals and Health Foods	3 (3+0)
Meat and Meat Products: Preparation and Utilization	3 (2+1)
Bakery and Confectionary	4 (2+2)
Food Toxicology	2(2+0)
Total	**22(16+6)**
VII SEMESTER	
In-Plant Training	20(0+20)
Total	**20(0+20)**

VIII SEMESTER	
Fruits and Vegetables: Preparation and Utilization - II	2(0+2)
Nutritional StatusAssessment Methods	3(0+3)
Food Service Management – II	3(0+3)
Diet and Nutrition Counseling	2(0+2)
Seminar	1(0+1)
Special Project	5(0+5)
Entrepreneurship Development and Business Management	4(0+4)
Total	**20(0+20)**

SYLLABUS

I Semester

1. General English 2(1+1)

Theory

Word, formation, prepositions, idiomatic, expressions, conditional, sentences and modal verbs. Synthesis and transformation; essay writing (5 topics to be discussed), precise writing. Study of Prose and short stories from brighter English (A book of short stories, plays, poems and essays by C.E. Eckersley, Orient Llongman, New Delhi, 1984) The Bachelor of Arts by R.K. Narayan

Practical

Based on lectures Language, work the prescribed lessons having a bearing on the topics covered in lectures. Identification of phonetic sounds and symbols Stress and intonation Listening comprehension. Conversation practice.

Suggested Readings:

- Allen, W. S. (1962) Living English Structure, Orient Longmans, London.
- Jones, Daniel. (1993). Everyman's English pronouncing dictionary. University Book Stall, New Delhi.
- Jones, D. (1970). An Outline of English phonetics, Arnold, London.
- George, H.V. (1970). Common errors in English learning, M/s Newbury House, London.
- Sharma, S.D. (1984). A textbook of spoken and written English, Vikas, Delhi.

2. Agricultural Informatics 3(1+2)

Theory

Introduction to computers, anatomy of computers, memory concepts, units of memory, operating system, definition and types. Application of MS-Office for creating, editing and formatting a document, data presentation, tabulation and graph creation, statistical analysis,

mathematical expressions. Database- Concepts and types, creating database, uses of DBMS in health and nutrition. Internet and World Wide Web (WWW)- Concepts, components and creation of web, HTML, XML coding.

Practical

Study of computer components, accessories, practice of important DOS commands. Introduction of different operating systems such as windows, Unix, Linux, creating files and folders, file management. Use of MS-WORD and MS Powerpoint for creating, editing and presenting a scientific document, handling of tabular data, animation, video tools, art tool, graphics, template and designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating database, preparing queries and reports. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management of health information through web. Use of smart phones and other devices for health warning signs and dietary management. Hands on practice on preparation of decision support system.

3. Environmental Studies and Disaster Management 3(2+1)

Theory

Multidisciplinary nature of environmental studies- Definition, scope and importance. Natural resources- Renewable and non-renewable resources and their associated problems. Forest resources- Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forest and tribal people. Water resources- Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources- Use and exploitation, environmental effects of extracting and using mineral resources. Food resources- World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources- Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources- Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

Ecosystems- Concept, structure and function of an ecosystem. Producers, consumers and decomposers, energy flow in the ecosystem, ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of forest, grassland, desert and aquatic ecosystems. Biodiversity and its conservation- Introduction, definition, genetic, species, ecosystem diversity and biogeographical classification of India. Value of biodiversity- Consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity- Habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India. In-situ and Ex-situ conservation of biodiversity.

Environmental pollution- Definition, cause, effects and control measures of air, water, soil, marine, noise and thermal pollution and nuclear hazards. Solid waste management- Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

Social issues and the environment- Unsustainable to sustainable development, urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics- Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection acts- Air (Prevention and control of pollution) act, water (Prevention and control of pollution) act, wildlife protection act, forest conservation act, Issues involved in enforcement of environmental legislation, public awareness. Human population and the environment- Population growth, variation among nations, population explosion. Role of Information Technology in environment and human health.

Natural disasters- Meaning and nature, types (floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves, global warming, sea level rise, ozone depletion) and effects. Man-made disasters- Nuclear, chemical, and biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. Disaster management- International strategy for disaster reduction at national and global levels; National disaster management framework- Financial arrangements, role of NGOs, community–based organizations and media, central, state, district and local administration, armed forces in disaster response, police and other organizations. Feeding the people struck by the disaster, managing house and dress need during disaster.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/rural/industrial/agricultural. Study of common plants, insects, birds and study of simple ecosystems i.e. pond, river, hill slopes, etc. Case-studies.

Suggested Readings:

- Bharucha, E. (2005). Text book of environmental studies. University Grants Commission, University Press, New Delhi.
- Kapur, A. (2005). Disasters in India: Studies of grim reality. Rawat publication, Jaipur.
- Chauhan, B.C. (2008). Environmental studies. University Science Press, New Delhi.
- De, A.K. (2010). Environmental chemistry. Willey Eastern ltd. New Delhi.
- Singh, S. and Singh, J. (2013). Disaster Management. Pravilika Publication Allahabad.

4. Elementary Human Physiology 3(2+1)

Theory

Introduction to anatomy and physiology and structural organization of body. The cell – Structure, its organelles, functions and multiplications, different types of cells and their functions, movement of particles across cell membrane - Active transport and passive transport ,Body fluids and its compartments and functions ,Water output and input into the body and maintenance of water balance in human body , the tissues – Types, structure and their functions, the skeletal system - Anatomy and functions, structure, formation and development of bones, different types of bones and types of joints and their movements, Circulatory system - The blood - Composition and function, blood clotting and blood grouping, Heart – Structure, functions, types of circulatory systems, blood pressure and heart rate and factors affecting it, electrocardiogram, the respiratory

system - anatomy, functions, mechanism of breathing and respiratory volumes, gas transport and respiratory adaptation, the digestive system - anatomy and functions of alimentary tract and accessory organs, process of digestion of food, absorption and assimilation of digested food, enzymes involved in digestion of food, liver - Structure and functions, Pancreas – Structure and functions, the urinary system - Anatomy and functions, formation and composition of urine, the endocrine system - important ductless glands of the body and their functions, the reproductive system - Male reproductive system – Anatomy and functions, female reproductive system – Anatomy and functions, menstrual cycle, the nervous system - elementary study of (anatomy and functions), sensory organs – (anatomy and functions). Glossary of terms used in physiology

Practical

Demonstration of animal viscera, identification of systems and organs, identification of cells – epithelial, muscle, nerve etc, Transverse section of stomach , intestine – small and large demonstration of specimens of spleen, kidney and brain models of excretory and reproductive organs and their histology, colorimeter, estimation of RBC count by heamocytometer, estimation of WBC count by heamocytometer, differential counting of WBC using peripheral smear, Estimation of PCV, ESR, micro and macro heamatocrit, estimation of bleeding and clotting time and blood groups, measurement of pulse rate and blood pressure, its variation with exercise, testing for sensation, special sensors, measurement of body temperature, diurnal variations.

Suggested Readings:

- Arthur J. V. Human physiology- The mechanisms of body function, Tata McGraw Hill Publishing Company, New Delhi.
- Samson, Applied physiology 10th edn. Revised by Keele, C.A. and Neil, B. Oxford University Press, New York.
- Guyton C. Text Book of medical physiology 5th edn. W.B. Saunders Company- Philadelphia, London.

5. Nutritional Biochemistry - I 3(2+1)

Theory

Introduction to biochemistry - Definition, objectives, scope and inter relationship between biochemistry and other biological science, Enzymes - Definition, types and classification of enzymes, definition and types of coenzymes, specificity of enzymes, isozymes, enzyme, kinetics including factors affecting enzyme action, velocity of enzyme catalyzed reactions, enzyme inhibition, intermediary metabolism - Carbohydrate metabolism, glycolysis, TCA cycle and energy generation, gluconeogenesis, glycogenesis, glycogenolysis, blood sugar regulation, Lipids - Oxidation and biosynthesis of fatty acids (saturated and mono-unsaturated) - Synthesis and utilization of ketone bodies, ketosis, fatty livers, proteins - General reaction of amino acid metabolism, urea cycle, lipoproteins - Types, composition, role and significance in disease.

Practical

Handling of equipment and instruments, preparation of samples, solutions and buffers, blood constituents: Estimation of serum protein (biuret method and lowry method),blood glucose (folin Wu method), serum inorganic phosphorus (Fiske and SubbaRow method), creatinine,

Urine constituents: Estimation of protein levels, glucose levels in urine, ketone bodies in urine, urine constituents- Repeat.

Suggested Reading:

- West, E. S., Todd, W. R.; Mason. H.S. and Van Bruggen J.T.: 4th Ed. Text book of Biochemistry. Amerind Publishing Co. Pvt. Ltd.
- Murray, r. K. Grannen, D. K.; Mayes, P. A. and Rodwell. V. W.: Harper's biochemistry. Lange Medical Book.
- Handler, P.: Smith E.I.; Stelten, D. W. : Principles of biochemistry, Me. Grew Hill Book Co.
- Lehninger, A.L.; Nelson, D. L. and Cox, M. M. Principles of biochemistry. CBS Publishers and Distributors.
- Devlin, T. M. : Text Book of biochemistry with clinical corelations. John Wiley and Sons.
- Stryer. L. biochemistry. Freeman W.H. and Co.Assaini. J.An introduction of Practical Biochemistry : D. Plummer Practical biochemistry : K Wilson and Walker Biochemical methods : S. Sadasivan and K Manikam Hawk's physiological Chemistry : B. L. Oser (ed)
- Practical biochemistry: R. L. Nath. A treatise on Analysis of Food, Fats and Oils: A. R. Sen, N.K. Pramanik and S.K. Roy.

6. Fundamentals of Food Science 3(2+1)

Theory

Cooking- Objectives, cooking methods, their types, merits and demerits. Cereals and millets - Structure, composition, processing techniques, effect of heat and acid, functions of starch in the cookery. Legumes, nuts and oil seeds - Composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - Types, composition, pigments, changes caused by heat, acid and alkali. Milk and milk products – Composition, types, products, effect of acid on milk cookery, uses and functions. Egg - Structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish- Types, structure, composition, pigments, factors affecting tenderness, post-mortem changes and changes during cooking. Sugars- Types, composition, manufacturing process, effect of heat and acid, functions in cookery. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats; Brief overview of beverages; Condiments and spices, importance in daily life.

Practical

Orientation to kitchen equipment and their uses, weighing and measuring food items and identification of the food grains, condiments and spices. Introduction to cooking methods. Cereal cookery– Practical exercise on dextrinization and gelatinization of rice starch, gluten formation in wheat. Legumes – Identification and cooking methods. Nuts and oilseeds- Use in food preparations. Vegetable cookery- Different preparations with vegetables and effect of heat and alkali on pigments. Preparation of soups, salads and beverages. Milk and milk products- Use in various preparations, egg cookery - Preparations showing functions of egg, various ways of using egg. Meat, poultry and fish cookery – Preparations involving various methods of cooking. Sugar – Preparations showing functions of sugar in cookery, fats and oils – Demonstration of smoking point, use in various preparations.

Suggested Reading:

- Fox,B. F. and Cameron,A. G. (1970). Food Science - a Chemical Approach. University Press, London
- Swaminathan, M. (1988). Handbook of Food Science and Experimental Foods BAPPCO, Bangalore
- Shakuntala Manay N, Shadaksharaswamy M (1998). Foods, Facts and Principles, New Age International Publishers, New Delhi

7. Principles of Human Nutrition 3(3+0)

Theory

Historical development and the relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition- Recommended dietary allowances, balanced diet, health, functional foods, phytochemicals, Nutraceuticals, dietary supplements, food groups. Energy-units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food, BMR- methods of measurement, factors affecting BMR. Digestion and absorption of carbohydrates, lipids and proteins. Carbohydrates- Types, functions, sources, requirement, health conditions affected by carbohydrates, significance of dietary fibre. Lipids- Types, functions, sources, requirement, health problems associated with lipids proteins- Types, functions, sources, requirement, quality evaluation, improvement and deficiency and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of fat soluble-(A, D, E, K), (water soluble – C, B Complex (thiamine, riboflavin, niacin, B6, Pantothenic acid, B12 and folic acid). Minerals-Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc, bio availability and factors calcium and iron. Water, functions, sources, distribution in body water balance and electrolyte balance.

Suggested Readings:

- Gopalan, C., Ramsastri, B.V. and Balasubramanian, S.C. (1990). Nutritive value of Indian foods.
- ICMR, (2010). Recommended dietary allowance for Indians, ICMR, Delhi.
- Srilakshmi, B (2002). Nutrition science, new age Int. Ltd. Pub., New Delhi
- Mudambi, S. R. and Rajagopal. M.V. (2001). Fundamentals of foods and nutrition. New Delhi, New Age International (P) Ltd. New Delhi.
- Srilakshmi, B. (2005). Dietetics. New Delhi 5th edn. New Age International (P) Limited. New Delhi.

National Service Scheme 2(0+2)

The course aims at evoking social consciousness among students through various activities viz. working together, constructive and creative social work, increasing knowledge about self and community, contribution in solving social problems, to be skillful in executing democratic leadership, developing skill in programme development, to be able for self employment, reducing gap between educated and uneducated, arousing desire to help weaker sections of society.

II Semester

1. Technical Writing (English) 2(1+1)

Theory

Nature of technical style vs. general style, writing process (prewriting, drafting, rewriting and editing). Effect of diction, sentence- structure and paragraphs on style; manuscript form, numbers, abbreviation, hyphenation of compound terms, decimal system of numbering headings, equations, documentation, sentence correction. Paragraph writing- Definition, requirements of a good paragraph (Unity, coherence and emphasis), topic sentence, various orders to develop a paragraph (Inductive, deductive, question to answer, exposition, time order, comparison and contrast, enumeration, space order). Report writing- Definition and cardinal characteristics of report, analyzing the report. Report formats- Blank form, letter form, memorandum form and general survey report. Technical correspondence- General principles of technical correspondence, parts of a letter (Heading, address, salutation, body, complimentary closing, signature), type of letters (letters giving instructions, inquiries and answers to inquiries, complaints and adjustments, letter urging action, applications and resumes). Proposal writing- Definition and kinds of proposal, division of formal proposal (Front matter, letter of transmittal, title page, summary or abstract, table of contents, statement of request and body). Writing scientific and semi-technical articles- Source material, topic selection, literature review, tables, figures, footnotes, bibliography.

Practical

Exercise on identification of phonetic sounds, symbols, consonants, pyre vowels, diphthongs, organs of speech, place of articulation and manner of articulation (Voiceless and voiced sounds). Writing of a technical report, paragraph, formal correspondence, proposal and scientific and semi-technical articles.

Suggested Readings

- Strunk, Jr.; William and White, E.B. (1967). The elements of style. New York: Macmillan.
- Leegget, G. C.; Mead, D. and Charvat, W. (1988). Essentials of grammar and composition. New Delhi: Prentice- Hall (Indian reprint).
- Sherman, T.A. and Simon, S. J. (1990). Modern technical writing. New Jersey: Prentice-Hall.
- Alvarez, J.A. (1980). The elements of technical writing. New York: Harcourt.
- Connor, J.D. (1992). Better English pronunciation. New Delhi, University Book Stall.
- Jones, D. and Glimson, A.C. (1997). English pronouncing dictionary, London.
- Bansal, R.K. and Harrison, J.B. (1983). Spoken English, Orient Longman, New Delhi.
- Krishnamohan and Banerjee, M. (1990). Developing Communication Skills. MacMillan India Ltd, New Delhi.

2. Introduction to Rural Sociology 2(2+0)

Theory

Rural sociology- Meaning, scope and significance. Structural differentiation in terms of difference and characteristics of rural and urban societies. Planned social change - Approaches to rural planning, improvement and transformation and their shortcomings. Indian rural development

programs (IRDPs). Indian rural social stratification: Castes- Basic notions, changes and its role in economy and policy, difference between caste and class, backward classes and implementations of constitutional provisions. Indian rural institutions: Social- Family and marriage (Nature, forms and changes), Economic-political: Land relations and changes; rural poverty: its manifestations and causes. Socio-religious: Functional significance of beliefs, traditions and customs. Rural social changes - Processes and factors of transformation. Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

- Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
- Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. ed.
- Doshi, S.L. (2007). Rural sociology. Delhi Rawat Publishers.
- Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers.
- Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers.

3. Nutritional Biochemistry - II 3(3+0)

Theory

Molecular aspects of transport, passive diffusion, facilitated diffusion, active transport. Introduction to nucleic acids- DNA, RNA - Structure, replication, transcription, genetic code (in brief) elementary knowledge of biosynthesis of proteins. Vitamins - Chemistry and biochemical role of fat soluble vitamins - A, D, E and K, water soluble vitamins – B_1, B_2, B_6, niacin and vitamin C, minerals – calcium, iron, magnesium, sodium, potassium, iodine, Trace minerals – zinc, copper, chromium, selenium, biochemical role of inorganic elements.

Suggested Reading:

- West, E. S., Todd, W. R.; Mason. H.S. and Van Bruggen J.T.: 4th Ed. Text book of biochemistry. Amerind Publishing Co. Pvt. Ltd.
- Murray, R. K. Grannen, D. K.; Mayes, P. A. and Rodwell. V. W.: Harper's biochemistry. Lange Medical Book.

4. Methods of Cookery 3(2+1)

Theory

Kitchen attire and equipments, cooking of food, heat and heat transfer cooking methods, effect of cooking on food and their nutritive value, basics of culinary practice, thickening and binding agents, basic flavoring stocks essence and glazes sauces soups garnishes, basics of cookery of various food - cereals, pulses, egg, fish, meat and poultry, principles and practice of boiling, steaming, frying, stewing, roasting, baking, grilling and combined methods of cookery

Practical

Preparation of recipes from different food groups such as cereals, pulses, eggs, vegetables, fruits and milk Preparation of food product using various cooking method:-Boiling, steaming, frying, stewing, roasting, baking, grilling and combined methods of cookery.

Suggested Readings:

- Fuller J. (1966). Chefs manual and kitchen management, B.T. Badtsford Ltd.
- Treat N. and Richard S. (1977). Quantity cookery. Little brown and Co.
- Klest, B.B., Wood, L., Horger, V.F. and Shugart G.S. (1977) Food Service in Institutions, John Kliley and Sons.
- Srilakshmi, B. (2010). Food Science. 5th edn. New Age International. Pvt. Limited.
- Swaminathan, M.S. (1993) Food science and experimentalfoods. Ganesh.

5. Economics and Marketing 3(2+1)

Theory

Terms and definitions in Economics; Consumption, demand and supply. Factors affecting production. Gross Domestic Product (GDP) – Role of poultry sector in National GDP. Marketing-Definition, marketing process, need for marketing, role of marketing, marketing functions, classification of markets, marketing of various channels, price spread, marketing efficiency, integration, constraints in marketing of agricultural produce, market intelligence, bank norms, insurance, SWOT analysis, crisis management. Techno-economic parameters for preparation of projects and basic guidelines for preparation of project report.

Practical

Techno-economic parameters for preparation of project. Preparation of bankable projects for various agricultural products and its value added products. Identification of marketing channel, calculation of price spread, identification of market structure and visit to different markets.

5. Food Analysis 4(2+2)

Theory

Introduction to food analysis- definition, Reasons for food analysis, official methods, Rules and regulation for food analysis and importance of food analysis in quality control, Sample and sampling techniques, familiarization to terms and calculations used in preparation of various standard solutions, principles, techniques and applications of colorimetric and spectrophotometer, analysis of carbohydrates- introduction, methods of analysis, sample preparation, extraction of monosaccharide's, oligosaccharides, chemical methods for carbohydrates analysis gravimetric methods, titremetric methods and colorimetric methods, enzymatic methods, analysis of polysaccharides- starch, crude fiber and dietary fiber, analysis of moisture importance of moisture analysis– methods of analysis direct methods, evaporation methods, analysis of moisture - indirect methods, chemical and distillation methods, analysis of moisture – instrumental methods, analysis of proteins – importance of protein analysis, protein analysis by Kjeldhal, dumas, biuret, Lowry, Dye binding, turbid and UV visible spectroscopy methods, analysis of amino acids-Characterization, basic principles of chromatography, types of chromatography and its applications, Analysis of fats- bysolvent, non solvent and instrumental methods, analysis of composition fats and its physical parameters, Analysis of antinutritional factors- characterization, basic principles -tannins, phytates, oxalates etc. Principles, techniques and applications of HPLC, TLC, Analysis of ash- introduction and importance, dry ashing, wet ashing and low plasma temperature ashing, Analysis of different minerals by gravimetric and titration methods, principles, techniques and

applications of AAS and AES, PH meter, electrophoresis, introduction to animal assay. principles, techniques and applications of colour estimating instruments.

Practical

Introduction to glassware's used in laboratory, preparation of samples and preparation of solutions buffers, estimation of moisture in food stuffs, estimation of bulk density of foods, estimation of colour using spectrophotometer, physical analysis-specific gravity, quantitative estimation of proximate principles- Ash, minerals, free fatty acids, protein, estimation of sugars-reducing and non-reducing , estimation of starch digestibility, quantitative estimation of vitamins by use of colorimetry, quantitative estimation of minerals by use of UV spectrophotometer, quantitative estimation of amino acids by use of paper chromatography, quantitative estimation of vitamins by use of HPLC, quantitative estimation of fatty acids by use of GC, quantitative estimation of pesticide residues by use of GC, quantitative estimation of minerals by use of atomic absorption spectrophotometer , quantitative estimation of minerals and vitamins by use of photo fluorometry, estimation of food adulteration , estimation of food adulteration.

Suggested Reading:

- AOAC (1995). Association of official analytical chemists. Washington, DC.
- Gruenwedels DW and whitakor JR (1984). Food analysis: Principles and techniques. Vols. I-VIII. Marcel Dekker.
- Joslyn MA. (1970). Methods in food analysis: Physical, chemical and instrumental Methods of analysis. academic Press.
- Pomeranz Y and Molean CE. (1977). Food analysis theory and practice. AVIPubl.
- Sawhney SK and Singh R. (2000). Introductory practical biochemistry. Narosa.

6. Food Preservation and Storage 4(2+2)

Theory

Indian and global scenario on food production and processing- quality requirement of raw material for processing plants primary processing secondary processing -storage changes in grains- food spoilage-causes and factors effecting, chemical nature. principle methods of food preservation- drying and dehydration, use of high temperature, use of salt, use of sugar,use of low temperature, preservative-food material as preservatives, use of chemicals, radiation, combination of above methods-changes in constituents, preservation by concentration, recent methods in preservation, effect of food processing and preservation on the nutritive value of foods, Traditional methods of storage and preservation, food flavours, importance of storage of semi perishable and non perishable foods - packaging and packaging material, labelling and costing of the product

Practical

Market survey of raw and preserved foods. Preparation of preserved products. Squash, cordial, crush, jams, jellies, marmalade, candy, preserves, murabbas, pickles with and without oil, chutneys, ketchup, sauces, candies, toffees, cheese and syrup. Shelf life and sensory evaluation of developed products Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Visits to food processing and preservation units, canning and bottling units, grain storage institute dairy plant and FCI godown.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
- Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
- Vijay K., (1999), Text book of Food, Storage and Preservation, Kalyani Publishers, New Dehi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
- Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.

III Semester

1. Elementary Statistics 3(2+1)

Theory

Introduction to statistics, definitions, functions, uses and limitations classification and tabulation of data, qualitative and quantitative classification, discrete and continuous variables, frequency tables, grouped and ungrouped data. Diagrammatic representation of data, one, two and three dimensional diagrams with applications. Graphical representation of data, histogram, frequency polygon, frequency curve, ogives. Measures of central tendency, introduction to basic concepts of logarithms, AM, GM, HM, median. mode with merits, demerits and uses, relationship between AM, GM and HM, quartile deviation, mean deviation from AM, median and mode, variance, standard deviation, coefficient of variation. Measures of dispersion, range coefficients, inter quartile range, quartile deviation, coefficient of quartile deviation, mean deviation from AM, median and mode, variance, standard deviation, coefficient variation. Moments, raw moments, central moments for grouped and ungrouped data, relationship between raw moments and central moments. Measures of skewness and kurtosis, definitions of symmetrical distribution, skewness and kurtosis, relationship between mean, median and mode and between quartiles for symmetrical and skewed distributions. Probability theory, introduction to simple problems of permutations and combinations, definition of random experiment sample space, events, mutually exclusive and equally likely events. Definition of probability, simple problems based on probability, addition and multiplication theorem of probability, conditional events and independent events, correlation and linear regression analysis, definition of correlation its types, scatter diagrams, karl pearson's formula of correlation coefficients, properties of correlation coefficient, definition of regression, regression equations of Y on X and of X on Y, relationship between correlation coefficient and regression coefficients. Problems based on correlation and regression. Tests of significance, basic definitions, hypothesis, null and alternative hypothesis, tests statistic, testing of hypothesis, one sample t-test and two sample fisher's t-test. Chi-square test of goodness of fit and Chi-square test of independence of attributes. Discrete and continuous probability distributions, definition of random variable, discrete and continuous random variables probability distribution of random variable, concepts of discrete and continuous probability distribution, basic concept of binomial theorem, binomial distribution, Poisson distribution, normal distribution and applications. Analysis of variance, definition of analysis of variance, assignable and nonassignable factors, analysis of one way classified data. Introduction to sampling methods, definition of population,

random sample, sampling versus complete enumeration, use of random number table for selecting a simple random sample, simple random sampling with and without replacements.

Practical

Graphical representation of data Diagrammatic representation of data. Measures of central tendency (Ungrouped and grouped data) with calculation of quartiles, deciles and percentiles. Measures of dispersion (Ungrouped and grouped data). Moments, measures of skewness and kurtosis (Ungrouped and grouped data), Moments, measures of skewness and kurtosis (Ungrouped and grouped data). Correlation and regression analysis one sample t-test. Application of two sample Fisher's t-test Chi-square test of goodness of fit Chi-square test of independence of attributes Analysis of variance one way classification. Selection of random sample using simple random sampling.

Suggested Readings:

- Elhance, D. N.Fundamentals of Statistics
- Agarwal, B. L.Basic Statistics
- Singh and VermaAgricultural Statistics
- Kapoor and SaxenaMathematical Statistics
- Hall and KnightHigher Algebra

2. Food Microbiology 3(2+1)

Theory

Basic aspects and scope of food microbiology; Intrinsic and extrinsic factors that affect microbial growth in foods. Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; chemical changes caused by microorganisms; control of spoilage. Food preservation - Physical methods. Chemical preservatives and natural antimicrobial compounds, biology based preservation system. Control of microorganisms by use of low and high temperature, asepsis, water activity, drying, preservatives, radiation and pressure for control of microorganisms; Microbiology of milk and milk products; Sources of contamination, spoilage and prevention; Microbiology of fruits and vegetables; cereal and cereal products; meat and meat products; fish and other sea foods; poultry and eggs; sugar and sugar products; salts and spices; contamination, spoilage and prevention.

Practical

Changes in practices : General laboratory practices in microbiology laboratory, Equipment used in food microbiology laboratory, Aseptic methods, Sterilization methods, Morphological studies, Preparation of media, Isolation and enrichment of microorganisms, Microbial analysis of food products and water. Isolation of molds from foods. Microbial examination of cereal and cereal products, vegetable and fruits, meat and meat products, fish and other sea foods, Eggs and poultry, milk and milk products; sugar, salts and spices.

Suggested Reading:

- Banawart GJ. (1989). Basic food microbiology. 2nd Ed. AVI Publ.

- Frazier J and Westhoff DC. (1988). Food microbiology. 4th Ed. McGraw Hill.
- Garbutt J. (1997). Essentials of food microbiology. Arnold Heinemann.
- Jay JM, Loessner MJ and Golden DA. (2005). Modern food microbiology. 7thEd. Springer.
- Ray B. (2004). Fundamentals of food microbiology.3rd Ed. CRC.
- Robinson RK. (Ed.). (1983). Dairy microbiology. Applied Science.
- Steinkraus KS. (1996). Handbook of Indigenous Fermented Foods. Marcel Dekker.

3. Introduction to Clinical Nutrition 4(3+1)

Theory

Metabolic changes and clinical diagnosis in various diseases. Nutrient deficiency diseases. Anaemia , vitamin B complex deficiencies, Vitamin A deficiency disease, Iodine deficiency disorders, Calcium and vitamin D deficiency diseases, ascorbic acid deficiency. Metabolic changes and clinical diagnosis in degenerative diseases: Diabetes, Cardiovascular diseases, renal disorder, liver diseases, cancer. Interpretation of report of blood and urine in different disease conditions. Drug and nutrient interaction, effect of drugs on nutritional status. Effect of diet and nutritional status on drug effectiveness.

Practicals

Identification and interpretation of clinical signs of nutritional deficiency diseases sampling of blood and urine for nutritional status estimation of haemoglobin. Estimation of glucose in blood and urine in normal and diabetic persons. Estimation of lipid profile in normal and heart patients. Estimation of serum retinol total protein and serum albumin visit to a clinical laboratory.

Suggested Readings:

- Lee, R.D. and Nieman, D.C. (1993). Nutritional assessment. Pub. Brown and Benchmark, USA.
- Pathak, N.N. (1997). Analytical techniques in clinical nutrition (manual); Centre of Advanced Studies in animal nutrition IVRI, Izatnagar.
- Oser, B.L. (1979). Hawk's physiological chemistry. Tata Mc Graw Hill Pub. Co. Ltd., New Delhi
- American Journal of Clinical Nutrition.

4. Normal Nutrition and Meal Planning 3(2+1)

Theory

Basic principles of menu planning, planning menus for individual and family. Classification of vegetarianism. Factors influencing food intake and food habits. Basic principles of meal planning, planning meals for individual and family. Factors affecting food requirements of individuals, families and different groups of people. Meal planning for special occasions. Steps involved in meal planning. Food groups and their use in meal planning. Recommended dietary allowances of macro and micro nutrients for different age groups. Food exchange list. Use of food exchange list in diet planning, planning breakfast, lunch, tea, dinner, packed lunch and snacks; considering

RDA for individuals Importance of balanced diets. Food and nutrient requirement of adults (male and female of all activities level), pregnant women, lactating women, infants and normal infants. Breast feeding, advantages of breast feeding, prelacteal feeding, breast feeding during illness, feeding of pre term baby, feeding problems. Weaning and complementary feeding. Food and nutrient requirement of pre-school children, school age children, adolescents, age people. physiological and psychological factors affecting the diet plan.

Practical

Standardization of serving sizes, portion, cost of locally available common foods. Planning preparation and nutrient calculation of diets of preschool children, school going children, adolescents and adults. packed lunches for school children. Practice in formal and informal table setting and table manners.

Suggested Readings

- Robinson and Weicley, (1984). Basic Nutrition and diet Therapy. Macmillian Publishing Co. Inc. New York and London.
- Gopalan, C., Ramsastri, B.V. and Balasubramanian, S.C. (1990). Nutritive Value of Indian Foods.
- ICMR, (2010). Recommended Dietary allowance for Indians, ICMR, Delhi.
- Srilakshmi, B (2002). Nutrition science, New age Int. Ltd. Pub., New Delhi
- Joshi, S. (2000). Nutrition and dietetics. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Sharma S. (2006). Human nutrition and meal planning. Delhi, Jnanada Prakasham (PandD). Mudambi, S. R. and Rajagopal. M.V. (2001). Fundamentals of foods and nutrition. New Delhi, New Age International (P) Ltd. New Delhi.
- Srilakshmi, B. (2005). Dietetics. New Delhi 5th edn. New Age International (P) Limited. New Delhi.

5. Community Nutrition 4(2+2)

Theory

Basic concept of community nutrition role of nutritionist in improving nutrition in community Food habits and influencing factors, Food taboos Mortality and morbidity pattern of vulnerable groups and their causes. Nutritional needs of normal infants, prelacteal feeding, exclusive breast feeding, feeding of full term and premature infants. Importance of breast feeding and supplementary foods in combating malnutrition in infants and young children. Growth monitoring Malnutrition. Definition and causes, classification of grades of malnutrition. Assessment of nutritional status. Major nutritional problems in community. National programmes and policies for improving nutritional status of community. Role of national and international agencies in improving nutritional status of the community. Nutrition education: Objectives, methods, channels and its role in control of malnutrition in community.

Practical

Assessment of nutritional status of an individual/community using anthropometry and dietary survey Visit to local health centers to identify clinical signs and symptoms of nutritional problems

Visit to Anganwadi centres and evaluation of feeding provided at these centres. Development of audio- visual aids planning, implementation and evaluation of nutrition education programme for a target group.

Suggested Readings:

- Sehgal, S. and Raghuvanshi, R.S. (2007). Textbook of community nutrition, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.
- Latham, M.C. (1997). Human nutrition in the developing world. Food and agricultural organization of United Nations.
- Srilakshmi, B. (2012). Nutrition science, New Age International Pvt. Ltd. Publishers. New Delhi.
- Srilakshmi, B. (2012). Dietetics, New age international Pvt. Ltd. Publishers. New Delhi.
- Dahiya, S., Boora, P. and Rani, V. (2013) A manual on Community nutrition, Deptt. of Foods and Nutrition, published under ICAR, Assistance scheme.
- Bamji, S.M., Rao, N.P., Reddy, V. (1996) Textbook of human nutrition. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Swaminathan, M. (1985). Essentials of food and nutrition. 2nd edition, Vol. II. The Bangalore printing and publishing company Ltd. Bangalore.

6. Cereals and Millets: Preparation and Utilization 3(2+1)

Theory

Major cereals and millets of India, structure and composition of cereal grains, storage of cereals, Suitability of commercial grains for processing, evaluation of varietal differences Wheat types and wheat hardness - Soft wheat, hard wheat, durum wheat. Wheat milling operations, commercial roller flour milling, air classification Suitability of wheat flour for particular end use, flour treatments, gluten and functionality, dough rheology, bread quality, wheat products Rice-Structure and composition, rice milling, milled rice, ageing of rice, parboiling of paddy, cooking of rice, processed rice products and by-products, fermented rice products Maize and sorghum-Structure, composition, milling Barley, oat and millets- Structure, composition, malting, milling by products utilization of all commercial grains. Preparation of flakes, starch, syrup, germ oil and steep liquor.

Practicals

Physico-chemical properties of grains. Quality test of rice – amylase content determination. Estimation of gluten content. Rheological tests-Mixograph, farinograph, alveograph, extensograph. Chemical tests- Sedimentation test, flour swelling volume, starch gelatinization, paste viscosity properties Preparation of wheat products- Bread and biscuits. Preparation of fermented rice products. Visit to flour mills, rice mills, bakery units.

Suggested Readings:

- Khader , V. (2001. Text book of food science and technology. Directorate of information and Publications of Agriculture, ICAR, Krishi Anusandhan Bhawan, Pusa, New Delhi

- Srilakshmi B. (2001). Food science. New Age International Pvt. Ltd. New Delhi
- Salunkhe, D. and Despande, S.S. (1991) Foods of plant origin: Production, technology and human nutrition. The AVI Publishings Inc. New York
- Ram, S and Mishra, B. (2010) Cereals-processing and nutritional quality. New India Publishing Agency, Pitam Pura,New Delhi
- Potty, V.H. and Mulky, M.J. (1993). Food processing. Oxford and IBH.
- Fellow, P.J.(2009) Food processing Technology 3rd Ed. Wood Publishing Ltd. Cambridge England.
- Manay N.S and Shadaksharaswamy, M.(2001). Foods facts and principles. Wiley Eastern Ltd. New Delhi, Bangalore, Bombay, Calcutta , Hyderabad

7. Food Service Management- I 2(2+0)

Theory

Development and types of food service institutions, historical development. Management, organization and administration of a food service establishment. Organization of kitchen, storage and service areas, layout designs. Equipments- Classification, selection, operation, purchasing, care and maintenance. Food purchasing, receiving, storage, menu planning, food production and service. Financial management- Cost concepts, food cost control, pricing, book-keeping, accounting. Personnel management- Policies, recruitment, selection, facilities, benefits, trainings and development. Sanitation, hygiene and safety in food service establishment. Laws governing food service establishments, legal issues. Current issues.

Suggested readings

- Chakrabarty MM. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall.
- Dendy DAV &Dobraszczyk BJ. 2001. Cereal and Cereal Products. Aspen.
- Hamilton RJ &Bhati A. 1980. Fats and Oils - Chemistry and Technology. App. Sci. Publ.
- Hoseney RS. 1994. Principles of Cereal Science and Technology. 2nd Ed. AACC.
- Kay DE. 1979. Food Legumes. Tropical Products Institute.
- Kent NL. 1983. Technology of Cereals. 4th Ed. Pergamon Press.
- Kulp K & Ponte GJ. 2000. Handbook of Cereal Science and Technology. 2nd Ed. Marcel Dekker.
- Lorenz KL.1991. Handbook of Cereal Science and Technology. Marcel Dekker.
- Marshall WE & Wadsworth JI. 1994. Rice Science and Technology. Marcel Dekker.
- Mathews RH. 1989. Legumes Chemistry, Technology and Human Nutrition. Marcel Dekker.
- Matz SA. 1969. Cereal Science. AVI Publ.
- Paquot C. 1979. Standard Methods of Analysis of Oils, Fats and Derivatives. Pergamon Press.
- Pomeranz Y. 1987. Modern Cereal Science & Technology. VCH Publ.
- Salunkhe DK.1992. World Oilseeds: Chemistry, Technology and Utilization. VNR. Swern D. 1964. Bailey's Industrial Oil and Fat Products
- Sethi and Malhan. (1993) Catering management: An integrated approach. Wiley Eastern.
- West, Wood and Hanger. Food Service in institutions. John Wiley and Sons, Inc. Hoboken, New Jersey.

IV Semester

1. Food Product Development and Formulations 2(1+1)

Theory

Basic principles of food product development Sensory properties of food and their role in product development Bulk food preparation for food institutions and enterprises: Servings, nutritive value and costing Evaluation of food: Objective and subjective methods, selection and training of judges, Development of score cards and analysis of data Consumer evaluation: development of schedule and data analysis. Packaging materials and labeling Food safety and quality control issues in product development, food quality regulations and standards, quality control and HACCP Product formulation and development for general and therapeutic use.

Practical

Sensory evaluation: Methods, training of judges, score card preparation Selection and modification of food products to be developed, formulation and standardization of products, objective and subjective evaluation of the products, evaluation of consumer acceptability, packaging and sale of products, presentation of developed food products, Video shooting of product preparation.

Suggested Readings

- Altschul A., M. (1993). Low calorie foods. Marcel Dekker.
- Goldberg, I. (1994). Functional foods: Designer foods, Pharma Foods, Neutraceuticals. Springer.
- Matz, S.A. (2004). Formulating and processing of dietetic foods. CHIPS Publ.
- Kalia, M. and Sood, S. (2010). Food preservation and processing. Revised edition, Kalyani Publishers, New Delhi.
- Srilakshmi, B. (2010). Food science (Fifth ed.) New Age International Pvt. Limited, Pub., New Delhi.
- Gordon, W.F. (2011). New food product development: From concept to market place (third edition). CPR, Press.

2. Fruits and Vegetables: Preparation and Utilization –I 2(1+1)

Theory

Importance and scope of fruits and vegetables in human diet Harvesting and processing of fruits and vegetables Selection and purchase of fruits and vegetables for preservation General principles involved in preservation of fruit and vegetables products Processed fruit and vegetable products. Specification of processed products Post- harvest practices and changes Carbonated beverages, non-alcoholic beverages and fruit juice concentrates Pickles, vinegar, tea, coffee and cocoa products Wine and fermentation technology.

Practical

Evaluation of pectin grade; Canning of mango/guava/papaya; Preparation and quality evaluation of fruit jam with fruits of regional importance; Preparation and quality evaluation of

fruit jelly with fruits of regional importance ;Preparation and quality evaluation of fruit marmalade; Preparation and quality evaluation of fruit preserve and candy; Preparation and quality evaluation of fruit RTS; Preparation and quality evaluation of squash / syrup; Preparation of grape raisin / dried fig / dried banana; Processing of tomato products; Preparation and evaluation of dehydrated vegetables; Preparation and quality evaluation of wafers with vegetables / tubers; Preparation of fruit cheese; Preparation of pickle / mixed pickle; Preparation of dried ginger / mango powder (amchur);Final practical examination

Suggested Reading:

- Barret DM, Somogyi LP and Ramaswamy H. 2005. Processing of Fruits. CRC Press
- FAO. 2007. Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual. FAO Agr. Ser. Bull., 149.
- Fellows P. 2007. Guidelines for Small-Scale Fruit and Vegetables Processors. FAO Agr. Ser. Bull., 127.
- Kalia, M. and Sood, S. 2010. Food Preservation and Processing. Revised edition, Kalyani Publishers, New Delhi.
- Lal G, Siddappa GS and Tandon GL. 1998. Preservation of Fruits and Vegetables. ICAR.
- Salunkhe DK andKadam SS.1995. Handbook of Fruit Science and Technology: Production, Composition and Processing. Marce
- Sivasankar, B. 2002. Food Processing and Preservation. PHI Learning Pvt. Ltd.
- Singh, I. S. 2009. Post harvest handelling and processing of fruits and vegetables. Westville Publishing House, New Delhi.

3. Nutrition Through Life Cycle 3(2+1)

Theory

Infancy- Role of nutrition on physical and mental development, rate of growth-weight as an indicator, assessment of growth, nutrient requirement during infancy, feeding of infants, value of breast feeding on infants, breast feeding versus artificial feeding, types of milk and their use in infant feeding. Weaning and supplementary foods, weaning practices in community, feeding of premature and low-birth-weight infants. Nutritional disorders and common ailments in infancy, feeding the sick child, immunization schedule and growth charts Preschool age: Physical growth and mental development, prevalence of malnutrition in preschool years and food habits, nutritional requirements during preschool age and supplementary foods School age. Physical growth and mental development, nutritional requirements during school age, specific problems, specific problems in feeding school children Adolescence. Physical and physiological changes, nutritional requirements, food preferences and nutritional problems, problems, growth spurt and nutrition, adolescent fads influencing nutrition. Adulthood, Sex, occupation and income, nutritional requirements, biological and nutritional consequences and complications due to pollutants, vegetarianism. Nutrition, wok capacity and physical fitness. Nutrition, infection and immunity, nutrients and drugs interaction. Pregnancy. Physiological changes in pregnancy, weight gain during pregnancy, food and nutrient requirements. Complications of pregnancy and their nutritional management, impact of nutrition on the outcome of pregnancy. Nutritional need of fetus during different stages of fetal cell growth and maternal nutritional needs.

Psycho-physiology of lactation; milk synthesis and secretion, maternal needs during lactation, composition of colostrums and mature human milk, milk of mothers of pre-term babies. Non-nutritional factors of human milk; immunological factors, enzymes, hormones. Human milk banking. Elderly. Physical and physiological changes, nutritional requirements, problems of old age, nutrients influencing aging process

Practicals

Grouping of foods based on richness of nutrients and quantifying foods to give uniform content of each nutrient. Planning and formulation of food exchange lists. Planning, preparation and evaluation of diet for adult men and women involved in different activities. Planning, preparation and evaluation of diets for pregnant women, , lactating mothers, weaning and supplementary foods for infants, preschool children, school going children, packed lunches for preschoolers and school children, adolescent boys and girls, elderly, preschool children with pem and vitamin. A deficiency Planning diets for anaemic children, adolescents and pregnant women.

Suggested Readings:

- Moris,E.S. (1994). Modern nutrition in health and disease. Leaned Febin.ger, USA
- Srilakshmi, B. (1995). Dietetics. Newage international publishers, New Delhi.
- Corinne H.R, Marilyn R. L, Wanda L. C and E. Garwick. (1982). Normal and therapeutic nutrition. (pp- 1-16). New York, Macmillan Publishing Company.
- Williams, S.R.; Worthington, R.S.; Sneholinka, E.D.; Pipes, P.; Ress, J.M. and Mahal, K.L. (1988). Introduction to nutrition throughout the life cycle. Times Mirroe/Mosby College Publishers.

4. Milk and Milk Products: Preparation and Utilization 4(2+2)

Theory

Introduction, importance and scope of fluid milk industry in India and abroad: Brief history and present status. Composition of milk, nutritive value of milk of cow and buffalo. Physico-chemical properties of milk and milk constituents: Physical state, acidity, pH, density and specific gravity, freezing point, colour and flavor. Microbiology of milk. Types of micro organisms, their production and consequent results in milk production. Types of milk_ Sterilized Milk; Homogenized Milk; Flavoured Milks; Standardized Milk; Reconstituted/Re-hydrated Milk; Recombined Milk; Toned Milk. Milk products- traditional products- butter, ghee, khoa, cheese in theory. Steps of milk processing: collection, chilling, standardization, pasteurization, homogenization, bactofugation, and principles of dehydration. Management of processing plant: Various kinds of designs and layouts of plants Value addition for fluid milk. Waste management Quality control aspects of milk: Status of antibiotics, pesticides, heavy metals etc., Good manufacturing practices, implementation of HACCP standards, cleaning and sanitization of fluid plant: Indian standards for milk and milk products as per PFA, BIS, AGMARK etc., cleaning and sanitization procedures. Judging and grading of milk, defects in milk, their causes and prevention.

Practical

Sampling of milk. Estimation of fat, SNF, TS platform tests. Cream separation. Detection of adulterants Microbiological quality evaluation of milk and milk products Preparation of milk

products. Paneer, channa, icecream, khoa, burfi, flavoured milk, rasogulla. Visit to modern milk processing and manufacturing plants.

Suggested Readings:

- Aneja R.P., Mathur B.N., Chandan, R.C., and Banerjee, A.K. (2002) Technology of Indian milk products. Dairy India Yearbook
- Jenness, R. and Patton S. (1959) Principles of Dairy Chemistry
- Lampert, L.M. (1970) Modern dairy products. Chemical Publishing Company Inc. New York
- Srinivasan, M. R. and Anantkrishanan C.P. (1964) Milk Products of India
- Sukumar ,De. (2001).Out lines of dairy technology Oxford Uni. Press New Delhi

5. Public Health Nutrition 4(3+1)

Theory

Scope of public health. Public health problems of India, nutrient deficiency diseases and other diseases, their etiology, prevalence and prevention. The basic concept of health, health as a human right, national health policy and national nutritional policy. National programmes relevant for public health. Vitamin A deficiency disorder control programme. National diarrhoeal disease programme, national iodine deficiency. Disorder control programme, iron deficiency, anemia prophylaxis programme. National malaria eradication programme, national immunization programme, national programme for control of tuberculosis, national leprosy eradication programme, national aids control programme, bational guinea worm eradication programme, national kala azar control programme, other health and nutrition programmes Factors affecting implementation of programmes in rural areas. Modulating factors in nutrition for public health. Child care. Existing picture of child health, objective and imaginative approach to child care. Care of infants and women, hereditary disorders. Health problems of aged and their care. Special care and priority for mentally handicappe. Occupational health and industrial health policy. Traditional medicine, vegetarianism, health food, genetically modified foods and their relevance in human health. Epidemiology as a basis of health policy

Practical

Epidemiological approach to study individual disease in a community. Analysis of data and report writing. Discussion for preventive and therapeutic strategies. Public health campaign in a village.

Suggested Readings

- Mukhopadhyay, A. (1992). State of India's health. Voluntary Health Association of India.
- Srilakshmi, B.(2002). Nutrition science. New Age International (P)Limited.
- McLaren, D.S. (1976). Nutrition in the community. John Wiley and Sons, London.
- DeMaeyer, E.M. (1989). Preventing and controlling iron deficiency anaemia through primary health care. A guide for health administrators and programme managers. WHO, Geneva.
- WHO 2001. Assessment of iodine deficiency disorders and monitoring their elimination. A guide for programme managers 2nded.
- Meashan, A.R. and Chatterjee, M. (1999). Wasting Away: The crisis of malnutrition in India. The World Bank, Washington, D.C.

- Krishnaswamy, K. (2000). Twenty fice years of National Nutrition Monitoring Bureau. NIN, Indian Council of Medical Research, Hyderabad.

6. Food Chemistry 4(3+1)

Theory

Properties of foods. Solubility, vapour pressure, boiling point, freezing point, osmotic pressure, viscosity, surface tension, specific gravity, oxidation and reduction. Acids, bases and buffers. Chemical bonding, octet rule, ionic bond, covalent bond, polar and nonpolar molecules, hydrogen bond Colloids, sols, gels, emulsions and foams. Composition of foods- classification, structure and properties of carbohydrates, proteins,lipids. Water,- physical problem, free, adsorbed and bound water; Properties of minerals and vitamins, pigments. Structure and properties of chlorophyll, anthocyanins, flavanoids, tannins, betalains, quinones, carotenoids, myoglobin and haemoglobin. Flavour compounds, terpenoids, flavanoids, sulphur compounds and volatile flavour compounds. Enzymes, enzyme inhibitors, enzymatic browning, enzymes in food processing. Food and Food Products: Composition of beverages- hot drinks, tea, coffee, cocoa, cold drinks, soft-drinks, fruit beverages and alcoholic drinks-beer, wine etc. Classification, composition and effect of processing of fruits and vegetables. Structure, composition, processing and effects on composition of cereals, pulses and oilseeds. Composition, processing and changes in processing of milk, eggs, meat and poultry. Sugars and sweeteners, reaction of sugars, non nutritive sweeteners. Food additives: Antioxidants, chelating agents, colouring agents, curing agents, emulsions, flavours, and flavour enhancers, humectants and anti-caking agents, leavening agents, nutrient supplements, preservatives, stabilizers, thickeners.

Practical

Basic measurements- Temperature, volume, weight, density and specific gravity Weight and volume of food stuffs- Flours, sugar, fat, eggs. Preparation of standard solutions. Percentage volume by volume, percentage weight by volume, molar, normal. Measurement of pH by pH meter and by indicators acid base and and oxidation –Reduction titrations and freezing point. Effect of kind and quantity of solutes on boiling point. Osmotic principles in fruits. Effect of acid and base on some vegetables. Flour paste, chocolates, sucrose, starch and jelly. Qualities of flour: Absorptive power, gluten and effect of other ingredients on gluten. Crystalization of sugars from syrups. Tests for unsaturation and rancidity of fats: Iodine value, acid value, saponification value, peroxide value, kreis test, TBA number, smoke point. Effect of heat on proteins.

Suggested Readings:

- Manay, N.S. and Shadaksharswamy, M. (2001). Food facts and principles, II Ed. . New Age International (P)Ltd. Publishers, New Delhi.
- Aurand, L.W. and Woods A.E. (1973). Food chemistry. The AVI Publishing Company, Inc., Westport Connecticut.
- Mondy, N.I. (1980). Experimental food chemistry. AVI Publishing Company, Inc. Westport Connecticut.

7. Communication Skills and Personality Development 3(2+1)

Theory

Communication skills- Process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Role of ICT in communication. Recent advances in communication- Print and electronic, internet, e-mail, fax, mobile, interactive video and teleconferencing, computer, e-governance.

Meaning and definition of personality; Theoretical perspectives on personality- Behavioural trait and humanistic personality pattern; moulding the personality patterns. Personality development- Self perception, self concept, self esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family). Aspirations, achievements and fulfillment. Dressing for formal and informal occasions

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations. Developing questionnaire to study impact of physique, educational institutions, aspirations on personality; developing questionnaire to study social prescriptions, gender and family on personality, aspirations and achievements. Collecting data through the questionnaires on small samples. Report writing and presentation. Case study of an individual suffering with personality disorders.

V Semester

1. Therapeutic Nutrition–I 4 (2+2)

Theory

Importance of therapeutic meal planning and factors to be considered in meal planning. Use of food groups and exchange list in therapeutic meal planning. Importance and modification of normal diet to therapeutic diets – Nutrients, consistency, temperature,; Methods of feeding (normal and artificial) – Oral, enteral, parenteral feeding. Causes, symptoms and dietary management in various nutritional deficiencies – Energy, protein, vitamins A, D, C and B complex, iron, calcium and zinc. Infections and fevers: Types, causes, symptoms and dietary management in acute and chronic fevers. Gastrointestinal disorders: Diarrhoea, constipation, peptic ulcers, GERD, ulcerative colitis, diverticulitis, irritable bowel disease, malabsorption syndrome. Liver and gall bladder diseases – Causes, symptoms and dietary management of Jaundice, hepatitis, cirrhosis, ascites, hepatic coma, cholelithiasis. Eating disorders – Anorexia nervosa, bulimia, underweight, overweight and obesity and problems of weight control.

Practical

Market survey for determining cost of locally available common foods; Standardization of serving sizes for different food items, portioning. Planning and preparation of soft and liquid diets, ORS and bland diet and therapeutic diets for typhoid, tuberculosis, influenza, malaria and AIDS. Planning and preparation of diets for gastrointestinal disorders i.e. diarrhoea, constipation, peptic ulcers, GERD, ulcerative colitis, diverticulitis, irritable bowel disease, malabsorption syndrome. Planning and preparation of diets for liver and gall bladder diseases i.e. Jaundice, hepatitis, cirrhosis, ascites, hepatic coma and cholelithiasis and eating disorders i.e. anorexia nervosa, bulimia, underweight, overweight and obesity and problems of weight control.

Suggested Readings

- Antia,P. (1986). Clinical dietetics and nutrition. Oxford Univ. Bombay.
- Moris,E.S. (1994). Modern nutrition in health and disease. Leaned febiger, USA.
- Srilakshmi, B. (1995). Dietetics. New age international publishers, New Delhi.
- Corinne H. Robinson, Marilyn R. Lawler, Wanda L. Chenoweth, Ann E. Garwick. (1982). Normal and Therapeutic Nutrition. (pp- 1-16). New York, Macmillan Publishing Company.
- Elia, M., Ljungqvist, O., Stratton, R. and Susan, L. (Eds.). (2012). Clinical Nutrition, 2nd Edition.Wiley-Blackwell
- Gopalan, C., Ramsastri, B.V. and Balasubramanian, S.C. (2012). Nutritive value of Indian foods.
- ICMR. (2010). Recommended Dietary Allowances for Indians, ICMR, Delhi.
- Joshi, S. (2000). Nutrition and dietetics. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

2. Food Hygiene and Sanitation 4(2+2)

Theory

Concept and significance of hygiene and sanitation in relation to food industry. Food storage general guidelines and storage of specific foods principles of hygiene and sanitation- sanitary procedures while preparation, cooking, and holding food, serving and displaying food, specific food operations. Sources of food contamination Sanitation of physical plant (premises) and sanitation of equipment- cleaning procedures. Personal hygiene and food handling habits of personnel. Water supply sources, impurities of water. Water purification methods. Domestic and Industrial. Food and water borne infections. Prevention and control. Regulatory laws- Environmental pollution- Sanitary regulations and standards.

Practical

Identification of micro organisms, preparation of slides, preparation of media. Collection of water samples. Testing of water for: (i) Physical quality (ii) Bacteriological quality. Survey of hygienic and sanitary condition in food shops/food vendors. Visit to food industries. Report writing.

Suggested Readings:

- Bhat, RV and Rao, RN (1997). Food safety. BAPPCO Ltd., Banglore
- Hobbs, BC and Gilber RJ. (1982). Food poisoning and food hygiene. Ballantyne LTD., London.

- John, N. (1995).Managing food hygiene. McMillan Press Ltd. UK
- Longree, K and Armbuster G (1996). Quantity food sanitation John Wiley and Sons. New York.
- OECD. (2003).Assessing microbial safety of drinking water: Improving approaches and methods. IWA publishers
- Roberts, D. and Greenwood M. (2002). Practical food microbiology, 3rd Edition. Wiley-Blackwell Publishers.
- Roday, S. (2012).Food hygiene and sanitation. Tata McGraw-Hill Education publishers.
- The microbiological examination of foods and water. www.marietta.edu/~spilatrs/biol202/labexercises/9-Food_and_water.pdf
- WHO, (1995). Food hygiene in catering establishments. Legislation and Model Regulation,WHO Offset publication No. 34 Geneva.

3. Foods Standards and Quality Control 4(2+2)

Theory

Food quality and quality attributes - Classification of quality attributes and their role in food quality, objectives, importance and functions of quality control, principles of quality assurance, quality assessment of raw materials, International standards, food additives, introduction and importance, classification of preservatives, colouring agents, emulsifying and stabilizing agents, antioxidants, various methods / techniques for the assessment of quality of different foods, instrumental analysis of quality control. Different ways of testing texture of different foods, grading and marking standards and specification for finished products, food adulteration- introduction and various ways of adulteration, introduction to sensory analysis, general testing conditions, requirements of sensory laboratory, organizing sensory evaluation programme, selection of sensory panelists, Factors influencing sensory measurements, Sensory quality parameters –Size, shape, texture, aroma, taste, color and gloss, threshold and dilution tests, different tests for sensory evaluation– discrimination, descriptive, affective, flavour profile and tests, ranking tests, methods of sensory evaluation of their food products, computer-aided sensory evaluation of food and beverage, statistical analysis of sensory and objective analysis data. consumer studies and different types of consumer studies, introduction to HACCP, implementation in food industry. Food safety and quality control Food grade standards for different processed products

Practical

Sampling techniques for collection of agriculture, horticulture and animal foods. Collection of food samples from different sources, Physical examination and grading of grains, spices etc for quality, exercise on identification of basic taste- sweet, sour, salty and bitter, triangle test, Sensory evaluation techniques- duo-trio test, score card method, Sensory evaluation of a food product, Demonstration of objective tests for quality evaluation, Detection of food adulteration in grain samples and spices, oils and milk, Collection of food products with artificial colouring and checking for quality,Visit to quality control lab, foods, water.

Suggested Readings

- Carol E, Mellin; D. and Barbara A C. (1995). Food safety , food fesearch Institute, University of Wisconsin- Madison. Marcel Dekker Inc. New York.
- Soharb and Shasisareen. The Food Industry- A practical guide- BIS, New Delhi, Pub by APEDA
- Surveillence, Prevention and control of food contaminants, Proceedings of National Symposium, ICMR, New Delhi,1996

4. Sports Nutrition and Physical Fitness 3(2+1)

Theory

Overview of nutritional management vis-a-vis physical fitness, techniques and methods of measuring physical fitness. Body composition -methods of measuring body composition - direct and indirect, Body composition in different physiological conditions and factors affecting it. Energy metabolism and physical fitness- aerobic and anaerobic, concept, importance, influencing factors. Techniques to measure energy expenditure and energy intake, Aging physiology, mechanism and role of nutrients in arresting aging process, aging theories, nutritional requirements of sports personnel involved in various sports, Basic exercise physiology and biochemistry -Physiological and metabolic changes during and after sports activity. Macronutrients metabolism in exercise – carbohydrates problems and fat (Fueling before, during and after exercise). Effects of dehydration and rehydration in exercise and role of water and electrolytes in performance. Vitamins metabolism in sports. Free radicals in exercise role of antioxidants in exercise. Minerals and trace minerals metabolism in exercise and essential minerals and trace minerals in sports. Sports nutrition products, sports nutrition, theory to practice –,Special consideration in sports nutrition- Women, young, diabetic, vegetarian athletes, Sport specific nutrition –Gymnastics, weight lifters, skiers, cyclists, swimming, skating, ,Winning recipes for peak performance.

Practical

Development of project proposal on nutrition in physical fitness. Development of methodology for collection of data, assessment of nutritional status and physical fitness, practice of using anthropometry, clinical and dietary assessment techniques, assessment of body composition of the selected group. Development and standardization of tool for physical fitness. Assessment of physical fitness of the selected group using standard tool. Use and practice of ergonomic equipment for a assessment of energy expenditure for different activities. Compilation of data of anthropometry and clinical observation. Analysis of dietary intake to assess the nutrient intake, interpretation of nutrient intake in comparison with RDA, compilation of data on energy expenditure, analysis of data and Final report writing of the project and presentation.

Suggested Reading:

- Falkner, F. and Tanner JM. (1978). Human growth - Principles and prenatal growth. Vol. I.
- Falkner, F. and Tarnner JM. (1980). Human growth methodology. Ecological, genetic, and nutritional effects on growth. Vol. III. Plenum Press.
- Passmore, R. and Eastwood MA. (1986). Human nutrition and dietetics. ELBS Churchill Livngstone.
- Pike, R.L. and Brown M.L. (1988). Nutrition - An Integrated Approach. John Wiley and Sons.

5. Nutrition in Emergencies 2(2+0)

Theory

Definition and historical perspective of national emergencies Starvation in emergencies arising out of drought, floods, earth quakes, locust attack, war wrong policies and properties. Effect of short, medium and long term emergencies on food and nutrients, intake, Major nutritional deficiency diseases in emergencies. Food needs at national level during normal emergencies, precautions against food shortage. Mobilization of local resources; general fund distribution, mass and supplementary feeding, therapeutic feeding, social funds. Control of communicable diseases, public health and hygiene problems during Emergencies.

Suggested Readings:

- Messer E, Mark J, Cohen C andJashinta D. 1998. Food from Peace:
- Breaking the Links between Conflicts and Hunger. IFPRI, Washington.
- Spark A. 2007. Nutrition in Public Health: Principles, Policies and Practice. CRC Press.
- WHO,2000 The Management of Nutrition in Major Emergencies..

6. Nutrition Education 3(1+2)

Theory

Objectives, principles and importance of nutrition education in a community. Goals and history of public health nutrition. Identification of nutritional problems and target groups. Nutritional surveys, National Nutrition Monitoring Bureau. Deficiency diseases and public health problems-Vit. A, iron and iodine deficiencies, other micronutrient deficiencies. Communication techniques: Process, its components. Communication techniques: Mass, group and individual; advantages and disadvantages. Theory and practice of audio-visual teaching. Learning by doing, learning by observation, symbolic experience. Classification and use of audio visual aid-Electronic aid, non projected and three dimensional. Selection and evaluation of audio visual aids. Nutrition education: Planning effective programmes for target groups, developing appropriate messages.

Practical

Preparation and use of instructional material- Charts, posters, calendars, flipcharts, pamphlets. Practicing use of nutrition education material on vulnerable groups in the community, rural and urban. Evaluation of nutrition education programmes executed. Assessment of nutritional status: Techniques employed for-height, weight, body mass index, skin fold measurements. Inferences to identify nutritional problems.

Suggested Readings

- Obert, J.C. (1986). Community nutrition. Macmillan Publishing Co., N.Y.
- Reddy, A.A. (2001). Extension education. Sree Lakshmi Press, Bapatla.
- Ray, G.L. (1991). Extension communication and management. Naya Prokash, Kolkata.
- Rathore, O.S.; Chauhan, M.S; Dhakar, S.D. and Ojha, S.N. (2001). Handbook of extension education. Agrotech Publishing Academy, Udaipur.
- Dale, E. Audio-visual methods in teaching. The Dryden Press. Latest edition.

7. Nutrigenomics 3(3+0)

Theory

Genomics – scope and importance, Definition, global impact of genomics; genomics in health care, agriculture and environment; processes and products of biotechnology; application of genomics in development of nutritious foods. Genes – nature, concept and synthesis; chemical nature of DNA, nucleotides and nucleosides; structure of RNA – RNA splicing; units of gene – gene expression, regulation and transcription; genetic engineering for human health; production of human peptide hormone genes; Single cell protein; Role of genomics in enzymology and product development, fermentation process, fruit juice extraction, genetic improvement of food grade microorganisms; Nutritional significance of food products developed by biotechnological techniques; Scientific, technological and resource constraints on genomics; important factors affecting development in nutria genomics.

Suggested Readings

- Nestle M. 2003. Safe Food: Bacteria, Biotechnology and Bioterrorism. University of California Press.
- Rogers PL and Fleet GH. 1989. Biotechnology and Food Industry. Univ. of Minnesota.

VI Semester

1. Food Processing and Packaging 4(3+1)

Theory

Food processing and preservation techniques for cereals, milk, fruits and vegetables, oil seeds, meat, fish and poultry and their impact on physical and chemical characteristics. Physico chemical characteristics, nutritional quality and shelf life studies. Factors effecting quality of processed foods. Food packaging, package functions, requirement and packaging materials. Principles in the development of protective packaging. Laws related to packaging. Shelf-life of packed food, special problems in packaging of foodstuffs.

Practical

Market survey for packaged processed food stuffs. Cereal cookery. Preparations showing dextrinization and gelatinization, gluten formation and influence factors. Vegetable cookery: effect of heat and alkali on pigment, preparation of soups, salads and beverages. Use of milk and milk products and egg in various preparations Estimation of shelf- life of packaged food stuffs.

Suggested Readings:

- Potter, N.N. (1996). Food science. The AVI Publishing Company, Inc., Westport, Connecticut.
- Kalia, M. and Sood, S. (2010). Food preservation and processing. Revised edition, Kalyani Publishers, New Delhi.
- Srilakshmi, B. (2010). Food science (Fifth ed.) New Age International Pvt. Limited, Pub., New Delhi.
- Frank, A., and Paine, H.Y. (2003). A Handbook of food packaging. Springer science and business Media, U.K.

- Gordon L. and Robertson. Food packaging-principles and applications, Marcel Dekka Inc, Newyork

2. Pulses and Oilseeds: Preparation and Utilization 3(2+1)

Theory

Food uses of major pulses- Bengal gram, green gram, black gram, red gram, lentils etc. Primary processing of pulses- Cleaning, drying, storage, control of storage pests. Secondary processing methods-Dehulling, small scale processing, large scale processing. Traditional *dal* mills and modern *dal* mills, nutrient losses during processing. Processing methods of pulses like soaking, germination, cooking, fermentation etc. Major oilseeds produced in India and their utility-groundnut, rapeseed/ mustard, soybean, sesame seed, sunflower, safflower, cottonseed, linseed, caster. Pre treatments and oil extraction from different oilseeds. Refining, bleaching, deodorization, hydrogenation processes of edible oils Anti-nutritional factors and toxic constituents of pulses and oilseeds.Technology of production of oilseed meals/flours, protein concentrates and isolates of pulses and oilseeds and their utilization. By product utilization of pulses and oilseeds.

Practical

Visit to traditional *dal* mills, modern *dal* mills, oil mills to expose students to *dal* milling operations and oil extraction operations. Demonstrations on soaking, dehulling, germination, fermentation methods Analysis of antinutrients- Phytic acid, saponins, trypsin inhibitors etc. Preparation of snacks based on pulses and oilseeds. Preparation of recipes based on germinated and fermented pulses.

Suggested Readings:

- Khader,V.Text Book of Food science and technology. Directorate of information and publications of agriculture, ICAR, Krishi Anusandhan Bhawan, Pusa, New Delhi
- Srilakshmi B. (2010). Food science. New Age International Pvt. Ltd. New Delhi
- Salunkhe, D. and Despande, S.S. foods of plant origin: Production, technology and human nutrition. The AVI Publishings Inc. New York
- Kalia,M and Sood S.(2010), Food preservation and processing. Kalyani Publishers, Ludhiana
- Potty, V.H. and Mulky, M.J. Food processing. Oxford and IBH.

3. Nutraceuticals and Health Foods 3(3+0)

Theory

Introduction, relationship between nutraceuticals, foods and medicines. Definition of nutraceuticals and functional foods, synonymous terms i.e. bioactive compound, phytchemicals, classification of nutraceutical substances based on food sources and based on mechanism of action, labeling and health claims. Regulatory issues for nutraceuticals including national and international standards. Functional foods. Definition, classification and importance. Need for Nutraceuticals Nutraceuticals: deleted). Global Markets and trends. Potential health benefits of major nutraceuticals, omega-3, lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc,.metabolism, bioavailability and pharmacokinetics of nutraceuticals. Concept of angiogenesis, nutraceuticals for joint heath, cardiovascular diseases, cancer, diabetes, obesity,

eye health, cholesterol management. mental health. Safety, adverse effects and interactions of nutraceuticals and functions of foods. Processing technologies. Therapeutic use of nutraceuticals and functional foods Safety aspects of functional foods. Analytical techniques. Quality of nutraceuticals. Nutraceutical Stability. Concerns and shelf life testing. Regulatory aspects of functional foods. Legal aspects of functional foods. Current research in functional foods.

Suggested Readings:

- Robert EC. (2006). Handbook of nutraceuticals and functional foods. 2nd edn. Wildman.
- Shi J. (Ed.). (2006). Functional food. ingredients and nutraceuticals: Processing Technologies. CRC Press.
- Webb GP. (2006). Dietary supplements and functional foods. Blackwell Publ.
- Robert. E.C (2002). Hand book of neutraceuticals and functional foods, CRC, Press
- Goldber. I. (1999). Functional foods: Designer foods, Pharma foods and Nutraceuticals, An Aspen Publications.

4. Meat and Meat Products: Preparation and Utilization 3(2+1)

Theory

Development of meat industry. Meat byproduct utilization. Pre-slaughter operations of meat animals and poultry birds. Structure, composition, nutritive value, postmortem changes and eating quality of meat tissues. Principles of various preservation techniques like chilling, freezing, curing, smoking, thermal processing, canning and irradiation. Meat cutting and packaging. Microbial and other deteriorative changes in meat and their identification. Standards and quality control measures adopted for meat and meat products in India and abroad. Principles of preparation of different meat products. Meat food products order, meat regulations under FSSAI, eating quality of meat, sensory evaluation of meat food products. Fraudulent substitution of meat and its recognition. Organic meat, value added meat products.

Suggested Readings:

- Forrest, J. C., Aberle E. D. , Harlod B. H. , Max D. J. , Robert A. M. (1975).
- Principles of meat science, W. H. Freeman and Company, San Francisco.
- Sharma B.D. (2005). meat and meat production technology (including poultry production technology). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.

5. Bakery and Confectionary 4(2+2)

Theory

Introduction to baking science. Basic materials used in bakery and confectionery, selection, properties and functions. Flours- constituents, functions and characteristics of good flour and tests. Different types of flour mixtures used bakery and confectionery, egg structure, composition and its functions in bakery and confectionery. Different types of fats and oils used in bakery and confectionery and their functions. Sugars and functions and types of sugars used in bakery and confectionery, cooking of sugar and its stages, leavening agents used in bakery and confectionery and their functions, liquids and moisturizing agents used in bakery and confectionery and their functions. Salt and its functions in bakery and confectionery and their functions, yeast and types

of yeast used in bakery and confectionery and their functions. Improvers and emulsifiers used in bakery and confectionery and their functions. Biscuits and cookies- basic ingredients required and their functions, techniques in preparation of biscuits and cookies and different types of biscuits and cookies, faults and remedies in biscuit and cookies preparation, Color, flavoring and related products used in bakery and confectionery. Cakes- Types of cakes, ingredients required and their role in cake preparation. Balancing a cake formula ,characteristics of good cake -external and internal characteristics, faults and remedies in cakes preparation, gelling, whipping agents and related products used bakery and confectionery, bread – Ingredients required in bread preparation and their functions, steps involved in preparation of bread, different methods of bread preparation. Characteristics of good bread -External and internal characteristics bread diseases and preventive measures- Faults and remedies in bread preparation, Icing – Types of icing and ingredients used in icing and their role gums, jellies-introduction, technology and chemistry of the hydrocolloids, processing treatments, tools and techniques used in bakery, equipment used in bakery, caramel, toffee and fondant-introduction, ingredients, structure of toffee, formulations, texture of toffee and fudge, quality control of bakery products.

Practical

Use of different bakery equipment, balancing the formula for bakery products , demonstration on standard method of making different types of biscuits, salt, coconut and fruit biscuits ,biscuits, Demonstration on standard method of making different types of cookies, preparation of different types of cookies, plain sponge cake, chocolate cake, pineapple upside down cake, walnut cake, madiera cake, fruit / plum cake, carrot cake, Demonstration on standard method of making of pastries, pastries, icings and cake decoration.

Suggested Readings:

- Edmund, B. B. and James, steward. Cake Making, G.S T. Bamford, Leonard Hill Book, London
- Peter R. W. Biscuit manufacture- Fundamentals of Online Production. Elseveier Publishers
- Fance, W.J and Wragg, BH. Up-to- date bread making, Maclaren and Sons, London.

6. Food Toxicology 2(2+0)

Theory

Introduction and significance of food toxicology. Food poisoning –Types, causative factors, signs and symptoms, preventive measures. Natural food toxins – Anti-nutritional factors, other food toxins, their harmful effects and methods of removal. Microbial toxins and food intoxication – Source of contamination, effect on health, preventive measures, methods of inactivation / destruction. Chemical toxins – Pesticides, insecticides, metallic and others, residual effects, preventive measures, methods of removal. Food packaging material – Potential contaminants from food packaging material.

Suggested Reading:

- Kramer and Kramer (1984) Nutritional toxicology Vol I and II.
- Fennamma, O.R (1996) Food chemistry.

7. Therapeutic Nutrition - II 3(2+1)

Theory

Principles and objectives of therapeutic diets. Cardiovascular diseases- Causes, symptoms and dietary management in atherosclerosis and hypertension, myocardial infarction, cerebrovascular stroke, congestive heart failure. Diabetes mellitus and gout- Types, causes, symptoms and dietary management. Renal disorders – Physiology of kidney; causes, symptoms and dietary management in nephrosis, nephritis, acute and chronic renal failure, renal calculi; dialysis. Respiratory disorders – Acute and chronic COPD, acute respiratory disorders. Cancer- Causes, symptoms and dietary management. Dietitian – Definition, role and responsibilities of a dietitian, code of ethics, competencies of dietitian. Management of dietetics department, guidelines and requirements for establishing a diet counseling centre, techniques for diet counseling,stages of change in behavior.

Practical

Planning and preparation of diets for patients suffering from atherosclerosis, hypertension, myocardial infarction, cerebrovascular stroke, congestive heart failure, different types of diabetes mellitus, gout. Diet planning and preparation for various eating disorders i.e. anorexia nervosa, bulimia, underweight, overweight and obesity. Planning and preparation of diets for renal disorders i.e. nephrosis, nephritis, acute and chronic renal failure, renal calculi and respiratory disorders – Acute and chronic COPD, acute respiratory disorders. Setting up a unit for nutrition counseling. Role play exercises for counseling.

Suggested Readings

- Antia,P. (1986). Clinical dietetics and nutrition. Oxford univ. Bombay.
- Moris,E.S. (1994). Modern nutrition in health and disease. Leaned febiger, USA.
- Srilakshmi, B. (1995). Dietetics. New age international publishers, New Delhi.
- Corinne H. Robinson, Marilyn R. Lawler, Wanda L. Chenoweth, Ann E. Garwick. (1982). Normal and Therapeutic Nutrition. (pp- 1-16). New York, Macmillan Publishing Company.

VII Semester

1. In-plant Training 20(0+20)

1. Hospitals
2. Testing labs
3. Processing units/ Food Industries

Provide platform to study two topics in Food Science and Nutrition in depth and present to a group.

VIII Semester

1. Fruits and Vegetables: Preparation and Utilization - II 2(0+2)

Practical

Grading, selection and preparation of fruits and vegetables for preservation Preparation of various fruits, vegetables and related products Canning and hot packing of fruit and vegetable products Visit to fruit and vegetable processing industries.

Suggested readings:

- Kalia, M. and Sood, S. (2010). Food preservation and processing. Revised edition, Kalyani Publishers, New Delhi.
- Sivasankar, B. (2002). Food processing and preservation. PHI Learning Pvt. Ltd.
- Singh, I. S. (2009). Post harvest handelling and processing of fruits and vegetables. Westville Publishing House, New Delhi.

2. Nutritional Status Assessment Methods 3(0+3)

Practical

Assessment of nutritional status of community using dietary surveys, clinical, surveys, anthropometric measurements-Data collection, tabulation, interpretation and report writing. Target group selection from local hospitals suffering from nutritional deficiencies, tabulation, interpretation and report writing of their tested biomarkers.

Suggested Readings:

- Sehgal S. and Raghuvanshi RS. (2007). Textbook of community nutrition Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.
- Latham. M.C. (1997). Human nutrition in the developing world. Food and Agricultural Organization of United Nations.
- Srilakshmi, B. (2012). Nutrition science, New age international pvt. Ltd. Publishers. New Delhi.
- Srilakshmi, B. (2012). Dietetics, New age international pvt. Ltd. Publishers. New Delhi.
- Dahiya, S., Boora, P. and Rani, V. (2013). A manual on Community Nutrition, Department of Foods and Nutrition, published under ICAR Assistance scheme.
- Bamji, S.M., Rao, N.P. and Reddy, V. (1996). Textbook of human nutrition. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Swaminathan, M. (1985). Essential of food and nutrition. 2nd edition, Vol. II. The Bangalore printing and publishing company Ltd. Bangalore.

3. Diet and Nutrition Counseling 2(0+2)

Practical

Self assessment of role as a dietitian – Pre-test on role, summary of competencies, preparation of self confidence checklist and post test on self role. Preparation of SOAP notes based on case studies and group discussion. Preparation of overweight and underweight fact list handout and development of counseling guidelines for weight loss and weight gain. Weight loss counseling – Use of role play technique, workshop for patients at obesity clinic. Visit to hospitals with therapeutic kitchen setup. Diabetic diet counseling at diet and nutrition counseling centre, diabetic clinics, diabetic diet exhibition in collaboration with hospitals for the benefit of public, development of dietary fat facts list, cholesterol facts list, sodium facts list, Development of dietary counseling tips for different cardiovascular disorder and counseling; cardiac patients using role play technique, presentation in specialty hospital (CVD for patients as well as attendants). Diet exhibition on

cardiovascular disorders in a specialty hospital / general hospital, preparation of handouts on ulcer facts list, high fibre facts list, low residue facts list, low lactose facts list, counseling for patients suffering from diarrhoea, constipation, colitis, diverticulosis and ulcer. Preparation of SOAP notes and gall bladder facts list handout and counseling a patient of gall stones. Preparation of liver disease facts list handout, collection of case history of patient suffering from hepatitis, cirrhosis of liver, alcoholics. Counseling the patient and conducting group discussion. Preparation of kidney disease facts list handout and development of counseling tips for kidney disorders, dietary counseling in a specialty hospital / diet and nutrition counseling centre for kidney disorder and diet exhibition for kidney disorder. Preparation of cancer facts list handout, Preparation of list of parenteral and enteral products available in the market for use during counseling. Setting up a unit for nutrition counseling. Role play exercises for counseling. Supervised counseling of patients/clients.

Suggested readings

- Antia,P. (1986). Clinical dietetics and nutrition. Oxford univ. Bombay.
- Moris,E.S. (1994). Modern nutrition in health and disease. Leaned febiger, USA.
- Srilakshmi, B. (1995). Dietetics. New age international publishers, New Delhi.
- Corinne H. Robinson, Marilyn R. Lawler, Wanda L. Chenoweth, Ann E. Garwick. (1982). Normal and Therapeutic Nutrition. (pp- 1-16). New York, Macmillan Publishing Company.

4. Food Service Management – II 3(0+3)

Practical

Introduction to quantity food production, familiarization to equipment for quantity food production, standardization of recipes – procedure. Practical exercise on standardization of recipe, multiplication of standard recipe, portioning and cost calculation. Standardization of recipes suitable for different catering services i.e. cafeterias /canteens, snack bars, industrial canteens, residential hostels. Costing of recipes planned and fixing the price. Exercise on quantity food production for different type of food service establishments. Visit to residential hostel, hospital canteen, industrial canteen, star hotel and fast food centre to observe the organization, management and administration. Making a detailed project report for establishing a food service unit including making purchase documents for equipment purchase and tenders etc. Organizing and planning menu for college canteen as a catering enterprise, setting up of a canteen, management of college canteen - procurement of materials. Practical exercise on food preparation, pricing and sale. Preparation and presentation of report on management of canteen.

Suggested reading:

- Fuller J. 1966. Chefs Manual and a Kitchen Management. B.T. Badtsford Ltd.
- Sethi M &Malhan S. 1997. Catering Management - An Integral Approach. New Age International.
- Treat N & Richards 1997. Quantity Cookery. Little Brown & Co.
- West BB, Wood L, Harger VF &Shugart GS. 1977. Food Service in Institutions, John Wiley & Sons.

5. Seminar 1(0+1)

6. Special Project 5(0+5)

Practical

Preparation of an assignment and accessing information. The student will submit a 3,500 word assignment. The assignment will consist of a product description under the headings. Food forumation, manufacturing process, quality control, nutritional value, packaging, distribution and marketing, financial management, Floor planning and layout. Where the student's employer is not involved in the manufacture of a product an alternative topic relevant to the company can be agreed with the programme manager. The topic to be covered will be decided by the student in association with their employer and should include the development of a new product or the evaluation of a new process or the study of a particular problem or a literature review. The student will be required to give a short presentation on their assignment to the class and lecturer.

7. Entrepreneurship Development and Business Management 4(0+4)

Practical

Practical exercise on entrepreneurship motivation training– Micro lab Interface with successful food entrepreneurs. Market survey for identification of products and product selection, cost estimation. Project formulation, group discussion and report writing . Visit to a government agency for appraisal on policies. Visit to non governmental institutions promoting entrepreneurship. Critical analysis of financial institutions government and non- government, preparation of financial statements and group discussion. Financial analysis of projects prepared, planning, implementation of the project. Learning product promotion techniques, developing brand name and label and group discussion. Appraisal of packaging materials and techniques, analysis of advertisements.Visit to successful enterprises. Performance review of the unit – Profitability and report.

Suggested readings

- Balasubramaniyan, A. (1998), Personal management, everest Publishing House, Pune
- Kotler, P. (1997) Marketing management 9th edn. Prentice-Hall of India, New Delhi
- Sivakamasundari, S. (1995) Entrepreneurship development for rural women- Vol-I, Asian and Pacific Centre for Transfer of Technology, New Delhi

Minimum Standards for Establishing a College of Community Science (Home Science)

1. Degree Nomenclature:

- B.Sc. (Hons) Community Science
- B.Sc. (Hons) Food Nutrition and Dietetics

2. Eligibility Criteria : 10+2 /intermediate with PCB/PCM/PCMB (P- Physics, C-Chemistry, M-Mathematics, B-Biology) from a recognised Board/university

3. Medium of Instruction : English

4. Minimum Intake: 60 students per year

5. Departments:

1. Department of Food Science and Nutrition
2. Department of Food Policy and Public Health Nutrition
3. Department of Apparel Design
4. Department of Family Resource Management and Consumer Science
5. Department of Human Development and Family studies
6. Department of Textile Science and Design
7. Department of Extension and Communication Management

6. Minimum faculty and staff for one degree program:

Department	Asstt. Prof. Prof.	Assoc. Prof.	Prof.	Total
Department of Food Science and Nutrition	4	2	1	7
Department of Food Policy and Public Health Nutrition	4	2	1	7
Department of Apparel Design Management	4	2	1	7
Department of Textile Science and Design	4	2	1	7
Deptt. of Family Resource Management and Consumer Science	4	2	1	7
Deptt. of Human Development and Family Studies	4	2	1	7
Deptt. of Extension Education and Communication Management	4	2	1	7
Total	**28**	**14**	**07**	**49**

Additional Faculty Requirements for New Programs where Home Science program is existing

Professor : 02
Associate Professor : 04
Assistant Professor : 10

7. Administrative setup of the college:

Office space for Dean's office, Dean's committee room, account section, students record section, ministerial staff room, computer cell, academics and controller of exam cell, toilets and

conveniences, visitors room and information room shall be required.

Administrative & Technical Staff requirement for divisions/Departments/Sections

Sl. No.	Divisions/Departments/Sections	Assistant / Steno	Clerk	Lab Asstt./Technician/ Attendants	Attendant/ Messenger	Total
1.	Department of Food Science and Nutrition	1	1	4	1	7
2.	Department of Food Policy and Public Health Nutrition	1	1	4	1	7
3.	Department of Family Resource Management and Consumer Science	1	1	4	1	7
4.	Department of Extension Education & Communication Management	1	1	4	1	7
5.	Department of Apparel Design	1	1	4	1	7
6.	Department of Textile Science and Design	1	1	4	1	7
7.	Department of Human Development and Family Studies	1	1	4	1	7
	TOTAL	**7**	**7**	**28**	**7**	**49**

8. Manpower Requirement of Dean's Office and other common facilities

Sl. No.	Name of the Post	No. of Posts
1.	Dean	01
A. Establishment		
1	Assistant Administrative officer	01
2	P.A./P.S. to Dean	01
3	Senior Assistants (Academic, budget and establishment)	03
4	Clerks (one each for Academic, budget and establishment and one for girls hostel)	04
5	Messengers	03
6	Asstt. Librarian	01
7	Shelve Assistants	02
8	Assistant Professor Physical Education & Sports	01
9	Steno	02
10	Computer assistant	01
11	Driver (one each for light and heavy vehicle)	02
12	Store Keeper	01

Sl. No.	Name of the Post	No. of Posts
13	Electrician	01
14	Medical Officer	01
15	Compounder	01
16	Nurse	01
17	Hostel Warden	Charge with faculty
18	Assistant Warden	02
19	Cook	01
20	Assistant Cook	01
21	Mess Helpers/ waiters (service)	06
23	Attendants for Deans Office, library, sports, Medical Hospital	08

9. Floor Space (Department wise):

Sr. No.	Details	Number	Dimensions (ft)
1	Head of the Department's Chamber	5	10 x 15 each
2	Office Room	5	15 x 20 each
3	Associate Professors' Rooms	5	10 x 10 each
4	Faculty Rooms(with individual workstations)	5	20 x 30 each
5	Laboratories	15	20 x 30 each (3 labs per department)
College Building			
1	Class Rooms	4	Seating capacity of 65 each
2	Multipurpose Room/Examination Hall	1	Seating capacity of 100
3	Toilets	9	2 ladies' and 1 gents'/floor(for 3 floors)
Other Infrastructure			
1	Auditorium	1	Seating capacity of 500 persons
2	Dispensary	1	As per requirement
3	Sports Complex	1 each	Outdoor & Indoor
4	Multi Gym	1	As per requirement
5	Faculty Room for sports complex	1	10 x 15
6	Store Room for sports complex	1	10 x 20
7	Toilets for sports complex	1 each	For ladies and gents
5	Hostel	1	To accommodate 200 students and with provision of 3 guest rooms.
6	Parking facility	As per the requirement	
7	Library	1	As per the requirement
8	Production cum Training Centre	1	As per the requirement

10. Laboratory Equipment

No.	Analytical Laboratory
1	HPLC
2	Spectro photo meter-2
3	Kjel plus
4	Refrigerated centrifuge
5	Deep freeze
6	Moisture estimation equipments
7	Vacuum cleaner
8	Ultrasonic cleaner
9	Muffle furnace
10	Autoclave
11	Flash evaporator
12	Laminarflow
13	Hot air oven
14	Colonycounter
15	Incubator
16	Magneticstirrerwith hotplate
17	Viscometer
18	Soxplus
19	Fibreplus
20	Viscometer
21	Metabolic shaker
22	Waterbath shaker
23	Photofluorometer
24	Distillation apparatus
25	Ion meter
26	Centrifuge
27	pH meter
28	BODincubator
29	Sieve shaker
30	Pipette washer
31	Cyclo mixer
32	Spectrophotometer
33	Colonycounter
34	Homogenizer
35	WileyMill
36	Cabinet refrigerator
No.	**CateringLaboratory**
1	Microwaveovens
2	Hot casecabinet
3	Flycatcher
4	Aircurtain
5	Food processor
6	Dosagriddleplate
7	Waterpurifier
8	Refrigerators
9	Washingmachine
10	Cookingrange and utensils
11	Juicerand blender
12	Utensilsfor cooking andserving
No.	**NutritionCounsellingCentre**
1	Computers
2	Scanners
3	Video-editing workstation
4	LCD projector
5	Laptop
6	Printers
7	Photocopiers
8	Plasma screen
9	Camera
10	Measuring equipment
11	Anthropometric kit
12	Body Composition Analyser

No.	Computer Lab (Clothing CAD Lab)
1	Textile designing software
2	Apparel designing software
3	Fashion illustration software
4	Weavedesigning software
5	Computers with accessories
6	Digitizer
7	Plotter
8	Digital camera
No.	**LaundryLab**
1	Rack for keeping chemicals
2	Spirit lamps
3	Projection microscope
4	Weighingbalance
5	Pickglasses
6	Knittingmachines(Flatbed and Circular)
7	Fully automatic washing machine
8	Refrigerator
No.	**List of Furniture**
1	Students chairs
2	Students stools
3	Book Racks
4	Storage cabinets
No.	**Resource Management Equipment Lab**
1	Water Filter
2	Microwave Oven
3	Electric Oven
4	Vacuum Cleaner
5	Weighing Machine (Personal)
6	Geyser
7	Halogen Heater
8	Emergency Light
9	Refrigerator

10	Cooking Range
11	Washing Machine
12	Hand Machanical Grinder
13	LP GStove (4 burner)
14	Kitchen Took Set
15	Oven Cookery Utensils
16	Surface Cookery Utensils
17	Coffee Percolator(all three types)
18	Dishwasher
19	Juicer
20	Hand Mixer
21	Coconut CutterGrater
22	Chili Cutter
23	Bar Blender
24	Pressure Cooker
25	Food Processor
26	Thermo Flask
27	ElectricTandoor
28	Sandwich Maker
29	Bread Toaster
30	Potato Chipper
31	Electric Kettle
32	Sprout Maker
33	Idli Maker
34	Electric Iron
35	Ironing Stand
36	Chopper
37	Cutter
38	Citrus Press
39	Tomato Slicer
40	Squeezer
41	Salt and Pepper Grinder
42	Grater

43	Chipser
44	Solar Educational Kit
No.	**Housing and Space Management lab.**
1	Overhead Projector +Screen
2	LED Project + Monitor
3	Drawing Board
4	Drawing Scale
5	Engineering Scale
6	T-Set Square Scale
No.	**Interior Designand Decoration Lab**
1	Flower Press
2	Potter's Wheel
3	Sponge
4	Display Board Wall Mounted
5	Portable Display Boards
6	Flowervases
No.	**TestingLaboratory**
1.	Weighing Machine
2.	Speech Audiometer
3.	Infantometer
4.	Digital HB Metter
5.	Bathroom scale
6.	Anthropometric Rod
7.	Standford Binescale
8.	Beam Balance
10.	Stapler bigsize
11.	Sliding Caliper
12.	Spreading Caliper
13.	Assophemeter Caliper
14.	Colour mixer
15.	Depth Prescription apparatus

16.	Mirror drawingapparatus
17.	Attention board
18.	Stop Watch
19.	Lever Actuated Balance
20.	Bhatia Battery
21.	Scientific Calculator
22.	Top Pan SelfIndicating Balance
23.	Metronome
24.	Weighing Balance
25.	Skin fold Caliper
26.	Developmental Assessment Scale
27.	Wechsler Intelligence Scale
28.	Cognitive tests
29.	Psychological Tests
No.	**Photography Lab**
1	Digital Camera
2	SLR Camera
3	Colour Photo Printer
4	Video Camera
No.	**Clinical Investigation Laboratory**
1	Gluco meter
2	B. P. Instrument
3	Pedo meter
4	Haemoglobin meter
5	Anthropometric rod
6	Infanto meter
7	Skinfold caliper
8	Weighing balance
9	Vernier caliper
10	Body composition analyzer
11	Heart Rate Monitor
12	Blood Analyser

No.	Processing Laband Product Development Laboratory
1	Popping machine
2	Utensil rack
3	Potato bin
4	OTG
5	Fryer
6	Counter refrigerator
7	Masalagrinder
8	Wet grinder
9	Potato pealer
10	Vaccum sealingmachine
11	Hand refractometer
12	Flour mill
13	Bakingovens
14	Heavyduty
15	Lyophilizer
16	Vegetable cutter
17	Dough kneader
18	Multimill
19	Working table
20	Vacuum oven
21	Tray dryer
22	Grinding mill
23	Canning equipment
24	Bottling equipment
25	Pouch filling machine
26	Coffeemaker
27	Teamaker
28	Electronic kitchen balance
29	Refrigerator
30	Deep freeze
31	Heavyduty Mixer, Juicer, Grinder
32	Stone separator
33	Chiller
34	Extruder
35	Pulper/ smoother
36	Rotimaker
37	Utensilsfor cooking and serving
No.	**Weaving Lab**
1	Loom (Handloom)
2	Table loom forsample weaving
3	Bobbin winding machine
4	Creel board
5	Wrapping drum
No.	**Clothing Lab**
1	Footoperated sewing machine
2	Button hole machine
3	Interlock machine
4	Overlock machine
5	Cutting table-individual use (2'x4')
6	Cutting table (Group- 5'x7')
7	Iron and ironing board
8	Cutting, measuring (anthropometric kits, marking, pressing, miscellaneous tools
9	Embroidery machine (Electric)
10	Embroidery machine (Computerized)
No.	**Flatpatternand Draping Lab**
1	Industrial sewing machine
2	Dress forms of different sizes
3	Mannequins'(Male/Female/Children)
4	Fashion Illustration boards with stands
No.	**Dyeingand Printing Lab**
1	Distillation unit
2	Hot plates
3	Steaming chamber

4	Screen Printing table 4'x7'
5	Block Printing table 4'x4'
6	Microwave oven
7	Water purifier
No.	**Office Requirements**
1	LCD projectors and Screen
2	Printers
3	Spiral Binding Machine
4	Cutting Machine
5	Lamination machine
6	Photocopier
45	Solar Cooker
46	Solar Cooker (Parabolic Type)
47	Solar Lantern
48	Solar Drier
49	Solar Water Heater
50	Rice Cooker
51	Water Cooler (Dispenser)
52	Induction Cooker
53	Air Fryer
54	Gas Connection
55	Food Adulteration Testing Kit
56	Knife Set
57	Dinner Set
58	Tea Set
59	Cutlery Set
60	Table Mats and Table Napkins
No.	**Ergonomics Lab**
1	Digital Camera
2	Weighing Machine (Electronic)
3	Stopwatch
4	Hygrometer

5	Lux Mater
6	Heart Rate Monitor
7	Treadmill
8	Hygrothermometer
9	Pedometer
10	Goneometer
11	Vibrometer
12	B.P. Monitor
13	Grip Dynamometer
14	Spreading Caliber
15	Anthropometry Meter
16	Sitting Height Machine
17	Lamination Machine
18	Paper Cutting Machine
19	Spiral Binder
20	Laser Printer
21	Laserjet Colour Printer
22	Scanner Scan jet
23	Computer System
24	Interior Designer Software (Autocad, Home Architect Deluxe)
25	3D Max (Software)
26	Advanced 3DMax (Software)
No.	**Multimedia Lab**
1	Overhead Projector
2	Public Address System
3	16 mm film projector
4	Auto slide projector
5	Record player
6	Epidiascope
7	V.C.R.
8	Motorized screen
9	Digital Camera

10	Video Camera
11	Computer with accessories
12	V.C.D. Player
13	Plus Direct Projector
14	Colour T.V.
15	Digital Camera
16	L.C.D.
17	Slide Projector
18	Scanner
19	Microphone
20	Motorize screen
21	Video Camera
22	Camera
23	Computer with accessories
24	Director Projector
25	Digital Camera
26	Slide projector
27	Printer
28	Scanner
29	Overhead Projector

No.	Laboratory Nursery School
1.	Video Camera
2.	V.C.R
3.	Audio System
4.	Voltage Stabilizer
5.	Projector LCD
6.	Digital Camera
7.	Refrigerator
8.	Projector Slide film
9.	AV folding projector
10.	Radiator
11.	Music system
12.	Vaccum cleaner
13.	DVD Player
14.	VCD Player
15.	Radio Recorder
16.	Cooler
17.	Slide projector
18.	Colour T.V.
19.	Washing Machine
20.	Microwave

HORTICULTURE

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG degree nomenclature

i). UG degree: B.Sc. (Hons.) Horticulture

ii). PG Degrees: M. Sc (Horticulture) and Ph.D. (Horticulture) with following specializations :

S. No.	Specialization in M. Sc and Ph.D.
1	Fruit Science
2	Vegetable Science
3	Postharvest Technology
4	Floriculture and Landscape Architecture
5	Plantation, Spices, Medicinal and Aromatic Crops
6	Molecular Biology and Biotechnology
7	Genetics and Plant Breeding
8	Plant Pathology
9	Entomology
10	Soil science and Agricultural Chemistry
11	Seed Science and Technology
12	Economics and Marketing
13	Extension

Restructuring of UG programmes for increased practical / practice contents (Department Wise Courses)

I	Fruit Science	
1.	Fundamentals of Horticulture	3(2+1)
2.	Plant Propagation and Nursery Management	2(1+1)
3.	Tropical and Subtropical Fruits	3(2+1)
4.	Orchard and Estate Management	2(1+1)
5.	Plantation Crops	3(2+1)
6.	Temperate Fruit crops	2(1+1)
7.	Weed Management in Horticultural Crops	2(1+1)

8.	Principles of Plant Breeding	3(2+1)
9.	Principles of Genetics and Cytogenetics	3(2+1)
10.	Breeding of Fruit and Plantation Crops	3(2+1)
11.	Dryland Horticulture	2(1+1)
	Total	**28 (17+ 11)**
II	**Vegetable Science**	
1.	Tropical and Subtropical Vegetable crops	3(2+1)
2.	Spices and Condiments	3(2+1)
3.	Breeding of Vegetable Tuber and Spice Crops	3(2+1)
4.	Seed Production of Vegetable Tuber and Spice Crops	3(2+1)
5.	Temperate Vegetable crops	2(1+1)
6.	Potato and Tuber Crops	2(1+1)
7.	Precision Farming and Protected Cultivation	3(2+1)
	Total	**19 (12+7)**
III	**Postharvest Technology**	
1.	Postharvest Management of Horticultural Crops	3(2+1)
2.	Processing of Horticultural Crops	3(1+2)
3.	Fundamentals of Food Technology	2(1+1)
	Total	**8 (4+4)**
IV	**Floriculture & Landscape Architecture**	
1.	Ornamental Horticulture	2(1+1)
2.	Breeding and Seed Production of Flower and Ornamental Crops	3(2+1)
3.	Principles of Landscape Architecture	2(1+1)
4.	Commercial Floriculture	3(2+1)
5.	Medicinal and Aromatic Crops	3(2+1)
	Total	**13 (8+5)**
V	**Plant Protection**	
1.	Fundamentals of Plant Pathology	3(2+1)
2.	Diseases of Fruit, Plantation and Medicinal and Aromatic Crops	3(2+1)
3.	Diseases of Vegetable, Ornamental and Spice Crops	3(2+1)
4.	Fundamentals of Entomology	3(2+1)
5.	Nematode Pests of Horticultural Crops and their Management	2(1+1)
6.	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	3(2+1)

7.	Apiculture, Sericulture and Lac Culture	2(1+1)
8.	Insect Pests of Vegetable, Ornamental and Spice Crops	3(2+1)
	Total	**22 (14+8)**
VI	**Natural Resource Management**	
1.	Fundamentals of Soil Science	2(1+1)
2.	Soil Fertility and Nutrient Management	2(1+1)
3.	Environmental Studies and Disaster Management	3(2+1)
4.	Soil, Water and Plant Analysis	2(1+1)
5.	Farm Power and Machinery	2(1+1)
6.	Water Management in Horticultural Crops	2(1+1)
7.	Organic Farming	3(2+1)
8.	Agro-meteorology and Climate Change	2(1+1)
9.	Introductory Agro-forestry	2(1+1)
10.	Introduction to Major Field Crops	2(1+1)
	Total	**22 (12+10)**
VII	**Basic Sciences**	
1.	Elementary Statistics and Computer Application	3(2+1)
2.	Elementary Plant Biochemistry	2(1+1)
3.	Elementary Plant Biotechnology	2(1+1)
4.	Introductory Crop Physiology	2(1+1)
5.	Growth and Development of Horticultural Crops	2(1+1)
6.	Introductory Microbiology	2(1+1)
	Total	**13 (7+6)**
VIII	**Social Sciences**	
1.	Economics and Marketing	3(2+1)
2.	Horti-Business Management	2(2+0)
3.	Fundamentals of Extension Education	2(1+1)
4.	Entrepreneurship Development and Business Management#	2(1+1)
5.	Communication Skills and Personality Development#	2(1+1)
6.	Information and Communication Technology	2(1+1)
7.	Physical and Health Education (NC)*	1(0+1)
8.	NSS/NCC(NC)*	1(0+1)
	Total	**15 (8+7)**
	Grand Total	**140 (82+58)**

S. No.	Activity	Credits
1	Experiential learning (Professional Package)	0+20
2	RHWE& Placement in Industries	0+20
	Total	**0+40**

S. No.	RHWE Programme schedule	Duration
1	Orientation Programme	2 weeks
2	Village stay at RSK/Hobli level	12 weeks
3	All India Study Tour	3 weeks
4	Placement Programme	4 weeks
5	Report writing & Final Examination	3 weeks
	Total	**24 Weeks**

STUDENT READY:

Professional Packages Hands on Training /Experimental Learning Modules: Final year B.Sc. (Hort.) students can select two modules under STUDENT READY- Experiential Learning programme depending on the facilities available at the college.

1. Commercial Horticulture
2. Protected cultivation of high value Horticulture crops
3. Processing of fruits and vegetables for value addition
4. Floriculture and landscape architecture
5. Bio-inputs: Bio-fertilizers and bio-pesticides
6. Mass multiplication of plant and molecules through tissue culture
7. Mushroom culture
8. Bee keeping

Batch of student can select two modules under STUDENT READY- ExperientialLearning Programme depending on the facilities available at the college.

II. Rural Horticultural Work Experience Programme (0+20)

i. STUDENT READY - Placement in Industries (0+10)

ii. STUDENT READY- Placement in Villages (0+10)

Semesterwise courses

Semester – I

S.N.	Title of the Course	Credit Hours
1	Elementary Statistics and Computer Application	3(2+1)
2	Fundamental of Soil Science	2(1+1)

S.N.	Title of the Course	Credit Hours
3	Economics and Marketing	3(2+1)
4	Elementary Plant Biochemistry	2(1+1)
5	Introductory Crop Physiology	2(1+1)
6	Fundamentals of Horticulture	3(2+1)
7	Principles of Landscape Architecture	2(1+1)
8	Principles of Genetics and Cytogenetics	3(2+1)
9	Introductory Microbiology	2(1+1)
10	Communication Skills and Personality Development	2(1+1)
11	National Service Scheme/National Cadet Corp	1 (0+1)(NC)*
	Total	**25(14+11)**

Semester – II

S.N.	Title of the Course	Credit Hours
1	Tropical and Subtropical Fruits	3(2+1)
2	Tropical and Subtropical Vegetables	3(2+1)
3	Principles of Plant Breeding	3(2+1)
4	Soil Fertility and Nutrient Management	2(1+1)
5	Water Management in Horticultural Crops	2(1+1)
6	Plant Propagation and Nursery Management	2(1+1)
7	Environmental Studies and Disaster Management#	3(2+1)
8	Growth and Development of Horticultural Crops	2(1+1)
9	Physical and Health Education	1(0+1) (NC)*
10	Information and communication technology*	2(1+1) (NC)*
	Total	**23(13+10)**

Semester – III

S.N.	Title of the Course	Credit Hours
1	Fundamentals of Plant Pathology	3(2+1)
2	Fundamentals of Entomology	3(2+1)
3	Temperate Vegetable Crops	2(1+1)
4	Nematode pests of horticultural crops and their Management	2(1+1)
5	Diseases of fruit, Plantation, Medicinal and Aromatic Crops	3(2+1)
6	Fundamentals of Food Technology	2(1+1)
7	Temperate Fruit Crops	2(1+1)

8	Weed Management in Horticultural Crops	2(1+1)
9	Commercial Floriculture	3(2+1)
10	Elementary Plant Biotechnology	2(1+1)
	Total	**24 (14+10)**

Semester – IV

S.N.	Title of the Course	Credit Hours
1	Soil, Water and Plant Analysis	2(1+1)
2	Spices and Condiments	3(2+1)
3	Ornamental Horticulture	2(1+1)
4	Plantation Crops	3(2+1)
5	Breeding of Fruit and Plantation Crops	3(2+1)
6	Farm Power and Machinery	2(1+1)
7	Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops	3(2+1)
8	Precision Farming and Protected Cultivation	3(2+1)
9	Dry land Horticulture	2(1+1)
	Total	**23(14+9)**

Semester – V

S.N.	Title of the Course	Credit Hours
1	Organic Farming	3 (2+1)
2	Introduction to Major Field Crops	2 (1+1)
3	Medicinal and Aromatic crops	3 (2+1)
4	Introductory Agroforestry	2 (1+1)
5	Breeding of Vegetable, Tuber and Spice Crops	3 (2+1)
6	Diseases of Vegetables, Ornamentals and Spice Crops	3 (2+1)
7	Orchard and Estate Management	2(1+1)
8	Agro-meteorology and Climate Change	2 (1+1)
9	Potato and tuber crops	2 (1+1)
	Total	**22(13+9)**

Semester – VI

S.N.	Title of the Course	Credit Hours
1	Apiculture, Sericulture and Lac culture	2(1+1)
2	Insect Pests of Vegetable, Ornamental and Spice Crops	3(2+1)

3	Postharvest Management of Horticultural Crops	3(2+1)
4	Seed production of Vegetable, Tuber and Spice Crops	3(2+1)
5	Breeding and Seed Production of Flower and Ornamental Plants	3(2+1)
6	Processing of Horticultural Crops	3(1+2)
7	Horti-Business Management	2(2+0)
8	Entrepreneurship Development and Business Management#	2(1+1)
9	Fundamentals of Extension Education	2 (1+1)
	Total	**23 (14+9)**

Semester – VII

Rural Horticultural Work Experience Programme

S.N.	Title of the Course	Credit Hours
1	STUDENT READY - Placement in Industries	0+10
2	STUDENT READY- Placement in Villages	0+10
	Total	**20 (0+20)**

Semester – VIII

S.N.		Title of the Course	Credit Hours
STUDENT READY: Experimental Learning programme			20(0+20)
1	Commercial Horticulture	No change	
2	Protective Cultivation of High Value Horticulture Crops	No change	
3	Processing of Fruits and Vegetables for Value Addition	No change	
4	Floriculture and Landscape Architecture	New Module	
5	Bio-inputs: Bio-fertilizers and Bio-pesticides.	New Module	
6	Mass Multiplication of Plant And Molecules through Tissue Culture	New Module	
7	Mushroom culture	New Module	
8	Bee keeping	New Module	
	Total	20 (0+20)	

The student undergoing ELP may be allowed to register for a maximum two courses in which they have failed but completed requisite percentage of attendance.

SYLLABUS

I. FRUIT SCIENCE

1. Fundamentals of Horticulture 3(2+1)

Theroy

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops. Principles objectives, types and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming, market chain management.

Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

Suggested Reading:

- Prasad and Kumar, 2014. *Principles of Horticulture* 2nd Edn. Agrobios (India).
- Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1st Edn. IBDC Publishers.
- Gardner/Bardford/Hooker. J.R., 1957. *Fundamentals of Fruit Production*. Mac Graw Hill Book Co., New York.
- Edmond,J.B, Sen,T.L, Andrews,F.S and Halfacre R.G., 1963. *Fundamentals of Horticulture*. Tata Mc Graw Hill Publishing Co., New Delhi.
- Kumar, N., 1990. *Introduction to Horticulture*. Rajyalakshmi publications, Nagarcoil, Tamilnadu
- Jitendra Singh, 2002. *Basic Horticulture*. Kalyani Publishers, Hyderabad.
- Denisen E.L.,1957. *Principles of Horticulture*. Macmillan Publishing Co., New York.
- Chadha,K.L.(ICAR),2002,2001. *HandbookofHorticulture* . ICAR, NewDelhi
- K.V.Peter, 2009. *Basics Horticulture.* New India Publishing Agency
- Kausal Kumar Misra and Rajesh Kumar, 2014. *Fundamentals of Horticulture.* Biotech Books.
- D.K. Salunkhe and S.S. Kadam, 2013. *A handbook of Fruit Science and Technology*. CRC Press.

- S. Prasad and U. Kumar, 2010. *A handbook of Fruit Production*. Agrobios (India).
- Jitendra Singh, 2011. *Basic Horticulture*. Kalyani Publications, New Delhi.

2. Plant Propagation and Nursery Management 2(1+1)

Theroy

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification & stratification) internal and external factors, nursery techniques nursery management, apomixes – mono-embrony, polyembrony, chimera& bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), use of growth regulators in seed, types and stages of seed germination with examples and vegetative propagation, methods and techniques of division-stolons, pseudobulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery, Cost of establishment of propagation structures.

Practical

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance.. Nutrient and plant protection applications during nursery.

Suggested Reading:

- Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. *Plant Propagation- Principles and Practices(7th Edition)*. PHI Learning Private Limited, New Delhi-110001
- T.K.Bose, S.K.Mitra, M.K.Sadhu, P. Das and D.Sanyal. *Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3rd Revised edition)*. Naya Udyog, 206, Bidhan Sarani, Kolkata 700006.
- Guy W. Adriance and Feed R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).

- S. Rajan and B. L. Markose (series editor Prof. K.V.Peter). *Propagation of Horticultural Crops- Horticulture Science Series vol.6.* New India Publishing Agency, Pitam Pura, New Delhi-110088.
- Hartman,H.T and Kester,D.E.1976.*Plant Propagation Principles and practices*. Prentice hall of India Pvt.Ltd., Bombay.
- Sadhu,M.K.1996. *Plant Propagation*. New age International Publishers, New Delhi.
- Mukhergee,S.K. and Majumdar,P.K.1973.Propagation of fruit crops. ICAR, New Delhi.
- Ganner,R.J. and Choudhri,S.A.1972.*Propagation of Tropical fruit trees*. Oxford and IBN publishing Co., New Delhi.
- Sarma,R.R.2002. *Propagation of Horticultural Crops*.Kalyani Publishers,(Principles and practices) New Delhi.
- Symmonds,1996. *Banana.II* edition Longman, London.
- Chundawat,B.S. 1990.*Arid fruit culture*. Oxford and IBH, New Delhi.
- Chadha,K.L. (ICAR)2002,2001.*Hand book of Horticulture*. ICAR, New Delhi.

3. Tropical and Sub-Tropical Fruits 3(2+1)

Theroy

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, , banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Practical

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

Suggested Reading:

- H.P.Singh and M.M.Mustafa, 2009. *Banana*-new innovations. Westville PublishingHouse, New Delhi.
- M.S.Ladaniya, 2013. *Citrus Fruits*. Elsevier, India post ltd.
- Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical*-Vol-I. Naya
- udyog-Kolkata
- Rajput, CBS and Srihari babu, R., 1985. *Citriculture*. Kalyani Publishers, New Delhi.
- Chundawat, B.S., 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.
- Chadha,K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
- Symmonds, 1996. *Banana*. II Edn. Longman, London.
- Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.
- W S Dhillon, 2013. *Fruit Productionin India.* Narendra Publishing House,
- New Delhi
- T.K.Chattopadhyay, 1997. *Text book on pomology*. Kalyani Publishers, New Delhi.
- R.E.Litz, 2009. *The Mango* 2nd Edn. Cabi Publishing, Willingford, U.K.
- K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.
- S.P. Singh, 2004. *Commercial fruits.* Kalyani Publishers, New Delhi.
- F.S. Davies and L.G.Albrigo, 2001. *Citrus*, Cab International.

4. Temperate Fruit Crops 2(1+1)

Theroy

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

Suggested Reading:

- Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292,Rajinder Nagar,Ludhiana-141008
- Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.

- Kaushal Kumar Misra.2014.*Text book of Advanced Pomology. Biotech Books*.4762-63, Ansari Road, Darya Ganj, New delhi-11002.
- Das B.C and Das S.N .*Cultivation of Minor Fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
- Pal J.S.2010. *Fruit Growing* .2010. Kalyani Publishers.B-1/292,Rajinder Nagar, Ludhiana-141008.
- Mitra S.K, Rathore D.S and Bose T .K. 1992. *Temperate Fruit Crops. Horticulture and Allied* Publishers, Calcutta.
- Chattopadhya, T.K. 2000. *A Text Book on Pomology (Temperate Fruits)* Vol. IV Kalyani Publishers, Hyderabad
- Chadha, T.R, 2001. *Text Book of Temperate Fruits*. Indian Council of Agricultural Research, New Delhi.
- David Jackson & N E Laone, 1999 *Subtropical and Temperate Fruit Production*. CABI, Publications.
- W S Dhillon. 2013. *Fruit Production In India*. Narendra Publishing House. New Delhi

5. Orchard and Estate Management 2(1+1)

Theroy

Orchard & estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of Horticultural crops.

Practical

Layout of different systems of orchard and estate, soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

Suggested Reading:

- Kumar, 1990. *Introduction to Horticulture crops*. Rajyalakshmi Publications,
- Nagercoil, Tamilnadu.
- Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping systems in the Tropics*.
- New age International (P) Ltd., Publishers, New Delhi.
- Shanmugavelu, K.G.1989. *Production Technology of Fruit Crops*. Oxford & IBH
- Publishing Co. Pvt.Ltd., New Delhi.
- WS. Dhillon and Bhatt. 2011. *Fruit Tree Physiology*. Narendra Publishing House,
- New Delhi.

- B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya
- Publishing House, New Delhi.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008.
- *Management of Horticultural Crops*. New India Publishing Agency, New Delhi.
- B .C. Mazumdar. 2004. *Orchard Irrigation and Soil Management Practices* Daya
- Publishing Agency, New Delhi. Daya Publishing Agency, New Delhi.

6. Plantation Crops 3(2+1)

Theory

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

Practical

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

Suggested Reading:

- Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.
- Thampan, P.K. 1981.*Hand Book of Coconut Palm*. Oxford IBH, New Delhi.
- Nair 1979. *Cashew*. CPCRI, Kerala
- Wood, GAR, 1975. *Cacao*. Longmen, London
- Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.
- Thompson, P.K. 1980. *Coconut.* Oxford & IBH Publishing Co. Ltd., New Delhi.

7. Weed Management in Horticultural Crops 2(1+1)

Theroy

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and

allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Suggested reading:

- Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Gupta, O.P. 1984. *Scientific Weed Management*. Today and Tomorrow Printers and Publishers, New Delhi.
- Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur.
- Naidu, V.S.G.R., *Handbook of Weed Identification*. Directorate of Weed Research, Jabalpur.
- Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. *Weed management of Horticultural Crops.* Agrobios (India), Jodhpur.
- Ramamoorthy, K. and Subbian, P., *Predominant Weed flora in hill –ecosystems*. Agrobios (India), Jodhpur.
- Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co., New Delhi.
- Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. *All About Weed Control*. Kalyani Publishers, Ludhiana.
- Tadulingam, C. and Venkatnarayana, D. 1955. *A Handbook of Some South Indian Weeds.* Government Press, Madras.
- Thakur, C. 1977. *Weed Science*. Metropolitan Book Co. Pvt. Ltd., New Delhi.

8. Principles of Genetics and Cytogenetics 3(2+1)

Theroy

Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, mitosis, meiosis and its significance. Gametogenesis and syngamy in plants. Mendelian genetics–Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Modification of monohybrid and dihybrid rations. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and

characters. Cytoplasmic inheritance and maternal effects. Chemical basis of heredity, structure of DNA and its replication. Evidence to prove DNA and RNA – as genetic material. Mutations and their classification. Chromosomal aberrations, changes in chromosome structure and number.

Practical

Study of fixatives and stains. Squash and smear techniques. Demonstrations of permanent slides and cell division, illustration in plant cells, pollen fertility and viability, determination of gametes, Solving problems of monohybrid, dihybrid, and test cross ratios using chi-square test, gene interactions, estimation of linkages using three point test cross from F_2 data and construction of linkage maps. Genetics variation in pea.

Suggested Reading:

- Gardner E J, Simmons M J &Snustard D P. *Principles of Genetics (VIII Edn)*. John Wiley & Sons, New York.
- Strickberger. *Genetics*. Macmillan Publishing Company, New York.
- William D. Stansfield. *Theory and Problems of Genetics (3rd Ed)*. Schaum's Outline series - McGraw-Hill Inc.
- Benjamin Lewin. *Genes (II edn)*. John Wiley & Sons, New York.
- Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.
- Swanson & Webster. *The Cell* (V edn). Prentice Hall of India Pvt. Ltd, New Delhi
- Norman,V. Rothwell. *Understanding Genetics* (IV Ed.). Oxford University Press, Oxford.
- Sinnut, Dunn & Dobzhansky. *Principles of Genetics* XIX reprint. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Griffiths, Miller, Suzuki Lewontin & Gelbart. *An introduction to Genetic Analysis* (V *Ed.).* W.H.Freeman & Company, Newyork
- Robert Schieif. *Genetics & Molecular Biology* (1986). The Benjamin/cummings publishing Co, Inc, California.
- Swanson, Merz & Young. *Cytogenetics* (II ed.). Prentice Hall of India Pvt. Ltd. New Delhi.
- Joseph Jahier& INRA working group. *Techniques of Plant Cytogenetics* (1986). Oxford & IBH Publishing Co Pvt.Ltd., New Delhi
- Loewy & Siekevitz. *Cell Structure & Function* (II Ed.). Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
- Stent & Calendar. *Molecular Genetics* (II Ed.). CBS Publishers, New Delhi
- Singh B D. *Fundamentals of Genetics*. Kalyani Publishers, New Delhi
- Srivastava&Tyagi. *Selected Problems in Genetics* (Vol.1-3). Anmol Publications Pvt. Ltd., New Delhi
- Khanna VK. Genetics–*Numerical Problems*. Kalyani Publishers, New Delhi.
- Farook& Khan. *Genetics & Cytogenetics* (I Ed.). Premier Publishing House, Hyderabad.
- Shukla. *Cell Biology* (2001). Dominant publishers, New Delhi
- George Acquaah. *Principles of Plant Genetics and Breeding*. Blackwell
- B.D. Singh. *Fundamental of Genetics*. Kalyani. India
- Gupta, P.K. 1985.*Cytology, genetics and cytogenetics*. Rastogi Publication, India.

9. Principles of Plant Breeding 3(2+1)

Theroy

Plant breeding as a dynamic science, genetic basis of Plant Breeding – classical, quantitative and molecular, Plant Breeding in India – limitations, major achievements, goal setting for future. Sexual reproduction (cross and self-pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding and marker assisted selection Hybridization and selection – goals of hybridization, selection of plants; population developed by hybridization – simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis – concepts, estimation and its genetic basis. Calculation of heterosis, heterobeltosis, GCA, SCA, inbreeding depression, heritability and genetic advance. Emasculation, pollination techniques in important horticultural crops. Breeding for resistance of biotic and abiotic stresses. Polyploidy breeding. Mutation breeding.

Practical

Breeding objectives and techniques in important horticultural crops. Floral biology – its measurement, emasculation, crossing and selfing techniques in major crops. Determination of mode of reproduction in crop plants, handling of breeding material, segregating generations (pedigree, bulk and back cross methods), Field layout, and maintenance of experimental records in self and cross pollinated crops. Demonstration of hybrid variation and production techniques. Hardy Weinberg Law and calculation, male sterility and incompatibility studies in horticultural crops calculation of inbreeding depression, heterosis, heterobeltioses, GCA, SCA, GA, heritability.

Suggested Reading:

- R.W. Allard. Principles of plant breeding. John Wiley & Sons, New York.
- V.L. Chopra. Plant breeding: Theory and Practice. Oxford & IBH Publishing CO. Pvt. Ltd., New Delhi.
- Phundan Singh. Essentials of plant breeding. Kalyani Publishers
- J.R. Sharma. Principles and practices of plant breeding. Tata McGraw Publishing Company Ltd., New Delhi
- B.D. Singh. Plant breeding : principles and methods. Kalyani Publishers, Ludhiana.
- R.C. Chaudhary. Plant Breeding
- Hays and Garber. Breeding crop plants. Mc Graw Hill Publications, New York
- G K Kallo. Breeding of vegetables. Panima publishers, New Delhi
- W.R. Fehr. Principles of cultivar development: theory and technique (Vol. 1). Macmillan Publishing Company, New York.
- D.S. Falconer. Introduction to quantitative genetics. Longman Scientific & Technical, Longman Group, UK, Ltd., England.
- R.K. Singh and B.D. Chaudhary. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, Ludhiana.
- K. Mather and J.L Jinks. Introduction to Biometrical genetics. Chapman and Hall, London
- B D Singh. Fundamental of Plant breeding. Kalyani. India.

- Pundan Singh. Essentials of plant breeding. Kalyani. India
- G. S. Chahal and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding. Narosa Publishing House, New Delhi.
- Poehlman, J.M. and Borthakar, D. 1995. Breeding Asian Field Crops. Oxford & IBH Publishing Co., New Delhi

10. Breeding of Fruit and Plantation Crops 3(2+1)

Theroy

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistchonut, Apple, Pear, Plum, Peach, Apricut and Strawberry.

Suggested Reading:

- Nijar 1985.Fruit breeding in India,Oxford & IBH Publishing Co. New Delhi
- Anil Kumar Shukla 2004. Fruit breeding approaches & Achievements.
- International Book Distributing Co. New Delhi.
- Kumar, N. 1997. Breeding of Horticultural Crops, Principles and Practices. New
- India Publishing Agency, New Delhi.
- Singh, B.D. 1983.Plant Breeding Principles and methods. Kalyani Publishers,
- New Delhi.

11. Dryland Horticulture 2(1+1)

Theroy

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rain shadow areas, scarse water resources, high temperature, soil erosion, run-off losses etc.

Techniques and management of dry land horticulture. watershed development, soil and water conservation methods-terraces, contour bunds,etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits,etc.,*in-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc. water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc.

Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc.

Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical

- Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.
- **Suggested reading:**
- Chundawat, B.S. 1990. *Arid Fruit Culture*. Oxford and IBH, New Delhi.
- P.L. Taroj, B.B. Vashishtha, D.G.Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency.

II. VEGETABLE SCIENCE

1. Tropical and Sub-tropical Vegetable Crops 3(2+1)

Theroy

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and sub-tropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

Suggested Reading:

- S. Thamburaj, 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi
- B.R.Choudhary, 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- T.K.Bose, 2002.*Vegetable Crops*. Nayaprakash. Kolkata

- P.Hazra, 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
- K.V.Kamath, 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004
- M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
- P.Hazra, 2006.*Vegetable science*. Kalyani Publishers. Ludhiana
- Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
- Uma Shankar,2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
- Nath Prem, 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi
- K.L.Chadha, 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G., 1989. *Production Technology of Vegetable Crops*. Oxford &IBH Publishing Co. Pvt. Ltd, New Delhi.
- Choudhury, B. (ICAR). 1990. Vegetables. 8th edition, National Book Trust, New Delhi.
- Singh, D.K., 2007. *Modern Vegetable varieties and production*. IBN publishers, Technology International Book Distributing Co, Lucknow.
- Premnath, Sundari Velayudhan and Singh, D.P., 1987. *Vegetables for the tropical region*. ICAR, New Delhi.

2. Spices and Condiments 3(2+1)

Theroy

History, scope and importance, Present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micropropagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper. Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, pepper, betel vine ginger, turmeric, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

Practical

Identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Visit to commercial plantations.

Suggested Reading:

- Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. *Production technology of spices and plantation crops*. . Agrosis, Jodhpur
- Shanmugavelu, K.G. and Madhava Rao, 1977. *Spices and Plantation Crops*. Madras Popular Book Depot.
- Kumar, N. J.B. M. Md. Abdul khaddar, Ranga Swamy, P. and Irulappan, I., 1997. *Introduction to Spices, Plantation Crops, and aromatic crops*. Oxford & IBH, New Delhi.
- Pruthi, J.S., 1980. *Spices and Condiments*. Academic Press, New York.
- Pruthi, J.S., 1993. *Major Spices of India- Crop Management Postharvest Technology*. ICAR, New Delhi.
- Pruthi, J.S., 2001. *Minor Spices and Condiments-Crop ManagementPost Harvest Technology.* ICAR, New Delhi.
- Purseglove, Brown, E.G. Green, G.Z. Robbins, S.R.J. London, Longman, 1981. *Spices* Vol.I & II.

3. Breeding of Vegetable, Tuber and Spice Crops 3(2+1)

Theroy

Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops Tomato, Brinjal, Bhendi, Capsicum, Chilli, Cucurbits, Cabbage, Cauliflower, Tuber crops, Potato, Carrot, Radish, Spice crops (Ginger, Turmeric).Breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adoptability and stability.

Practical

Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Suggested Reading:

- Hari Hara Ram, 2013.*Vegetable Breeding: Principle and Practices***.** Kalyani Publishers. Ludhiana.
- Vishnu Swaroop, 2014. *Vegetable Science &Technology in India*. Kalyani Publishers. Ludhiana.
- Kallo.G, 1998. *Vegetable Breeding (Vol.I to IV).* CRC Press. Florida. 1988.
- H.P. Singh, 2009.*Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.
- **M.S. Dhaliwal.** 2012**.** *Techniques of Developing Hybrids in Vegetable Crops***.** Agrobios. Jodhpur.
- P.K.Singh, 2005. *Hybrid Vegetable Development*. CRC Press. Florida.
- M.S.Dhaliwal, 2009. *Vegetable Seed Production & Hybrid Technology*. Kalyani Publishers. Ludhiana.

- Fageria, M.S., 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers, Ludhiana.

4. Seed Production of Vegetable, Tuber and Spice Crops 3(2+1)

Theroy

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

Suggested Reading:

- G.N. Kulkarni, 2002.Principles of Seed Technology. Kalyani Publishers, Ludhiana.
- L.O. Copeland, 1999.Principles of Seed Science and Technology. Springer Publications.
- N.P. Nema, 1988.Principles of seed certification and Testing. Allied Publications.
- P. Hazra and M.G. Som, 2009. Vegetable seed production and Hybrid Technology. Kalyani Publishers, Ludhiana.
- Agarwal, P. K. 2010. Techniques in Seed Science and Technology. South Asian
- Publishers. New Delhi.
- Agrawal R. L. 1999. Seed Technology. Oxford and IBH Publicity Company, New Delhi.
- Arya, Prem Singh. 2003. Vegetable seed Production Principles. Kalyani Publishers.
- Ludhiana.
- Fageria, M. S. 2011. Vegetable Crops- Breeding and Seed Production. Kalyani
- Publishers. Ludhiana.
- Geetharani, P. 2007. Seed Technology in Horticultural Crops. NPH Publications.
- Jodhpur.
- Singh, S.P. 2001. Seed Production in Commercial Vegetables. Agrotech Publishing Academy, Udaipur.
- Vanangamudi, K.2010. Vegetable Hybrid Seed Production and Management. Agrobios. Jodhpur.
- Singh, Prabhakar.2015.Seed Production Technology of vegetable. Daya Publishing House. New Delhi.

- Raymond A.T., 2000. Vegetable Seed Production. Oxford University Press, USA
- Prem Singh Arya, 2003. Vegetable breeding, production and seed production. Kalyani publishers, New Delhi.
- Rattan lal Agarwal, 1995. Seed technology. Oxford & IBH, New Delhi
- Singh, S.P. 2001. 1st edition, *Seed production of commercial vegetables*. Agrotech Publishing, Udaipur
- Vanangamudi, K. 2006. Natarajan, P. Srimathi, N.Natarajan, T. Saravanan, M. Bhaskaran, A. Bharathi, P. Nateshan, K. Malarkodi. *Advances in Seed Science*. Agrobios (India), Jodhpur.
- Nemgal Singh, P.K. Singh, Y.K. Singh and Virendra kumar, 2006. *Vegetable Seed Production Technology*. International book distributing co., Lucknow.
- Khare, D. and Bhole, M.S. 2000. *Seed Technology*. Scientific Publishers (India) Jodhpur.

5. Temperate Vegetable Crops 2(1+1)

Theroy

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, Vegetable kale.

Practical

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

Suggested Reading:

- S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
- B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata
- P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
- K.V.Kamath. 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008.*Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2004.*Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
- M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
- P.Hazra. 2006.*Vegetable science*. Kalyani Publishers .Ludhiana

- Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
- Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
- Nath Prem. 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi
- K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
- Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
- Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

6. Potato and Tuber Crops 2(1+1)

Theroy

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing. Crops to be covered – potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Seed collection, working out cost of cultivation, project preparation of commercial cultivation.

Suggested Reading:

- S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
- B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata
- P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
- K.V.Kamath. 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008.*Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana

- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2004.*Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
- M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
- P.Hazra. 2006.*Vegetable science*. Kalyani Publishers .Ludhiana
- Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
- Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
- Nath Prem. 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi
- K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
- Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
- Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.
- Vincent Lebot, 2008.*Tropical roots and tuber crops*. CAVI.
- J.E. Bradashaw, 2010. Root and tuber crops. Springer Publications.

7. Precision Farming & Protected Cultivation 3 (2+1)

Theroy

Precision farming – laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, mapping of soils and plant attributes, site specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

Practical

Study of different types of greenhouses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization; Visit to commercial green houses; Economics of protected cultivation.

Suggested Reading:

- Balraj Singh. 2006. *Protected cultivation of vegetable crops*. Kalyani Publishers, Ludhiana.
- Brahma Singh, 2014.*Advances in Protected Cultivation*. New India Publishing Agency. New Delhi.
- Reddy P. Parvatha, 2003. *Protected Cultivation*. Springer Publications. USA.
- **Reddy**, P. Parvatha. 2011. *Sustainable crop protection under Protected Cultivation*. Springer Publications. USA.
- Jitendra Singh, 2015.*Precision Farming in Horticulture*. New India Publishing Agency. New Delhi.
- Prasad S. 2005. *Greenhouse Management for Horticultural Crops*. Agrobios. Jodhpur.
- Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat.2013. *Precision forming in Horticulture*. New India Publishing Agency, New Delhi.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural crops*. New India Publishing Agency, New Delhi.
- Aldrich RA & Bartok JW. 1994. NRAES,Riley, Robb Hall. *Green House Engineering*. Cornell University, Ithaca, New York.
- Pant V Nelson. 1991.*Green House Operation and Management*. Bali Publ

III. POST HARVEST TECHNOLOGY

1. Postharvest Management of Horticultural Crops 3(2+1)

Theroy

Importance of Postharvest Technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants. Pre-harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process. Postharvest treatments of horticultural crops. Quality parameters and specifications. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Methods of storage for local market and export. Pre-harvest treatment and pre-cooling, pre-storage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging. Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.

Practical

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops, spices and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packing houses and cold storage units.

Suggested Reading:

- Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
- Wiils, McGlasson and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International
- Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
- Neetu Sharma and Mashkoor Alam, M. 1998. Post Harvest Diseases of Horticultural Perishables. International Book Distributing Co., Lucknow.
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi.
- Hulme, A.C. 1970. Food Science & Technology - A Series of Monograph. The Biochemistry of Fruits and their Products. Vol.-1. Academic Press London & New York.
- Mitra, S. K. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International.
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Thomposon, A. K. 1996. Post harvest Technology of Fruits and Vegetables. Blackwell Science.
- Battacharjee, S. K. and De, L. C. 2005. Post Harvest Technology of Flowers and Ornamentals Plants. Ponteer Publisher, Jaipur, India.
- Pruthi, J. S. 2001. Minor Spices and Condiments – Crop Managements and Post Harvest Technology. ICAR, New Delhi.
- Shanmugavelu, K. G., Kumar, N. and Peter K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios (India).
- Saraswathy, S. *et. al.* 2008. Post harvest Management of Horticultural Crops. Agribios (India).81-7754-322-9.
- Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4th edt.). US Davis, PHT Research and information Center.
- Jacob John, P. 2008. A Handbook on Post Harvest management of Fruits and vegetables. Daya Publishing House, Delhi-1081-7035-532-X.
- Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4 edt). US Davis, PHT Research and information Center.
- http://www.postharvest.com.au
- http://www.fao.org/infoods/index_en.stm
- www.postharvest.ucdavis.edu

2. Processing of Horticultural Crops 3(1+2)

Theroy

Importance and scope of fruit and vegetable preservation industry in India, food pipe line, losses in post-harvest operations, unit operations in food processing. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and

sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

Suggested Reading:

- Verma, L. R.and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.
- Dauthy, M. E. 1995. Fruits and Vegetables Processing- FAO Bulletin 119. International Book Distributing Co., Lucknow.
- Srivastava, R. P. & Sanjeev Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.
- Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press
- 0849356245
- Neetu Sharma and Mashkoor Alam, M. 1998. Post Harvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.
- Vijay, K. 2001. Text Book of Food Sciences and Technology. ICAR, New Delhi.
- Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi
- FAO - Training Manual No.17/2. 2007. Prevention of post harvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.
- Morris, T. N. 2006. Principles of Fruit Preservation. Biotech Books, Delhi.
- 81-7622-116-3.
- http://www.postharvest.com.au
- http://www.fao.org/infoods/index_en.stm
- Srivastava,R. PandSanjeevK.1998. Fruitandvegetablepreservation principlespractice. Internati onalBookDistributingCo.,Lucknow.
- Girdharilal, Siddappa, G. S. and Tandon, G. L.1998. Preservation off ruits and vegetables. ICAR, New Delhi.
- Dauthy and Mircea, E.1995. Fruit and vegetables processing. International Book Distribution Co, Lucknow.

- KaysandStanely,J.1998. Postharvestphysiologyof perishableplantproducts. CBSPublishers,Distributors,NewDelhi
- Bhatti,S1995.Vame, Fruitandvegetableprocessing. CBSPublishers,Distributors,NewDelhi.

3. Fundamentals of Food Technology 2(1+1)

Theroy

Food and its function, physico-chemical properties of foods, food preparation techniques, nutrition, relation of nutrition of good health. Characteristics of well and malnourished population. Energy, definition, determination of energy requirements, food energy, total energy needs of the body. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

Practical

Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy, value proteins and fats of foods. Planning diet for various age groups.

Suggested Reading:

- Dr. Swaminathan, M.1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
- Dr. Swaminathan, M. 1985. Essential of Food and Nutrition Vol. II. BAPPCO, Bangalore.
- Manoranjan, K. and Sangita, S. 1996. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
- Srilakshmi. 2010. Food Science. New age International 978-81-224-2724-0.
- Srilakshmi. 2005. Dietetics. New age International 978-81-224-1611-4.
- Shankunthala, M. 1972. Foods-Facts, Principles & Procedure. The Eastern Press, Bengaluru.
- Passmore, R. and Eastwood, M. A. 1986. Human Nutrition & Dietetics. ELBS
- 0443039194.
- Anita, T. 1996. Food and Nutrition. Oxford 0198327668.
- Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science and technology and Quality Management. Kalyani Publishers 81-272-2521-5.
- Monoranjam, K. and Sangita, S. 2008. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
- George, I. S. and Dennis, D. L. 1994. Chemistry for the Health Science. MacMillan 0-02-405161-6.
- Masferton and Hurley. 1989. Chemistry Principles and Reactions. Saunders Golden Sunburst 0-03-005889-9.
- Bettelheim and March. 1984. Introduction to General, Organic & Biochemistry. Harcourt Brace college Puplishers 0030202175 Sounders college Puplishing.

- Gopalan, G., Ramasastri, B.V. and Balasubramnian, S. C. 1989. Nutritive valve of the Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.
- http://www.fao.org/infoods/
- Swaminathan, M. 1988. Hand book of Food Science & Experimental Foods. Bappco publishers, Bangalore
- Manay, S.N, Shadaksharaswamy, M.1998. Food-facts & Principles New Age International Publishers, New Delhi
- Srilakshmi, B. 1995. Food Science. New Age International Publishers, New Delhi.

IV. FLORICULTURE & LANDSCAPE ARCHITECTURE

1. Ornamental Horticulture 2(1+1)

Theroy

History, definitions, scope of ornamental horticulture, aesthetic values, Floriculture industry, Importance, area and production, industrial importance of ornamental plants and flowers. Importance, classification, design values and general cultivation aspects for ornamental plants *viz*. Annuals, biennales herbaceous perennials, grasses and bulbous ornamentals. shrubs, climbers, trees, indoor plants, palms and cycads, ferns and sellagenellas, cacti and succulents, Importance, design and establishment of garden features/components viz. hedge, edge, borders, flower beds, bridges, paths, drives, fences, garden walls, gates, carpet bed, arbour, Patio, decking, retaining walls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools, waterfalls, fountains, bog garden, avenue planting and children garden. Lawn types, establishment and maintenance. Importance of Garden adornments viz. floral clock, bird bath, statutes, sculptures, lanterns, water basins, garden benches etc.. Importance of flower arrangement, Ikebana, techniques, types, suitable flowers and cut foliage, uses of vertical garden, bottle garden, terrariums, art of making bonsai, culture of bonsai and maintenance.

Practical

Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns and sellagenellas, Palms and cycads and Cacti and succulents. Planning and designing and establishment of garden features viz. lawn, hedge and edge, rockery, water garden, carpet bedding, shade garden, roof garden, Study and creation of terrariums, vertical garden, study and practice of different types of flower arrangements, preparation of floral bouquets, preparation of floral rangoli, veni etc., Study of Bonsai techniques, Bonsai practicing and training. Visit to nurseries and floriculture units.

Suggested Reading:

- Bose, Chowdhury and Sharma.1991.Tropical Garden Plants in colour .Horticulture and allied publishers, 3D Madhab Chatterjee street Kolkata.
- K.V.Peter.2009.Ornamental plants. New India publishing agency, Pitampura, New Delhi.
- Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries pvt. Ltd.

- Bimaldas Chowdhury and Balai Lal Jana.2014.Flowering Garden trees. Pointer publishers, Jaipur. India.
- Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
- Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
- Bose, T.K. Mukherjee, D. 2004. Gardening in India. Oxford & IBH Publishers.
- Chadha, K.L. and Chaudhary, B. 1986. Ornamental Horticulture in India. Publication andInformationdivision. ICAR,NewDelhi.

2. Breeding and Seed Production of Flower and Ornamental Crops 3(2+1)

Theroy

History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops *viz*., Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia Heliconia, Lilium, Gaillardia, Petunia, *Hibiscus*, Bouganvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, crossandra, marigold, , geranium, antirrhinium, china aster, orchids, anthurium, carnation, hibiscus etc. Breeding for disease resistance. Development of promising cultivars of important ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

Practical

Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods.

Suggested Reading:

- B.P. Pal. *The Rose in India*.1966.Directorate of Knowledge management in Agriculture, Indian council of Agriculture Research-New Delhi.
- T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers.* Partha Sankar Basu, Nayaudyog, 206, Bidhan Sarani, Kolkata-700006.
- S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
- D.J. Callaway and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press
- J. Harding, F.Singh and J.N. Mol. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers
- A. Vainstein. 2002. Breeding for Ornamental: Classical and Molecular Approaches. Springer Publishers
- Singh,B.D. 1983. Breeding Principles and Methods. Kalyani Publishers, New Delhi.
- R.L. Agarwal. 1996. Seed Technology. Oxford & IBH Publishers, New Delhi
- P.K. Agarwal. 1994. Principles of Seed Technology. ICAR Publication, New Delhi

3. Principles of Landscape Architecture 2(1 +1)

Theroy

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD and Arch CAD in designing gardens. Factors affecting landscape design viz. intial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc.. Elements of landscape gardens viz. tangible and intangible elements. Bio-aesthetic planning, definition, objectives, Planning and designing of home gardens, colonies, country planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydro electric stations, river banks, play grounds, Gardens for places of religious importance viz. temples, churches, mosques, tombs etc, Importance, features and establishment of English garden , Japanese gardens , Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens, Xeriscaping, definition, principles and practice.

Practical

Study of garden equipments. Study of Graphic language, Use of drawing equipments, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using Auto-cad/ archi-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, temples, churches, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

Suggested Reading:

- A.K. Tiwari and R. Kumar. 2012. *Fundamentals of ornamental horticulture and landscape gardening*. New India.
- H.S.Grewal and Parminder Singh. 2014. *Landscape designing and ornamental plants*
- R.K. Roy. *Fundamentals of Garden designing*.2013.New India publishing agency, Pitampura, New Delhi.
- Rajesh Srivastava. 2014. *Fundamentals of Garden designing*. Agrotech press, Jaipur, New Delhi.
- L.C. De. *Nursery and landscaping*.2013. Pointer publishers, Jaipur India.
- Bose, T.K. Malti, R.G. Dhua, R.S. & Das, P. 2004. Nayaprakash, Calcutta. Floriculture and Landscaping
- Arora, J.S. 2006. Kalyani publishers, Ludhiana. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana.
- Randhawa, G.S. and Amitabha Mukhopadhyay 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.

4. Commercial Floriculture 3(2+1)

Theroy

Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, crossandra, anthurium, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export market, production techniques of flowers and foliage filler materials growing of flowers under protected environments such as glass house, plastic house etc., postharvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers, production techniques for bulbous.

Practical

Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

Suggested Reading:

- A.K.Singh.2006.*Flower crops, cultivation and management*. New India publishing agency, Pitampura, New Delhi.
- T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003.*Commercial flowers.* Partha Sankar Basu, Nayaudyog,206, Bidhan Sarani, Kolkata-700006
- S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
- Dewasish Choudhary and Amal Mehta. 2010. *Flower crops cultivation and management*. Oxford book company Jaipur, India.
- Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd:
- Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana - 141 008.
- Prof. Bhattacharjee, S.K. Advanced Commercial Floriculture. Aavishkar Publishers Distributors, Jaipur - 320 003
- Prof. V.L. Sheela, 2008. Flower for trade. New India Publishing Agency, Pitampura, New Delhi-110088

5. Medicinal and Aromatic Crops 3(2+1)

Theroy

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical

composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils. Medicinal Plants: Withania, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy Ammi majus, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum and other species relevant to the local conditions. Marketing.

Practical

Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Suggested Reading:

- Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.
- Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants. United Press Limited.
- Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.
- Kumar, N. J.B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants.Oxford & IBH, New Delhi.
- Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, New Delhi.
- Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala soms and co-private Ltd, Bombay.

V. PLANT PROTECTION

1. Fundamentals of Plant Pathology 3(2+1)

Theroy

Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management. Fungicides classification based on chemical nature, Commonly used fungicides, bactericides and nematicides.

Practical

Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their applications.

Suggested Readings:

- N.G. Ravichandra, 2013.Fundamentals of Plant Pathology. PHI Hall of India, New
- Delhi
- R.S. Mehrohtra, Ashok Agarwal. *Fundamental of Plant Pathology-*
- Sambamurthy *A textbook of Plant Pathology-*
- R.S.Singh *Introduction to principles of plant pathology*
- Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.
- Mandahar,C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi.
- Mehrotra, R.S. and Aneja, K.R. 1990. . An Introduction to Mycology. New Age International (P) Ltd., New Delhi.
- Singh, R.S. 1982. Plant Pathogens - The Fungi. Oxford and IBH Publishing Co., New Delhi.
- Singh, R.S. 1989. Plant Pathogens - The Prokaryotes .Oxford and IBH Publishing Co., New Delhi.
- Dhingra and Sinclair 1993. Basic Plant Pathology Methods. CBS, Publishers & Distributors, New Delhi.
- Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.

2. Diseases of Fruit, Plantation, Medicinal and Aromatic Crops 3(2+1)

Theroy

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops *viz* mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

Suggested Reading:

- L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops-*, Indus Publishers
- Srikant Kulkarni, Yashoda R. Hedge, *Diseases of Plantation crops and their management-* Agrotech publication Academy.
- S.L. Godara, BBS Kapoor, B.S. Rathore *Disease management of spice crops-*, Madhu Publications.
- Alfred Steferud *Diseases of Plantation Crops-*, Biotech books.
- R.S.Singh, *Plant diseases* –Oxford and IBH Publishing Co. Pvt. Ltd.
- L.Darwin Christdhar Henry and H. Lewin Devasahayam. *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook, New India publishing. Agency.

- Anna L *A colour atlas of Post Harvest Diseases and Disorders of fruits and vegetables* -. Snowdon, CRC Press.
- Pathak, V.N. 1980.*Diseases of Fruit Crops*.Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
- Ranga Swamy, G. 1988.*Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi.
- Singh, R.S. 1996.*Plant Diseases*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
- Saha, L.R. 2002.*Hand Book of Plant Diseases*. Kalyani Publishers, New Delhi.
- Arjunan, Karthikeyan, Dinakaran, Raghuchander, 1999.*Diseases of Horticultural Crops*. Dept. of Plant Pathology, TNAU, Coimbatore
- Chadha, K.L. 2002.*Hand Book of Horticulture*. ICAR, New Delhi.
- Anna L.Snowdon *A colour atlas of Post Harvest Diseases and Disorders of fruits and vegetables*. CRC Press, New Delhi.
- L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*., Indus Publishers,New Delhi.
- Yashoda R. Hedge. *Diseases of Plantation crops and their managemen*t .Srikant Kulkarni, Agrotech publication Academy.
- S.L. Godara, BBS Kapoor, B.S. Rathore. *Disease management of spice crops*.,
- Madhu Publications.
- Ranga Swamy, G. 1988.*Diseases of crop plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi
- R.S.Singh, *Plant diseases*. Oxford and IBH Publishing Co. Pvt. Ltd.
- L. Darwin Christdhar Henry and H. Lewin Devasahayam, *An Illustrated Handbook*. New India publishing.Agency

3. Diseases of Vegetable, Ornamental and Spice Crops 3(2+1)

Theroy

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerebera, anthurium, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

Practical

Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops in field as well as in protected cultivation.

Suggested Reading:

- Srikant Kulkarni, Yashoda R. Hedge. *Diseases of Plantation crops and their management*-, Agrotech publication Academy
- S.L. Godara, BBS Kapoor, B.S. Rathore. *Disease management of spice crops*-, Madhu Publications

- L.Darwin Christdhar Henry and H.Lewin Devasahayam *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook –, New India publishing Agency
- Singh, R.S. 1994. *Diseases of Vegetable Crops*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
- Singh, R.S 1996. *Plant Diseases*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
- Sohi, H.S. 1992. *Diseases of Ornamental plants in India*. ICAR, New Delhi
- Ranga Swamy, G. 1988. *Diseases of Crop Plants in India*.Prentice Hall of India Pvt. Ltd., New Delhi.
- Saha, L.R. 2002. *Hand Book of Plant Diseases*. Kalyani Publishers
- Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. *Diseases of Horticultural Crops.* .Dept. of Plant Pathology,Tamilnadu Agricultural University Coimbatore.

4. Nematode Pests of Horticultural Crops and their Management 2(1+1)

Theroy

History and development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, sub-tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex. Integrated nematode management.

Practical

Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Suggested Reading:

- Upadhyay, K.D and Dwivedi, K. 1997. A text book of plant nematology. Amman Publishing House Aman publishing house, Meerut
- Vasanth Raju David, B. 2001. Elements of economic entomology. Popular book Depot, Chennai.
- Gopal Swaroop and Das Gupta 1986.ICAR, New Delhi. Plant Parasitic Nematodes of India Problems and Progress.
- Nair, M.R.G.K. 1975. Insects and Mites of Crops in India. ICAR, New Delhi
- Metcalf, R.L and Luckman, W.H. 1982. Introduction to Insect pest management Wiley Inter Science Publishing, New York.
- Butani, D.K. 1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi
- E.I.Jonathan, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, Agricultural Nematology. TNAU, Coimbatore.

5. Fundamentals of Entomology 3(2+1)

Theroy

Introduction to phylum arthropoda. Importance of class Insecta. Insect dominance. History of entomology in India, Importance of entomology in different fields. Definition, division and scope

of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetalia. Structure, function of cuticle & moulting and body segmentation, Anatomy of digestive, Circulatory, Sensory, respiratory, glandular, excretory, nervous and reproductive systems. Types of reproduction. Postembryonic development-eclosion. Matamorphosis. Types of egg larvae and pupa. Classification of insects upto orders, sub-order and families of economic importance and their distinguished characters. Plant mites – morphological features, important families with examples.

Practical

Insect collection and preservation. Identification of important insects. General body organization of insects. Study on morphology of grasshopper or cockroach. Preparation of permanent mounts of mouth parts, antennae, legs and wings. Dissection of grasshopper and caterpillar for study of internal morphology. Observations on metamorphosis of larvae and pupae. Dissection of cockroaches.

Suggested Reading:

- Awasthi, V.B. 1997. *Introduction to general and applied entomology*. Scientific Publishers, Jodhpur, 379 p.
- Borror, D.J., C.A. Triple Horn and N.F.Johnson. 1987. *An introduction to the study of insects (VI Edition)*. Harcourt Brace College Publishers, New York, 875p.
- Chapman, R.F. 1981. The Insects: Structure and function. Edward Arnold (Publishers) Ltd, London, 919p.
- Gullan, P.J. and Cranston, P.S. 2001. *The insects- An outline of entomology*, II edition, Chapman & Hall, Madras, 491p.
- Mani, M.S. 1968. *General entomology*. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 912p.
- Nayar, K.K., T.N.Ananthakrishnan and B.V. David. 1976. *General and applied entomology*, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.
- Richards, O.W. and R.G. Davies. 1977. *Imm's general text book of entomology*, Vol.1&2, Chapman and Hall Publication, London, 1345p.
- Romoser, W.S. 1988. *The Science of Entomology*, McMillan, New York, 449p.
- Saxena, S.C. 1992. *Biology of insects.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 366p.
- Srivastava, P.D. and R.P.Singh. 1997. *An introduction to entomology*, Concept Publishing Company, New Delhi, 269p.
- Tembhare, D.B. 1997. *Modern Entomology*. Himalaya Publishing House, Mumbai, 623p.
- Pedigo, L.P. 1999. *Entomology and pest management*. III Edition. Prentice Hall, New Jersey, USA, 691p.
- H. Lewin and Devasahayam. Practical manual of entomology insect and non-insect pests.
- Pant, N.C. and Ghai, S. 1981Insect physiology and anatomy, ICAR, New Delhi .
- Snodgrass, R.E. 2001.Principles of Insect Morphology.CBS Publishers and Distributors, New Delhi
- James, L, Nation. CRC Press, Insect Physiology and Biochemistry.Washington

6. Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops 3(2+1)

Theroy

General – economic classification of insects; Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, belladonna, pyrethrum, costus, crotalaria, datura, dioscorea, mint, opium, Solanum khasianum and. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs).

Practical

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.

Suggested Reading:

- Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.
- Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
- Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.
- Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.
- David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.
- David.V.Alford. Pest of fruit crops. A.M.Ranjith. Identification and management of Horticultural pest.
- Rachna and Benna kumari. Pest management and residual analysis in horticultural crop
- K. P. Srivastav and Y. S. Ahawat. Pest management in citrus
- Ramnivas Sharma. Identification and management of horticulture pest.
- Fryer. Insect pest of fruit crops
- A. S. Atwal. Agricultural pests of South Asia and their management
- Mark Vernon Slingerland and C. R. Crosby. Manual of fruit insects
- Metcalf, R. Land Luckman, W.H. 1982. Introduction to Insect pest management. WileyInterScience Publishing,NewYork
- Butani,D.K.1984. Insectsand Fruits. Periodical Expert Book Agency, New Delhi

7. Apiculture, Sericulture and Lac Culture 2(1+1)

Theroy

Introduction to beneficial insects. Importance and History of apiculture. Species of honey bees, Rock bee, Little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and

caste determination. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons, Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues.. Importance, History and development in India, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs. Silkworm rearing young age /chawki rearing and old age rearing of silkworms. Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardiness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture-Mulberry varieties, package of practices, Pests and diseases and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.

Practical

Honey bee colony, different bee hives and apiculture equipment. Summer and Winter management of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipments for silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

Suggested Reading:

- Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.
- Sunita, N.D, Guled ,M.B, Mulla S.R and Jagginavar,2003, Beekeeping, UAS Dharwad
- Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
- Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).
- Paul DeBach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991)
- YA Shinde and BR Patel. Sericulture in India
- Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd
- M.L. Narasaiah. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.
- Ganga,G. and Sulochana Chetty, J. 1997. An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
- Krishnaswamy, S. (Ed). 1978. Sericulture Manual - Silkworm Rearing. FAO Agrl. Services

bulletin, Rome.
- Singh, S. 1975. Bee keeping in India. ICAR, New Delhi.
- Glover, P.M. 1937. Lac cultivation in India. Indian Lac Research Institute, Ranchi.
- Jolly, M.S. 1987. "Appropriate sericulture techniques" International centre for training and Re searchinTropicalSericulture,Mysore,209.
- K.P.Srivastava .A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana
- B.r. David and V.V.Ramamurthy. Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai

8. Insect Pests of Vegetable, Ornamental and Spice Crops 3(2+1)

Theroy

Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect-pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host range, bio-ecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical

Study of symptoms, damage, collection, identification, preservation, assessment of damage/ population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

Suggested reading:

- Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur
- Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
- Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.
- Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.
- David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.
- P. Srivastava, Dhamo K. Butani Pest management in vegetables – Part1. Researcho Book Centre, 1998
- K.P. Srivastava, Dhamo K. Butani Pest management in vegetables – Part-2. Researcho Book Centre, 1998
- Rachna and Benna kumari. Pest management and residual analysis in horticultural crop
- Ramnivas sharma. Identification and management of horticulture pest.
- T. V. Sathe. Pests of ornamental plants.
- A. S. Atwal. Agricultural pests of south Asia and their management
- Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi.

- Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi
- Metcalf,R.LandLuckman,W.H.1982. IntroductiontoInsectpestmanagement. WileyInterScience Publishing,NewYork
- Dhalinal,.G.S.and Ramesh Arora Integrated Pest Management Concept and Approaches. Kalyani Publishers, Ludhiana.
- K.P.Srivastava.A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana
- Emmanuel, N, A. Sujatha, T.S.K. K. Kiran Patro, MLN Reddy, B. Srinivasulu, TSSK Sammuel Patro. Text Book on Integrated Pest Management of Horticultural Crops Astral International Publishers, New Delhi.

VI. NATURAL RESOURCE MANAGEMENT

1. Fundamentals of Soil Science 2(1+1)

Theroy

Composition of earth's crust, soil as a natural body – major components. Eluviations and alleviations formation of various soils. Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), AD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value hue and chroma. Munsellcolour chart, factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal, soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Rock & Minerals classification, Pedogenic process. Objectives of soil science research institute in India (NBSS&LUP, ISSS, LTFE & NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Soil Biology benefits and harmful effects. Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation.

Practical

Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Quantification of minerals and their abundance. Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Estimation of soil moisture using

gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of pore space of soil. Determination of filed capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by field method.

Suggested Reading:

- Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.
- Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
- Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.
- Biswas, T.D. and Mukharjee, S.K., 2015. *Text Book of Soil science*. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
- Brady, N.C., 1995. *The Nature and properties of Soils*. Macmillan Publishing Co, New York.
- Ghildyal, B.P. and Tripathi, R.P., 1987. *Soil Physics*. Acad. Press. New York.
- Kolay, A.K., 1983. *Basic concepts of Soil Science*. Wiley Eastern Ltd., New Delhi
- Brady, N. C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition), Pearson Education, New Delhi.
- Foth, H.D., 1991. *Fundamentals of Soil Science* (8th Edition), John Wiley & Sons, New Delhi.
- Das, D .K., 2011. *Introductory Soil Science* (3rd Edition), Kalyani publisher, Ludhiana (India).
- Khan, T. O. 2013 Forest Soils: *Properties and Management*. Springer International Publishing, Switzerland
- Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
- Gupta, P.K. 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
- Jaiswal, P.C. 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson, M. L. 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher

2. Soil Fertility and Nutrient Management 2(1+1)

Theroy

Introduction to soil fertility and productivity- factors affecting. Essential plant nutrient elements- functions, deficiency systems, transformations and availability. Acid, calcareous and salt affected soils – characteristics and management. Soil organic matter, Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition, soil buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Plant nutrient toxicity symptoms and remedies measures. Soil test crop response and targeted yield concept. Biofertilizer. Nutrient use efficiency and management. Secondary and micronutrient fertilizer. Fertilizer control order. Manures and fertilizers classification and

manufacturing process. Properties and fate of major and micronutrient in soils. Fertilizer use efficiency and management. Effect of potential toxic elements in soil productivity.

Practical

Analysis of soil for organic matter, available N,P,K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils. Estimation of organic carbon content in soil. Determination of Boron and chlorine content In soil. Determination of Calcium, Magnesium and Sulphur in soil. Sampling of organic manure and fertilizer for chemical analysis. Physical properties of organic manure and fertilizers. Total nitrogen in urea and farmyard manure. Estimation of ammonical nitrogen and nitrate nitrogen in ammonical fertilizer. Estimation of water soluble P_2O_5, Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate. Visiting of fertilizer testing laboratory.

Suggested Reading:

- Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers.* Agri. Horticultural Publishing House, Nagpur.
- Tandon HLS, 1994. *Fertilizers Guide*. Fertilizers Development Consultation Organization, New Delhi..
- Seetharaman S, Biswas B C, Yadav D S and Matheswaru S. Usage 1996. *Hand Bookon Fertilizers*. Oxford and IBH Publishing Company, New Delhi.
- The fertilizer Association of India, Shaheed Jit singh marg, New Delhi, 1985. Fertilizer control order
- Ranjan Kumar Basak , 2000. *Fertilizers A Text book.* Kalyani publishers, New Delhi.
- British Crop Production Council, U.K., 1995. The Pesticide Manual, A – World Compendium.
- Sree Ramulu US, 1991. *Chemistry of Insecticides*. Oxford and IBH Publishing and Fungicides Company, New Delhi.
- Nene Y L and Thapliyal P N, 1991. *Fungicides in plant disease control*. Oxford and IBH Publishing company, New Delhi.
- Havlin *et al.* 2014. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (8th Edition), PHI Learning Pvt. Ltd., Delhi.
- Binkley, D. and R. Fisher, 2012. *Ecology and Management of Forest Soils* (4th Edition), John Wiley & Sons Singapore Pvt. Ltd., Singapore
- Reddy M. V., 2001. *Management of Tropical Plantation Forests and Their Soil Litter System-Litter, Biota and Soil Nutrient Dynamics*, Science Publishers, U. S.
- Khan, T. O., 2013. *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland
- Brady, N. C. and Weil, R. R., 2010. E*lements of the Nature and Properties of Soils* (3rd Edition.), Pearson Education, New Delhi
- Das, D .K., 2011. Introductory Soil Science (3rd Edition), Kalyani Publisher, Ludhiana (India).
- Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. Indian Society of Soil Science, IARI, New Delhi.
- Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.

- Gupta, P.K., 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
- Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson, M. L., 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher
- J. Benton Jones, Jr., 2012. *Plant Nutrition and Soil Fertility Manual* (2nd Edition), CRC Press, USA.
- Mengel, *et al.,* 2001. *Principles of Plant Nutrition* (5th Edition), Springer
- Kanwar, J.S.(Ed).,1976. *Soil Fertility: The oryand Practice*, ICAR,NewDelhi
- Bear, F.E.,1964. *Chemistry of the Soil.* Oxford and IBH Publishing Co., New Delhi
- Richards, L.A., 1968. *Diagnosis and Improvement of Saline and Alkalinesoils*. Oxford& IBH Publishing Co. New Delhi (USDAH and Book No.60)
- Chopra, S.Cand Kanwar, J.S.,1976. *Analytical Agricultural Chemistry*. Kalyani Publishers, Ludhiana.
- Tisdale, S.L.Nelson, W.L.andBeaton,J.D.,1993. *Soil Fertility and Fertilizers*. Macmillan Publishing Company,New York
- Yawalkar, K.S.Agarwal,J.P.and Bokde,S.,1977. *Manuresand Fertilizers*. Agri-Horticultural Publishing House, Nagpur
- Seetharamaan, S.Biswas, B.C.Maheswari, S.and Ya dav, D.S., 1986. *Hand Bookon FertilizersTechnology*. The Fertilizers Association of India, New Delhi

3. Environmental Studies and Disaster Management 3(2+1)

Theroy

Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems, Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification

of India. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of - Air, Water, Soil, Marine, Noise and Thermal pollution and Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air, Water, Wildlife and Forest Conservation Acts, Issues involved in enforcement of environmental legislation and Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Field work: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management-Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Visit to local areas - river/forest/ grassland/catchment etc. to document components of ecosystem. Study of common plants, insects, birds and animals. Visit to industries to study pollution abatement techniques and case studies - solid waste management, Human population and the Environment.

Suggested Reading:

- A. Nandini, N. Suneetha and Sucharitha Tandon. *Environmental Studies*.
- Aswathanarayana, U. 1999. *Soil resources and the environment*. Oxford and IBH publishing Co., New Delhi. P. 173-195.
- D. D. Misra. *Fundamental Concepts in Environmental Studies*.

- Diwan, P. and P. Diwan. 1998. *Environmental Management Law and Administration*. Variety Books International, New Delhi.
- Krishnamurthy. *An Advanced Textbook on Biodiversity*.
- S. Deshwal A. Deshwal. *A Basic Course in Environmental Science.*
- Erach Bharucha 2005.Textbook of environmental studies for under graduate courses.UGC, University press, Hyderabad.
- Manohara Chary and Jayaram Reddy 2004.Principles of Environmental studies BB publishers, Hyderabad.
- William, P. Cunning Ham and Mary Ann. Inquiry and applications Cunningham 2005. Principles of Environmental science. Tata MCG raw-hill publishing company limited, New Delhi.
- Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India). Jodhpur.
- Spencer R. Weart. The discovery of global warming.
- Daniel B. Botkin, Edward A. Keller. Environmental Science.
- Richard T. Wright and Bernard J. Nebel Environmental science: toward a sustainable agriculture.
- Linfield C.Brown. Pollution prevention and control.

4. Soil, Water and Plant Analysis 2(1+1)

Theroy

Methods of soil and plant sampling and processing for analysis. Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential. Use of radio tracer techniques in soil fertility evaluation. Soil micro-organisms and their importance. Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values Quality of irrigation water. Radio tracer technology application in plant nutrient studies. Rapid tissue tests for soil and plant. Management of poor quality irrigation water in crop management. Soil and Water pollution.

Practical

Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Estimation of available macro and micronutrient elements in soils and their contents in plants. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of Calcium and Magnesium in soil and irrigation water. Determination of N, P, K, Ca, Mg, Sand micronutrients in plant samples. Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

Suggested Reading:

- H.L.S. Tandon. 2013, *Methods of analysis of soil, plant, water and fertilizers*. FDCO, New Delhi.
- Yawalkar,K.S.Agarwal,J.P.andBokde,S.,1977. *ManuresandFertilizers*. Agri-HorticulturalPublish

ingHouse,Nagpur.
- Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
- Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson M. L, 1967. *Soil Chemical Analysis*, Oxford and IBH Publishing Co., New Delhi.
- Richards L A, 1968. *Diagnosis and Improvement of Saline and Alkaline Soils*. Oxford and IBH publishing Co. New Delhi(USDA Hand Book No. 60)
- Chopra S.C. and Kanwar, J. S 1976. *Analytical Agricultural Chemistry*, Kalyani Publishers, Ludhiana.
- C. S. Piper. 2014, *Soil and plant analysis*, Scientific publishers India.
- Mushtaq A. Wan., 2014, *Soil, plant and water analysis manual*. Agrotech publishing company, Udaipur.
- P. K. Gupta., 2013, *Soil, plant, water and fertilizer analysis*. Agrobios, India.
- M. V. Durai., 2014, *Hand book of Soil, plant, water, fertilizers and manure analysis*. New India Publishing Agency.

5. Farm Power and Machinery 2(1+1)

Theroy

Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples. IC Engines: Basic principles of operation of compression, ignition and spark ignition engines, two stroke and four stroke engines, cooling and lubrication system, power transmission system, broad understanding of performance and efficiency, tractors, power tillers and their types and uses. Electric motors: types, construction and performance comparison. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of indigenous ploughs, improved indigenous ploughs, mould board ploughs, disc and rotary ploughs. Secondary tillage implements: construction and function of tillers, harrows, levelers, ridgers and bund formers. Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter. Grafting, pruning and training tools and equipment. Inter-culture equipment: sweep. Junior hoe, weeders, long handle weeders. Crop harvesting equipments: potato diggers, fruit pluckers, tapioca puller and hoists.

Practical

Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment, calculation of dilution ratio and operation.

Suggested Reading:

- T. P. Ojha and A.M.Michael. 2005. *Principles of Agricultural Engineering* (Volume - 1), Jain Brothers
- Manoj Kumar Ghoshal and Dhirendra Kumar Das. 2008. *Farm Power*,Kalyani Publishers.

- Surendra Singh. 2007. *Farm Machinery Principles and Applications*. ICAR Publications
- Roth/Field. 1992. *Introduction to Agricultural Engineering - Problem Solving Approaches,* 2nd. Edition. CBS publishers & distributors Pvt. Ltd.
- Surendra Singh & Verma. 2009. *Farm Machinery Maintenance & Management*. ICAR Publication.
- M.M. Pandey & Others. 2012. *Handbook of Agricultural Engineering*. ICAR publication
- Jagadishwar Sahay.1992. *Elementsof Agricultural Engineering*. AgroBookAgency,Patna.
- Michal AM and Ojha TP.1993.*VolI. Principles of Agricultural Engineering.*Jain Brothers,New Delhi.
- Kepner RARoy Bainerand Barger BL.1978. *Principles of Farm Machinery*. CBS Publisherand Distributors, Delhi.
- JainS C. 2003. *Farm Machinery-Anapproach.* Standard Publishers and Distributors, New Delhi
- Nakra, C.P.1986. *Farm Machinery and Equipment*. Dhanpat Raiand Sons, New Delhi
- Klenin, N.I.Popov, I.F.and Sakun,V.A.1985. *Agricultural Machines*. Amerind publishing Co. Pvt. Ltd., New Delhi.

6. Water Management in Horticultural Crops 2(1+1)

Theroy

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

Practical

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different, methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices.

Suggested Reading:

- Rao, Y.P. and Bhaskar, S.R. 2008. *Irrigation Technology. Theory and practice*. Agrotech publishing Academy, Udaipur.

- Dilip Kumar Mujmdar. 2004. *Irrigation Water Management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.,
- S.V. Patil & Rajakumar, G. R., 2016. *Water Management in Agriculture and Horticultural Crops*. Satish serial publishing House, Delhi.
- Carr M. K. V. and Elias Fereres. 2012. *Advances in Irrigation Agronomy*. Cambridge University Press.
- Michael, A.M. 2015. *Irrigation Theory and Practices*. Vikas publishing house Pvt., Ltd.

7. Organic Farming 3(2+1)

Theroy

Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports.

Practical

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, postharvest management.

Suggested Reading:

- A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
- Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
- S.P. Palaniappan and K.Annadurai. 2010. *Organic farming – Theory and Practice*. Scientific Publishers. Jodhpur.
- U.Thapa and P. Tripathy. 2006. *Organic farming in India- Problems and Prospects*. Agrotech publishing agency, Udaipur.
- G.K.Veeresh. 2006. *Organic farming*. Foundation Books. New Delhi.
- Purshit, S.S. 2006. *Trendsin Organic Farmingin India*. Agros Bios (INDIA), Jodhpur.
- Thampan, P. K. 1995. *Organic Agriculture*. Peckay tree Crops Development Foundation, Cochin, Kerala.
- Sathe, T.V.2004. *Vermiculture and Organic Farming*. Days Publishing House, New Delhi.

8. Agro-meteorology and Climate Change 2(1+1)

Theroy

Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought, weather disasters and their management atmospheric pollution and role

of meteorology. Basics of weather forecasting. Climate change-causes. Global warming-causes and remote sensing. Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases. Atmospheric chemistry. Plants sense and respond to changes in CO2 concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C3 and C4 species. plant development affected by growth in elevated CO2. Physiology of rising CO2 on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO2. Change in secondary metabolites and pest disease reaction of plants. The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

Practical

Site selection for Agromet observatory; Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine duration and solar radiation; Measurement of wind direction and speed and relative humidity; Study of weather forecasting and synoptic charts. Visit to Meteorological observatory, Visit to IMD meteorological observatory-Lay out plan of standard meteorological observatory. Recording of air and soil temperature. Measurement of radiation and components, Measurement of rainfall-different types of raingauges, Measurement of wind speed and direction and atmospheric humidity, Recording of evaporation. Synoptic charts and weather reports, symbols, *etc*.

Suggested Reading:

- A. K. Srivastava and P. K. Tyagi, 2011. *Practical Agricultural Meteorology*. New Delhi Publishing Agency, New Delhi.
- D.Lenka, 2006. *Climate, Weather and Crops in India*. Kalyani Publishers, New Delhi.
- G. S. L. H. V. Prasad Rao, 2008. *Agricultural Meteorology*. Prentice Hall of India Pvt. Ltd., New Delhi.
- H.S.Mavi and Graeme J. Tupper, 2005. *Agrometeorology – Principles and applications of climate studies in agriculture*. International Book Publishing Co., Lucknow.
- H.S.Mavi, 1994. *Introduction to Agrometeorology*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- H.V.Nanjappa and B.K.Ramachandrappa, 2007. *Manual on Practical Agricultural Meteorology*. Agrobios India. Jodhpur.
- S.R.Reddy, 1999. *Principles of Agronomy*. Kalyani Publishers, New Delhi.
- T.Yellamanda Reddy and G.H.Sankara Reddi, 2010. *Principles of Agronomy*. Kalyani Publishers, New Delhi.
- Pattersen, S.1958. *Introductionto Meteorology*. Mc. Graw Hill Book Co. Inc., New York

- Tailor, J.T.1967. *AgriculturalClimatology*. Pergman Press Ltd., Headington Hill Hall, Oxford, England
- Trewarthe,T.G.1968. *AnIntroductiontoClimate*.McGrawHillBookCo.Inc.,New York.
- Mavi,H.S.1985. *IntroductiontoAgrometeorology*. Oxford&IBHPublishingCo.,New Delhi.

9. Introductory Agro-forestry 2(1+1)

Theroy

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Status of Indian forests and role in India farming systems. Agroforestry system, sub-system and practice: agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry. Agroforestry projects – national, overseas, MPTS – their management practices, economics of cultivation – nursery and planting (*Acacia catechu*, *Dalbergiasissoo*, Tectona, Populus, Morus, Grewia, Eucalyptus, Quercus spp. and bamboo, tamarind, neem etc.).

Practical

Identification and seeds and seedlings of multipurpose tree species. Nursery practices for poplar, Grewiaoptiva, Morus alba, Acacia catechu, *Dalbergiasissoo*, robinia, leucaena etc. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages. Economics and marketing of products raised in agro-forestry systems.

Suggested Readings:

- A. K. Patra, 2013. *Agroforestry – Principles and Practices*. New India publishing agency.
- A. P. Dwivedi, 1992. *Agroforestry – Principles and Practices*. Oxfird and IBH Publishing company.
- Dadhwal et al., 2014. *Practical Manual on Agroforestry.* Jaya publishing house, Delhi.
- L.K. Jha, 2015. *Advances in Agroforestry*. APH Publishing corporation, New Delhi.
- Linford, Jenny, 2007. *A Concise Guide to Trees*. Parragon books service limited, Parragon.
- Negi, S.S., 2007. *Agroforestry Hand book*. International book distributer, New Delhi.
- P.S. Pathak and Ram Newaj, 2010. *Agroforestry – Potentials and Opportunities.* Agrobios, Jodhpur
- Pankaj Panwar & Sunil Puri, 2007. *Agroforestry: Systems & Practices.* New India publishing agency, New Delhi.
- Ramesh Umrani and C.K. Jain, 2010. *Agroforestry – Systems & Practices*. ABD Publishers, New Delhi.

- Ramachandran Nair, P.K. 1993. *AnIntroductionto Agroforestry*. First reprint in India–2008. Springer International Edition
- Tejawani, K.G. 1994. *Agro forestry in India*. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi
- Luna, R.K. 1989. *Plantation forestry in India*. International Book Distributors, Dehradun.
- Leda Satish. 2006. *Biodiesel and Jatropha Plantations*. AGROBIOS, Jodhpur.
- Chaturvedi, A.N. and Khanna, L.S. 1982. *Forest Menstruation*. Reprinted in 2006. International Book Distributors, Dehradun
- Negi,S.S.2006. *Forest Tree Seed*. Prashant Gahlotat Valley printers and publishers, Dehradun.
- Chundawat and S K Gautam.1996. *A text book of Agroforestry*. Oxford and IBH Publishing company Pvt. Ltd.

10. Introduction to Major Field Crops 2(1+1)

Theroy

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals, pulses, oil seeds and fodder crops, green manuring, crop rotation.

Practical

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

Suggested Reading:

- B. Gurarajan, R.Balasubramanian and V.Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
- Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH
- Publishing Co. Pvt. Ltd., New Delhi.
- Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
- Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICAR Publication.
- S.R.Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
- S.S.Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
- UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.
- Chidda Singh 1983. Modern Techniques of raising Field crops.Oxford & IBH, Publishing Co., New Delhi
- Rajendra Prasad 2002. Text Book of Field crops Production,ICAR, New Delhi.
- Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
- Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South
- Asian Publishers, New Delhi.

VII. BASIC SCIENCES

1. Elementary Statistics and Computer Application 3(2+1)

Theroy

Introduction to statistics, limitations of statistics. Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles, for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poison and normal distributions, sampling, basic concepts, sampling vs. complete enumeration parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of Significance: Basic concepts, tests for equality of means, and independent and paired t-tests, chi-square test for application of attributes and test for goodness of fit of Mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient. Experimental designs: Basic concepts, completely randomized design, randomized block design, latin square designs, factorial experiments, basic concepts, analysis of factorial experiments up to 3 factors – split plot design, strip plot design, long term experiments, plot size, guard rows. Computer application: Introduction to computers and personal computers, basic concepts, operating system, DOS and Windows, MS Word- Features of word processing, creating document and tables and printing of document, MS Excel-Concept of electronic spreadsheet, creating, editing and saving of spreadsheet, inbuilt statistical functions and formula bar, MS Power point-preparation, presentation of slides and slide show. Introduction to programming languages, BASIC language, concepts, basic and programming techniques, MS Office, Win Word, Excel, Power point, introduction to multi-media and its application. Visual basic-concepts, basic and programming techniques, introduction to internet.

Practical

Construction of frequency distribution table and its graphical representation, histogram, frequency polygon, frequency curve, bar chart, simple, multiple, component and percentage bar charts, pie chart, mean, mode for row and grouped data, percentiles, quadrille, and median for row and grouped data, coefficient of variation, 't' test for independent, will equal and unequal variants, paired 't' test, chi-square test for contingency tables and theoretical ratios, correlation and linear regression. Studies on computer components – Basic language, visual basic, programming techniques, MS Office, Excel, power point.

Suggested Reading:

- Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan chand and sons. New Delhi
- Nageswara Rao, G. 2007.*Statistics for Agricultural Sciences*. B.S. Publications,Hyderabad.

- Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad.
- Gupta, V.,2002. *ComdexComputerKit*. DreamTechPress,NewDelhi.
- Parmar, A. Mathur, N. DeeptiP .U. and Prasanna,V. B.,2000. *WorkingwithWINDOWS A Handson Tutorials*. Tata Mc Graw Hill Publishing Co., New Delhi.
- Bandari, V. B., 2012. *Fundamentals of Information Technology*. Pearson Education, New Delhi.
- Fundamentals of Computers. 2011. Pearson Education-ITL ESL, New Delhi,

2. Elementary Plant Biochemistry 2(1+1)

Theroy

Carbohydrates: Occurrence, classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation. Lipids: Classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance. Plant pigments – structure and function of chlorophyll and carotenoids, sterols, basic structure, role of brassino sterols in plants. Proteins: Classification, function and solubility, amino acids – classification and structure, essential amino acids, properties of amino acids, colour reactions, amphoteric nature and isomerism; structure of proteins –primary, secondary tertiary and quaternary properties and reaction of proteins. Enzymes: Classification and mechanism of action; factors affecting enzyme action, co-factors and coenzymes. Vitamins and minerals as co-enzymes/ co-factors. Carbohydrate metabolism – glycolysis and TCA-cycle; metabolism of lipids, fatty acid oxidation, biosynthesis of fatty acids, electron transport chain, bioenergetics of glucose and fatty acids, structure and function of nucleic acid replication, transcription and translation.

Practical

Preparation of standard solutions and reagents; Carbohydrates: Qualitative reactions; Estimation of starch; Estimation of reducing and non reducing sugars from fruits; Amino acids: Reactions of amino acids; Proteins: Estimation of proteins by Lowry's method; Fatty acids: Estimation of free fatty acids; Determination of iodine number of vegetable oils; Vitamins: Estimation of Ascorbic acid; Techniques: Paper chromatography, Thin layer chromatography; Electrophoresis of pigments extracted from flowers, Extraction of oil from oil seeds; Enzymes: Enzyme assay, Enzyme Immobilization.

Suggested Reading:

- Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry.* Freeman Publishers
- Narayanan L M. Biochemistry. Saras Publications
- Bose. Developments in Physiology Biochemistry & Molecular Biology of Plants Vol.-1. New India Publications.

- Voet, D and Voet J. G. 2004. Biochemistry 4th Edn. Wiley & sons Publishers. USA.
- Sadashiv, S and Manickam, A. 1996. Biochemical methods for Agricultural sciences. New age Interantional publishers, New Delhi.
- Voet, D. and Voet, J.G. 2004. (3rd edit). Biochemistry. John Wiley & sons Incl.USA.
- Rameshwar, A. 2006. (3rd edit). Practical Biochemistry. Kalyani Publishers, NewDelhi.
- Buchanan, B. B., Gruissem, W. and Jones, R. L. 2002. Biochemistry and molecular biology of plants. 2nd edition. Blackwell publications, UK.

3. Elementary Plant Biotechnology 2(1+1)

Theroy

Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of In-vitro cultures, Micropropagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples, Nano toxicology and safety.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoricsis techniques. Green synthesis of nano particles and their size characterization.

Suggested Reading:

- Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
- Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co., Meerut.
- Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, inc. USA.
- Gautam V K, 2005. *Agricultural Biotechnology*. Sublime Publications
- Thomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. *Molecular markers and Plant*

Biotechnology, New Publishers, New Delhi.
- Purohit, S.S., 2004. *A Laboratory Manual of Plant Biotechnology* 2nd Edn. Agribios, India.
- Singh, B.D. 2012. *Plant Biotechnology*. Kalyani publishers, Ludhiana
- Bilgrami, K.S. and Pandey, A.K.1992. *Introduction to Biotechnology*. CBS Pub. New Delhi
- Gupta, P.K. 1994. *Elements of Biotechnology*. Rastogi Pub. Meerut.
- Chahal, G.S. and Gosal, S.S.2003. *Principles and Procedures of Plant Approaches Breeding Biotechnological and Conventional*. Narosa Publishing House, New Delhi

4. Introductory Crop Physiology 2(1+1)

Theroy

Water Relations in Plants: Role of water in plant metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Biological Nitrogen Fixation Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO_2 fixation – C3, C4 and CA metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, Secondary metabolites and plant defense.

Practical

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

Suggested Reading:

- Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.
- Taiz, L. 2010.Plant Physiology. SINAUR. USA.
- Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.
- Edward E. Durna. 2014. Principles Of Horticultural Physiology. CABI, UK.
- Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.
- Richard, N. Arteca. 2004. Plant Growth Substances. CBS. New Delhi.
- Jacobs, W. P. 1979. Plant Hormones And Plant Development. Cambridge Univ. London.
- Basra, A. S. 2004. Plant Growth Regulators in Agriculture & Horticulture. HAWARTH press. New York.
- Lincoln Taiz and Eduards Zeiger (5th Edition). Plant physiology
- Noggle G.R and Fritz T.G. Introductory Plant Physiology
- Pandey and Sinha. Plant Physiology
- Salisbury and Ross. Plant Physiology

- Carl fedtke. Biochemistry and Physiology of Herbicide Action
- Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation
- Horst Marschner, Mineral Nutrition of Higher plants

5. Growth and Development of Horticultural Crops 2(1+1)

Theroy

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

Suggested Reading:

- Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.
- Taiz, L. 2010.Plant Physiology. SINAUR. USA.
- Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.
- Edward E. Durna. 2014. Principles of Horticultural Physiology. CABI, UK.
- Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.
- Richard, N. Arteca. 2004. Plant Growth Substances. CBS. New Delhi.
- Jacobs, W. P. 1979. Plant Hormones And Plant Development. Cambridge Univ. London.
- Basra, A. S. 2004. Plant Growth Regulators In Agriculture & Horticulture. HAWARTH press. New York.
- Lincoln Taiz and Eduards Zeiger (5th Edition). Plant physiology. Sinauer Associates, Inc.
- Noggle G.R and Fritz T.G.1944. Introductory Plant Physiology.
- Pandey and Sinha. Plant Physiology.

- JKA Bleasdale, Plant Physiology in relation to Horticulture
- Amarjit Basra, Plant Growth Regulators in Agriculture and Horticulture: Their role & Commercial Uses
- C.Rajendran, K.Ramamoorthy and S. Juliet Hepziba, Nutritional and Physiological
- Disorders in Crop Plants

6. Introductory Microbiology 2(1+1)

Theroy

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelia growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association. Sterilization methods – Physical and chemical, Isolation of pure cultures and preservation of cultures, Plant growth promoting microorganisms and mushrooms – Economical importance, Industrially important microorganisms in large scale production and common microbial fermentations. Mushrooms- edible and poisonous types, nutritive values, Culturing and production techniques.

Practical

Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plats, turbid metric estimation of microbial growth, mushroom culture- Spawn production, Culture and production techniques, harvesting, packing and storage.

Suggested Reading:

- M T Madigan, and J M Martinko, 2014. *Brock Biology of Microorganisms* 14th Edn. Pearson.
- M J Pelczer, 1998. *Microbiology* 5th Edn. Tata Mc. Grow Hill Education Pvt. Ltd.
- Stainer, R, 1987. *General Microbiology*. Palgrave Macmillan.
- Edward Alchano, 2002. *Introduction to Microbiology.* Jones and Bartlett hearing.
- R P Singh, 2007. *General Microbiology*. Kalyani Publishers.
- J Heritage, E G V Evans, R A Killington, 2008. *Introductory Microbiology*. Cambridge University press P. date.
- Pelczar, jr. M.J.E.C.S.Chan and Krieg, N.R. 1996. *Microbiology*. Mc Graw Hill Publishers, Newyork.
- Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. *Microbiology*. Mc Graw Hill Publishers, Newyork.
- Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. *Biology of Microorganisms*. Prentice Hall of India Pvt. Ltd., New Delhi.

- Jamaluddin, M. Malvidya, N. and Sharma, A. 2006. *General Microbiology*. Scientific Publishers, Washington.
- Sullia, S.B, and Shantaram 1998. *General Microbiology*. Oxford and IBH.

VIII. SOCIAL SCIENCES

1. Economics and Marketing 3(2+1)

Theroy

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engil's law of family expenditure – consumer's surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization – merits and demerits. Laws or return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures. Marketing- definition – Marketing Process – Need for marketing – Role of marketing –– Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

Suggested Reading

- H L Ahuja. S. Chand and Company Limited. *Advanced Economic Theory*. Micro Economic Analysis.
- Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.
- Dewett, K.K. and Chand, A.1979. *Modern Economic Theory*. S.Chand and Co., New Delhi
- Dewett, K.K. and Varma, J.D. 1986. Elementary Economics. S.Chand and Co., New Delhi.
- Gupta RD & Lekhi RK. 1982. Elementary Economic Theory. Kalyani Publishers.
- Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.
- Jhingan, M.L. 2012. Macro Economic Theory. Vrinda publishers, New Delhi .
- Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.
- SS Acharya and N L Agarwal. 2005. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd

- Sampat Mukherjee. 2002. *Modern Economic Theory*. New Age International.
- Subba Reddy, S., Raghu ram, P., Neelakanta Sastry T.V., Bhavani Devi. I., 2010, *Agricultural Economics*, Oxford & IBH Publishing Co. Private Limited, New Delhi
- Willium J. Stanton. 1984. *Fundamentals of Marketing*. Tata McGraw-Hill Publication, New Delhi.
- C.N. Sontakki. Marketing Management. Kalyani Publishers, New Delhi.
- John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. International Business, 15th Ed., Pearson Education
- Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi
- Fransis Cherunilam. International Business: Text and Cases, 5th Ed. PHI Learning, New Delhi.
- Prasanna Chandra. Projects. Tata McGraw-Hill Pu blication, New Delhi
- John M. Nicholas. *Project Management for Business and Technology* – Principles and Practices. Pearson Prentice Hall
- Harold Kerzner. Project Management – A System Approach to Planning, Scheduling, *and Controlling.* CBS Publishers & Distributors.
- Prasanna Chandra. *Projects – Planning, Analysis, Selection, Financing, Implementation, and Review.* Tata McGraw-Hill Publishing Company Ltd.
- P. Gopalakrishnan and V.E. Rama Moorthy. *Textbook of Project Management*. Macmillan.

2. Horti-Business Management 2(2+0)

Theroy

Farm management - definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concepts, curves and functions – factors, product, relationship – factors relationship, product relationship, optimum conditions, principles of opportunity cost-equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and rations, capital budgeting. Project management – project preparation evaluation measures.

Suggested Reading

- Heady Earl O and Herald R. Jenson,1954, *Farm Management Economics*. Prentice Hall, New Delhi
- S.S. Johl, J.R. Kapur ,2006, *Fundamentals of Farm Business Management*.
- Kalyani Publishers, New Delhi
- Karan Singh and Kahlon A S. *Economics of Farm Management in India*. Theory and Practice. New Delhi. Allied
- L.M. Prasad. 2001. *Principles and Practices of Management*, 9th Ed. S. Chand & Sons, New Delhi.
- Koontz Harold. *Principles of Managemen*t. Tata McGraw-Hill Education Private Limited, New Delhi.
- P.C. *Thomas. Managerial Economics*, 9th Ed. Kalyani Publishers.
- K.K. Dewett and M.H. Navalur. *Modern Economic Theory*. S. Chand & Sons, New Delhi.
- P. Subba Rao. *Human Resource Management*. Himalaya Publications.
- S.P. Jain. *Financial Accounting*. Kalyani Publications, Ludhiana.
- Shapiro E. *Macroeconomic analysis*. Galgotia Publications Delhi
- Barry P J, Hopkins J A and Baker C B. *Financial Management in Agriculture*, 6th ed. Danville, IL Interstate Publishers.
- Gittiner, J P., *Economic analysis of agricultural projects*. The John Hopkins University Press Baltimore, USA, 1982
- Benjamin Mc Donald P 1985. *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK
- Pandey U K 1990. *An Introduction to Agricultural Finance* .Kalyani Publishers New Delhi.

3. Fundamentals of Extension Education 2(1+1)

Theroy

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Horticulture extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in Horticulture programmes. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Adoption and diffusion process, Teaching and learning-concepts and principles, Teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. ICT in Extension education, ICT use in rural India.

Practical

Visits to study structure, functions, linkages and extension programmes of ICFRE institutes/ voluntary organizations/Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension programmes. Preparation of Village Agricultural productions plan.

Suggested Reading:

- Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
- Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
- Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship And Communication Skills*, Kalyani Publications.
- Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
- Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.
- M. Hilaris. Indian Agriculture and Information: Soundari, New century Publications, 2011and communication technology (ICT)

4. Entrepreneurship Development and Business Management 2(1+1)

Theroy

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export

and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Supply chain management and total quality management. Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business. Communication Skills: meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills developing organizational and managerial skills, problem solving skills. field diary and lab record; indexing, footnote and bibliographic procedures.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; Conducting market survey to the demand for product, preparing advertisements for popularization of product, news writing, preparing project proposals, individual, group presentation, features of oral presentation, presentation, evaluation of presentation and evaluation of sheet, dyadic communication-face to face conversation, telephone conversation, rate of speech and clarity of voice, speaking and listening politeness, telephone etiquettes, organising general and group meeting, salient features of participation in seminars and conferences, conducting and participating in mock interviews.

Suggested Reading:

- Benjamin MC Donald P. 1985, *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK.
- Chole, R. R. *et al.*, 2012, *Entrepreneurship Development and Communication skills*, Scientific publishers, Jodhpur.
- Gittiner, J P., 1982, *Economic Analysis of Agricultural Projects*, The John Hopkins University Press Baltimore, USA.
- Hopkins J A and Baker C B Danville, *Financial Management in Agriculture*, 6th ed Barry P J, IL Interstate Publishers.
- Kotler Philip and Armstrong, *Principles of Marketing*. Prentice-Hall.
- Pandey U. K., *An Introduction to Agricultural Finance.*
- Sagar Mondal and G. L. Ray, *Text Book on Rural Development, Entrepreneurship and Communication Skills,* Kalyani Publications.
- Somani, L. L., *Extension Education and Communication*, Agrotech, Publishing Academy, Udaipur.
- Dr.A.K.Singh,2009.Entrepreneurship Development and Management. Lakshmi Publications Ltd.,
- S. Anil Kumar, S.C Poornima, M.K. Abhraham and K. Jayashree, 2008; Entrepreneurship Development. New Age International Publishers

5. Communication Skills and Personality Development 2(1+1)

Theroy

Structural Grammar: Introduction of Word Classes; Structure of Verb in English; Uses of Tenses; Study of Voice; Study of Conjunctions and Prepositions; Sentence Patterns in English. Spoken English: Conversations of different situations in everyday life; the concept of stress; stress shift in words and sentences; silent letters in words and pronunciation of words with silent letters, the basic intonation patterns. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Structural Grammar: Exercises in word classes, identification and study of verbs in sentences, application of tenses and voice, exercises in conjunctions and prepositions, other structural grammar exercises, report writing, letter writing (different types of letters). Spoken English: Conversations of everyday life, the concept of stress; stress shift. Silent letters in words, basic intonation patterns, preparing and address.

Suggested Reading:

- Balasubramanian T. 1989. *A Text book of Phonetics for Indian Students*. Orient Longman, New Delhi.
- Balasubrmanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.
- Naterop, Jean, B. and Rod Revell. 1997. *Telephoning in English*. Cambridge University Press, Cambridge.
- Mohan Krishna and Meera Banerjee. 1990. *Developing Communication Skills*. Macmillan India Ltd. New Delhi.
- Krishnaswamy,. N and Sriraman, T. 1995. *Current English for Colleges*. Macmillan India Ltd. Madras.
- Narayanaswamy V R. 1979. *Strengthen your writing*. Orient Longman, New Delhi.
- Sharma R C and Krishna Mohan. 1978. *Business Correspondence*. Tata Mc Graw Hill publishing Company, New Delhi.
- Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.
- Covey Stephen R. 1989. *The Seven Habits of Highly Successful People*. Free Press.
- Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.
- Verma, KC. 2013. *The Art of Communication*. Kalpaz.
- Dr. T. Bharati, Dr. M. Hariprasad and Pro. V. Prakasam, Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi.
- Wren and Martin, S. Key to High School English Grammar and Composition- Chand and Company Ltd., New Delhi
- Wren and Martin, S. High School English Grammar and Composition- Chand and Company Ltd., New Delhi

- Raymond Murphy, English Grammar in Use. Cambridge University Press
- The Official Guide to the TOEFL Test-IV Edition, Educational Testing Services. Mc Graw Hill, New Delhi.
- Balasubramanyam,M.1985.Businesscommunication. VaniEducationalBooksAnsariroad,New Delhi.
- KrishnaMohanandMeeraBanerjee1990.DevelopingCommunicationSkills. Mac Millan IndiaLtd.

6. Information and Communication Technology 2(1+1)

Theroy

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of AV aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practical

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Suggested Readings

- Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology.* Kalyani Publishers.
- Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.
- Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt Ltd.
- Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI.

7. Physical and Health Education (NC) 1(0+1)

Practical

Physical Education: Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules are regulations of important games, skill development in any one of the games – football, hockey, cricket, volleyball, ball badminton, throw ball, tennikoit. Participation in one of the indoor games

– shuttle badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events – broad jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-today activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience. Importance of Asanas and Surya namaskar. Free hand exercises and Yoga. Recreation: definition, agencies promoting recreation, camping and recreation. Note: Warming up and conditioning exercises are compulsory before the commencement of each class.

Suggested Reading:

- O.P. Aneja. Encyclopaedia of Physical education, sports and exercise science (4 volumes).
- Anil Sharma. Encyclopaedia of Health and Physical Education (7 Volumes).
- N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).
- Pintu Modak, O P Sharma, Deepak Jain. Encyclopaedia of Sports and Games with latest rules and regulations (8 volumes).
- Edwin F Bryant. Yoga sutrap of Patanjali.

8. National Service Scheme/National Cadet Corps (NC) 1(0+1)

Practical

NSS: Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, non-formal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition. NCC: Introduction to NCC, defense services, system of NCCtraining, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill, weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self-defense, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defense, leadership and NCC song.

IX. STUDENT READY-PROGRAMME (ELP+RHWE) 40(0+40)

Practical

Students will practically gain hands on expertise for a semester in any two options out of commercial horticulture, protective cultivation of high value horticulture crops, processing of fruits and vegetables for value addition, floriculture and landscape gardening, production of bioinputs-biofertilizers and biopesticides, mass multiplication of plants and bio-molecules through

tissue culture, mushroom culture and bee keeping. In one semester students will be working with horticulture farmers/horticulture based industries in collaboration with developmental departments, extension functionaries, input suppliers, marketing and procurement functionaries, processing industries.

1) EXPERIENTIAL LEARNING PROGRAMME (ELP) 20(0+20)

1. **Module-I. Commercial Horticulture**: Nursery production of fruit crops: Raising of rootstocks, grafting and budding of rootstocks, management of grafted plants, plant certification, packaging and marketing, quality control. Nursery production of ornamentals: Production of plantlets, production of potted plants, management and maintenance, sale and marketing. Protected cultivation of vegetables and flowers: Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing.
2. **Module-II. Protective cultivation of high value horticulture crops**: Visit to commercial polyhouses, Project preparation and planning. Specialised lectures by commercial export house. Study of designs of green- house structures for cultivation of crops. Land preparation and soil treatment. Planting and production: Visit to export houses; Market intelligence; Marketing of produce; cost analysis; Visit to export houses; Market intelligence; Marketing of produce; cost analysis; institutional management. Report writing and viva-voce.
3. **Module-III. Processing of fruits and vegetables for value addition**: Planning and execution of a market survey, preparation of processing schedule, preparation of project module based on market information, calculation of capital costs, source of finance, assessment of working capital requirements and other financial aspects, identification of sources for procurement of raw material, production and quality analysis of fruits and vegetables products at commercial scale, packaging, labelling, pricing and marketing of product.
4. **Module-IV. Floriculture and landscape gardening**: Preparation of project report, soil and water analysis, preparation of land and layout. Production and Management of commercial flowers. Harvesting and postharvest handling of produce. Marketing of produce, Cost Analysis, Institutional Management, Visit to Flower growing areas and Export House, Attachment with private landscape agencies. Planning and designing, site analysis, selection and use of plant material for landscaping. Formal and informal garden, features, styles, principles and elements of landscaping. Preparation of landscape plans of home gardens, farm complexes, public parks, institutions, high ways, dams and avenues. Making of lawns, use of software in landscape. Making of bouquets, button hole, wreath, veni and gazaras, car and marriage palaces. Dry flower Technology (identification of suitable species, drying, packaging and forwarding techniques).
5. **Module-V. Bio-inputs: Bio-fertilizers and bio-pesticides**: Isolation and pure culture establishment of fertilisers and bio-pesticides. Culture methods and substrates. Scale of methods for bio-fertilizers and bio-pesticides. Substrate preparation and mixing techniques. Quality analysis of bio-fertilizers and bio-pesticides. Testing the final product in small scale level. Storage, marketing and cost analysis of bio-fertilizers and pesticides.

6. **Module-VI. Mass multiplication of plants and molecules through tissue culture**: Preparation of sock solutions of tissue culture media. Preparation of solid media and liquid media. Initiation of in vitro culture and multiplication (preparation of explant, inoculation and culturing) (crop to selected). Sub-culturing, Hardening and establishment, Initiation of callus cultures – suspension cultures, Induction of selected biomolecules in callus, Harvesting and extraction of biomolecule, Marketing and cost analysis.
7. **Module-VII. Mushroom culture**: Construction cultivation room/structure and Disinfection. Compost preparation & pasteurization. Procurement of mother culture and spawn preparation. Procurement of casing soil and preparation for production. Mushroom seeding, Casing with soil and maintenance, Harvesting, processing, Grading, packing, marketing and Cost economics of mushroom culture.
8. **Module-VIII. Bee keeping**: Procurement and arrangement of bee keeping equipments. Location and collection of potent nectar yielding bee flora seeds from wild. Raising/ enriching the high nectar yielding bee flora in the campus. Location and hiving the natural bee colony from the wild. Establishing the apiary with suitable/favourable necessaries. Maintenance and multiplication of hived colonies. Management of natural enemies and diseases of bees. Maintenance of bee colonies during dearth and honey flow seasons. Harvesting and Processing of honey and bee wax. Marketing and cost analysis.

2) RURAL HORTICULTURAL WORK EXPERIENCE PROGRAMME 20(0+20)

1. Placement in Industries (0+10)
2. Placement in Village (0+10)

Minimum Standards for Establishing a College of Horticulture

1. **Degree Nomenclature:** B.Sc. (Hons.) Horticulture
2. **Eligibility Criteria:** 10+2/intermediate with PCB, PCMB, PCM, PCForestry or Inter (Agriculture) (P- Physics, C-Chemistry, M-Mathematics, B-Biology), from recognised Board/university.
3. **Medium of Instruction:** English
4. **Minimum Intake:** 60 studentsper year
5. **Departments / Sections**
   1. Fruit Science
   2. Vegetable Science
   3. Floriculture and Landscape Architecture
   4. Postharvest Technology
   5. Plant Protection
   6. Basic Sciences
   7. Natural Resource Management
   8. Social Science

6. Faculty Requirements

Department	Faculty requirement			
	Prof.	Assoc. Prof	Asstt. Prof	Total
Department of Fruit Science (Breeding + Production)	1	2	3	6
Department of Vegetable science (Breeding + Production) + Seed Production/Seed Technology	1	1	4	6
Department of Floriculture and Landscape Architecture (Breeding + Production)	1	1	2	4
Department of Post Harvest Technology	1	1	2	4
Department of Plant protection Entomology +/ Nematology Plant pathology +/ Nematology	1	2	3	6
Department of Basic Sciences Biochemistry, Crop physiology, Biotechnology & genetics and plant breeding, Statistics, Computer science	1	2	6	9
Department of Natural Resource Management Soil Science & Agril. Chemistry, Microbiology, Water Tech centre (WTC), Environmental Science, Agricultural Engineering, Agro Forestry	1	1	6	8
Department of Social Science Agriculture Extension, Agriculture Economics, Agri/Horticulture Business Management, English, Physical Education, Library Science	1	1	5	7
Total	**8**	**11**	**31**	**50**

7. Administrative and Technical Requirements

Sl.No.	Non-teaching staff	Required
a)	Assistant Registrar/Administrative Officer	01
b)	Superintendent (Administration)	01
c)	Assistant Comptroller	01
d)	Assistant Engineer (Civil)	01
e)	Assistant Medical Officer	01
f)	Junior Engineer (Electrical)	01
g)	Lab Technician	01
h)	Library Assistant	02
i)	Lab Assistant	08
j)	Field assistant	08
k)	Shelf assistant	02
l)	Assistant-cum-Computer Operator	06
m)	Driver	06
n)	Tractor Driver	02
o)	Cook	04
p)	Care taker	03
q)	Plumber	01
r)	Electrician	01
s)	Bus helper	02
t)	Sports helper	02
u)	Gardener	06
v)	Janitor	02
w)	Office Attender	06
x)	Watchman	06
y)	Nurse (Female + Male)	02
	Total	**76**

8. Land requirement : 40 ha

9. Floor Space Civil Structures

College Main Building

Sr. No.	Details	No. of rooms	Dimensions (ft)
1	UG Class Rooms	05	70 students capacity
2	PG Class Rooms	12	(30 capacity)
	UG Labs	08	50 capacity with HOD and faculty chambers and store room attached
3	PG Labs	12	25capacity/separate lab/department where PG programme offered)
4	Seminar Hall	01	150 capacity
5	Examination Hall	01	150 capacity
6	Computer Laboratory	02	50 capacity (UG) + 25 capacity for (PG)
7	Central Instrumentation room	01 (only for PG)	40 x 40
8	Dean's Room and Office	02	20x24
9	PA's room		20x12
10	Mini Meeting Room	01 (attached to Dean Chamber)	20x48
11	Academic Unit	01	20x12
12	Administration Unit	01	20x12
13	Accounts unit	01	20x12
14	External Examination Unit	01	20x12
15	Student Welfare Unit	01	20x12
16	Days scholar lounge	02	1 for Boys and 1 for Girls
17	Placement / Counselling cell	01	20 x 12
18	Language Lab	01	20 x 20
19	General Store	01	20 x 12
20	Postharvest Technology Pilot plant	01	separate building shed for processing, value addition, packaging and dispatch

Library

Staff room (Assistant Librarian)	-	01
Stack room (borrowing)	-	01
Reference Hall / Journal section	-	01
Book bank	-	01
E-resource Centre	-	01
Photo-copying room	-	01
Reading Hall for students	-	01
Reading Hall for Staff - (Small)	-	01
Auditorium	-	01(optional 400 - 500 capacity)

Hostels and Guest House

UG Boys Hostel - 01: (150 capacity, 3 students per room) (Min. room size of 5m x 4m)

UG Girls Hostel - 01: (150 capacity, 3 students per room) (Min. room size of 5m x 4m)

PG Boys Hostel - 01: (50 capacity, Single bed) (Min. room size of 3m x 4m)

PG Girls Hostel - 01: (50 capacity, Single bed) (Min. room size of 3m x 4m)

International hostel - 01: (25 capacity, single bed room 25 for Ph.D. with Kitchen and Wash room attached) (Min. room size of 5m x 4m)

Vehicle parking sheds – 02: (Two wheeler) one each attached to Boys & Girls hostel

Farm / Orchard office

a. Farm Manager Office
b. Seed processing + Storage unit
c. Farm store
b. Threshing yard
e. Workers rest shed
f. Maintenance cell / Estate Branch
g. Implement Shed
h. Tractor Shed
i. Meteorological unit
j. Farm fencing

Vehicle parking shed (four & two wheeler + 2 buses)

Generator Shed / Battery Room

Guest Houses: 01 (10 VIP Suits + 20 Double bed rooms)

Farmers Training hostel (Men): 20 rooms with five beds each & attached bath room
Farm Women Hostel: 20 rooms with five beds each & attached bath room

Sports & Welfare

1. Four hundred meters track with pavilion & Gallery – 01
2. Courts - Volley ball - 02
   Basket ball - 02
   Kabbadi - 01
   Kho-Kho - 01
   Tennis - 01
3. Indoor games facilities
   Table tennis - 02 (each for boys and girls hostel)
   Shuttle badminton - 02 (each for boys and girls hostel)
   Gymnasium - 02 (each for boys and girls hostel)

4. Canteen - 02 (Staff + student)
5. Dispensary (10 beds) - 01
6. Stationery & Xerox point - 01
7. Bank & ATM - 01
8. Other utilities unit - 04 to 06

Research-cum-Instructional Farm

(Total area 40 ha/100 acres for UG additional 20 ha/50 acres for PG)

1. Crop Museum - Tech Demo Plot unit
2. Botanical Garden - 04 ha (Germplasm Centre cum Mother plant block)
3. Nursery - Polyhouses (6), shade houses (6), Glass house (2), Potting shed (2), Scion banks of important crops (1), Root stock block (1)
4. Structures of- Naturally ventilated - single span, multi span, medium, cost, various types high cost, and climate control structure with fan and pad system.
5. Bio-agents production units - 02
6. IFS model - 01
7. Experiential Learning Modules - 04
8. Composting unit and vermicomposting - 04

Irrigation, Water harvesting facilities

1. Bore wells / Lift Irrigation / Water treatment plant
2. Farm pond and watershed unit/ Heavy duty system RO & storage units – 02
3. Over head tank
4. Ground water sump
5. Irrigation network to farm
6. Roof water harvesting facility and collection pond/tank
7. Spent water treatment units, incinerator
8. Hydrological field lab
9. Drip/Sprinkler irrigation system

Farm Machinery

1. Tractors - 02
2. Tractor drawn water tank, trailer and other tractor bound land preparation, spraying, harvesting, Equipment, with a workshop - 01 Set
3. Power tiller - 02
4. Mini Tractor - 01
5. Power shears - 02
6. Weed cutter - 01
7. Laser leveler - 01

Mobility

10. Bus (60 seater) - 01
11. Minibus (40 seater) - 01
12. Car - 01
13. Jeep - 01
14. Multipurpose utility van - 01
15. Motor Cycle - 02

10. Laboratory Equipment

a) Equipments for UG laboratory

Sl. No.	Particulars	Quantity
1.	Weigh balance (0.001g)	8
2.	Weigh balance (0.01g)	8
3.	Weigh balance (0.1g)	8
4.	Weigh balance (60g)	2
5.	Single distillation unit	6
6.	pH meter	8
7.	EC Bridge	8
8.	Digital refractrometer	3
9.	Digital varnier calipers	2
10.	Compound microscope	25
11.	Hot air over	10
12.	Magnetic stirrer (liter)	8
13.	Micro oven (25 lt)	8
14.	Refrigerator (320 lt)	8
15.	Water bath with shaker (20 lt)	8
16.	Power pack - small	2
17.	Horizontal gel unit – medium	2
18.	Digital thermometer and hygrometer	8
19.	Liquid nitrogen container – 7 lt	4
20.	Air conditioner – 2 tone	8
21.	Online UPS – 10 volts	8
22.	Digital camera – 14m pix	8
23.	vortex	8
24.	Hot plate – 5 lt	8

Sl. No.	Particulars	Quantity
25.	Seed analyzer	1
26.	Seed coating machine	1
	Total	**178**

b) Equipments for centralized laboratory

Sl. No.	Particulars	Quantity
1.	Seed germinator	2
2.	Electrical conductivity	1
3.	Double distillation unit	5
4.	Lab microscope	3
5.	Stereo zoom microscope	2
6.	Fluorescent microscope	1
7.	Orbital shatter (8500ml conical flask cap)	4
8.	UV vis spectrophotometer	2
9.	Refrigerated centrifuge	2
10.	Microtome	1
11.	Vertical gel unit (dual unit max)	3
12.	Micro pipette (10 1, 100 1, 1000 1, 5000 1)	3
13.	BOD incubators	4
14.	Laminar air flow chamber	2
15.	Deep freezer vertical (-20oC, 275 lt)	4
16.	Autoclave (vertical) 250 lt	3
17.	Nitrogen distillation unit	2
18.	Fib estimation unit	2
19.	Flame ohoto meter	2
20.	Ultra pure water purification system	2
21.	Thermocycler unit	2
22.	Gel documentation unit	2
23.	Air conditioner – 2 tone	3
24.	Online UPS – 10 volts	2
25.	Growth chamber	2
26.	SPAD	2
27.	Chromatographic system (TLC HPLC)	1
28.	Colour meter	1

Sl. No.	Particulars	Quantity
29.	Texture analyzer	1
30.	Company analyzer	1
31.	Leaf area meter	1
32.	AAS	1
33.	Cultured trollies – 4	4
34.	Visco meter	1
35.	Cold store cum ripening chamber	1
36.	Water activity meter	1
	Total	**76**

c) Laboratory equipment required for PG

Sl. No.	Equipment	Quantity
1	Magnetic sterror	9
2	Vernier caliper (digital)	10
3	Refractometers (digital)	4
4	Pressure testers	4
5	Top pan balance	10
6	Humidifier	2
7	Plant press	8
8	Altimeter	4
9	Lux meter	4
10	Thermo hydrographs	8
11	Seed drier	2
12	Bee hives	20
13	Honey extractor with wax meter	2
14	Microscope with computer attachment	1
15	Tensio meter with digital sensors	24
16	Soil thermometers	24
17	Suction pump	2
18	Soil testing unitss	3
19	Oil extraction operators	2
20	Leaf scan meter	1
21	Root length scanner	1

Sl. No.	Equipment	Quantity
22	Silva compass	2
23	Clinometer	2
24	Range finder	1
25	fillescope	2.0
26	Digital planni meters	2
27	Increment stem boner – 12", 16", 20" and 25"	24
28	High limb chain saw	4
29	Wheeler penda	1
30	Abney's level	2
31	Wood moisture meter	1
32	Hot and cold press	1
33	Strength testing apparatus	1
34	Wood working machine	1
35	Wood grinder	1
36	Boiler	1
37	Hedge cutter	4
38	Gas liquid chrometaography	1
39	CO2 analyzer	1
40	Canopy analizer	1
41	Ultra centrifuge	1
42	Soil moisture pans	2
43	Cold rooms	2
44	Air curtain door	1
45	Aluminiumcallipers	10
46	Brine meter	1
47	Brine hydromer	1
48	Digital seed hunter	2
49	Digital pycnometer	1
50	Digital immerse tester/penetrometer	1
51	Cushocton silt sampler	1
52	GPS	1
53	Leet converter	5

Sl. No.	Equipment	Quantity
54	Hygrometer	1
55	Infra red thermometer	1
56	Moisture meter	1
57	Ozone generator	1
58	Psychrometer	1
59	Soil colour charts	2
60	Seed combined	5
61	Soxhletappatues	2
62	Surfuzing equipment	1
63	Viscocity meter	1
64	Turbidity meter	1
65	Water bath	3
66	Willing mill	2
67	Wind tunnel	1
68	Bomb calorimeter	1
69	Chlorophylll meter	1
70	cobousmeter	1
71	Work station	1
Total		**263**

d) Equipment for postharvest management lab

Sl. No.	Equipment	Quantity
1.	Walk in cool chamber	01
2.	Grading and packaging unit including shrink and vacuum packaging machine	-
3.	Bunch cutting machine / fruit harvesters	-
4.	Hydraulic fruit harvester	1
5.	Bunch tying machine	1
6.	Bundling machine for bunching	1
7.	Heat sealing machine	1
8.	Strapping machine for cartons	1
9.	Turgidity maching	1
10.	Refrigerated van	1

Sl. No.	Equipment	Quantity
11.	Ripening chamber	1
12.	Conditioning godown	1
13.	Pre cooling chamber	-
14.	Cooling chamber	-
15.	Zero energy cool chamber	-
16.	Seed germinator	-
17.	Freeze drier	1
Total		**11**

e) Equipment for fruits and vegetables processing and preservation lab

Sl. No.	Equipment	Quantity
A	**Measuring instruments**	
1	Weighing scale – platform type	1
2	Counter weight scale with pan indicator and weights	1
3	Jam boiling thermometer	2
4	Gelly thermometer	2
B	**Preparation, cutting, slicing, cubing, dicing equipment**	
1	Working table with stainless steel top	2
2	Stainless steel knives for cutting, coaring, pitting, peeling etc.	2 sets
3	Fruits / vegetable slicer (1HP)	1
4	Slicer with circular cutting knife	1
5	Fruits / vegetable slicer (0.5 HP)	1
6	Papaya cutter – 1 HP	1
7	Papaya slicer	1
8	Carrot slicer	1
9	Cherry peeler	1
10	Lemon or orange halving machine	1
11	Pineapple slicer – 2 HP	1
12	Pineapple coarer	5
13	Pineapple cutting knives	10
14	Dicing and cubing machine	1
15	Mango cutter	1

Sl. No.	Equipment	Quantity
16	Mushroom knives	10
17	Scooping knife	10
18	Lemon quartering machine	1
C	**Washing equipment**	
1.	Fruits and vegetables washer	1
2.	Rotary type fruits/vegetables washing machine	1
3.	Bottle washer	1
4.	Empty can washer and sterilizer (power type)	1
D	**Graders**	
1.	Fruit grader	1
2.	Pea grader (1.5hp)	1
E	**Dryer/Dehydrator**	
1.	Tray dryer (40 trays)	1
2.	Cabinet tray dryer (24 trays)	1
3.	Vegetable dryer	1
4.	Dryer/dehydrator/heater	1
5.	Drying oven	1
F	**Blanchers**	
1.	Blancher (0.5hp)	1
2.	Steam blancher	1
G	**Peelers/sheller**	
1.	Potato peeler (0.5hp)01	1
2.	Papaya peeler	1
3.	Lye peeler	1
4.	Pea sheller	1
H	**Kettler**	
1.	Steam jacketed kettle	1
2.	SS trays	10
I	**Grinders/pulverizer**	
1.	Mini pulverizer	1
2.	Orange peel shedding machine	1
J	**Juice extractor/fruit mills/pulpers**	
1.	Mini pulper (1hp)	1

Sl. No.	Equipment	Quantity
2.	Pulper (twin)/mango pulper	1
3.	Hydro extractor	1
4.	Oil type hydraulic juice press (power operated)	1
5.	Apple/fine apple/carrot juicer	1
6.	Fruit mill/custer	1
7.	Hand basnet press	2
8.	Hammer mill	1
9.	Apple/pear crusher	1
K	**Sterilizer/mixture/pasteurizers**	
1.	Juice pasteurizer	1
2.	homogenizer	1
3.	Storage and mixing	4
4.	Sterilization tony	1
L	**Canning equipment including canning retort/ pressure boxes, reforming unit, double seaming machine, hand cane seamer, cane opener lid embossing machine, steam checking gauge, vacuum tester, flame rectifier, etc. (complete set)**	
M	**Filling & packaging equipment**	
1.	Vacuum filling machine	1
2.	Crown corking machine	1
3.	Cup filling and reeling machine	1
4.	PP cap seeling machine	1
5.	Pouch filling and sealing machine	1
6.	Shrink packaging machine	1
N	**Miscellaneous**	
1.	Mixi	2
2.	Filter press (1hp)	1
3.	Steam generator/ mini boiler	1
4.	Pea pricking machine	1
5.	Roasting machine	1
6.	Pickle mixture	1
7.	centrifuge	1
8.	Straight line exhaust box	1
9.	Portable strimer	1
	Total	**120**

Campus shall be properly laid out depending on the location with proper Master plan.

1. With proper approach roads to various structures with street light (solar) facility for important roads.
2. All round the campus there shall be a proper fence or compound with tall growing trees to serve as wind break or shelter belts besides compound wall to ladies hostel.
3. Around main building and hostel building proper landscape gardening shall be established.
4. All along important roads, selected ornamental trees/useful trees shall be planted.
5. Each major department should have Research block of 4 hectare - Germplasm unit, evaluation/ trial block, Field laboratory, farm store etc.
6. Intercom network
7. Solar lighting
8. Solar water heating system
9. Underground electricity supply system (24 hrs line)
10. General security system/ office
11. All buildings with fire / electricity alarm and safety systems.
12. Proper storage systems and use of harmful chemicals insecticides and pesticides, etc.

SERICULTURE

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG nomenclature

i). UG degree: B.Sc. (Sericulture)

ii). PG degree: M.Sc. (Sericulture); Ph.D. (Sericulture)

Restructuring of UG programmes for increasedpractical and practice contents

Department-wise courses

Course No.	Title	Credit hours
I.	**Host Plant Production**	
	Core courses:	
1.	Cultivation of Host Plants of Silkworms	1+1
2.	Mulberry Production and Management	0+1
3.	Experimental Techniques in Sericultural Research	1+1
4.	Botany and Cytology of Host Plants of Silkworms	1+1
5.	Pests of Host Plants of Silkworms and their Management	1+1
6.	Diseases of Host Plants of Silkworms	1+1
	Associated courses:	
7.	Introductory Agriculture, Principles of Agronomy and Soil Management	2+1
8.	Water Management Including Micro Irrigation	1+1
9.	Agricultural Meteorology, Rainfed Agriculture and Watershed Management	1+1
10.	Farming Systems, Organic Farming and Sustainable Agriculture	2+1
11.	Agricultural Microbiology	1+1
12.	Applied Microbiology	1+1
13.	Fundamentals of Soil Science	2+1
14.	Soil Fertility and Nutrient Management	1+1

15.	Crop Physiology	2+1
16.	Farm Power, Renewable Energy, Surveying and Soil water Engineering	2+1
17.	Fundamentals of Plant Propagation and Nursery Management	1+1
18.	Dry land Horticulture	1+1
19.	Insect Morphology and Systematics	2+1
20.	Introduction to Apiculture	1+1
21.	Pests of Crops and Stored Products and Management	2+1
22.	Introductory Plant Pathology and Nematology	1+1
23.	Principles of Seed Science and Technology	2+1
24.	Introduction to Forestry	1+1
25.	Environmental Science and Agro-ecology	1+0
	Total	**56 (32+24)**
II.	**Sericulture Crop Improvement**	
	Core courses:	
1.	Genetics and Breeding of Host Plants of Silkworms	1+1
2.	Cytology and Genetics of Silkworms	2+1
3.	Silkworm Breeding	2+1
4.	Seri-Biotechnology	2+1
5.	Associated courses:	
6.	Plant Biotechnology	1+1
7.	Principles of Genetics	2+1
	Total	**16 (10+6)**
III.	**Cocoon Crop Production**	
	Core courses:	
1.	History, Development and Organization of Sericulture Industry	1+0
2.	Morphology and Systematics of Silkworm	1+1
3.	Silkworm Anatomy and Physiology	1+1
4.	Vanya Sericulture	2+1
5.	Mulberry Silkworm Rearing	2+1
6.	Bivoltine Sericulture	0+2
7.	Silkworm Seed Technology	2+1
8.	Commercial Silkworm Seed Production	0+1
9.	Diseases of Silkworms and Management	2+1

10.	Pests of Silkworms and Management	1+1
11.	Resource Generation and Management in Sericulture	0+1
12.	Entrepreneurship Development in Sericulture Crop Protection	0+1
	Total	**24 (12 + 12)**

IV.	**Silk Product Science**	
	Core courses:	
1.	Physics and Chemistry of Fibres	1+0
2.	Raw Silk Technology	2+1
3.	Planning and Management of Silk Reeling Industry	2+0
4.	Spun Silk Technology	0+1
5.	Silk Throwing, Dyeing and Weaving	0+2
6.	Apparels in Sericulture Industry	0+1
7.	Entrepreneurship Development in Sericulture	0+1
	Associated courses:	
8.	Management of Sericultural Machineries and Equipments	0+1
	Total	**12 (5 + 7)**
V.	**Basic Sciences and Humanities**	
1.	Fundamentals of Rural Sociology, Educational Psychology and Constitution of India	0+2
2.	Fundamentals of Extension and Rural Development	1+1
3.	Communication and Extension Methodology for Transfer of Technology	2+1
4.	Principles of Agricultural and Resource Economics	1+1
5.	Seri-business Management	1+1
6.	Agricultural Statistics	1+1
7.	Livestock and Fish Production Management	2+1
8.	Plant Biochemistry	1+1
9.	Introduction to Computers and Application	1+1
10.	Comprehension and Communicative English	1+1
11.	Physical Education, Health Education and Recreation	0+1*
12.	National Service Scheme	0+1*
	Total	**24 (11 + 13)**
	Grand Total	**132 (70 + 62)**

Note : * - Non- credit practical courses

STUDENT READY-Experiential Learning (ELP)+ RSWE

Course No.	Title	Credit hours
Experiental Learning Modules		
Module-I Host Plant Production		**0+20**
1.	Mulberry and Non-mulberry Host Plant Nursery Management	0+5
2.	Host Plants Production Technology For Mulberry and Non Mulberry	0+5
3.	Value Addition to Mulberry and Non-mulberry By-products	0+5
4.	Farm Mechanization	0+5
Module-II Cocoon Crop Production		**0+20**
1.	Seri Clinic	0+5
2.	Bivoltine Silkworm Rearing Technology	0+5
3.	Non-mulberry Silkworm Rearing Technology	0+5
4.	Value Addition to Grainage and Rearing By-products	0+5
Module-III Silk Product Science		**0+20**
1.	Raw Silk and Spun Silk Production Technology	0+5
2.	Entrepreneurship Development in Post Silk Technology	0+5
3.	Entrepreneurship Development in products technology	0+5
4.	Entrepreneurship Development in Silk Apparel Technology	0+5
Module-IV Natural Resources Management		**0+20**
1.	Soil Health Clinic	0+5
2.	Problematic Soils and their Management	0+5
3.	Integrated Farming Systems	0+5
4.	Water Management (Watershed, Micro-irrigation, Problematic Water)	0+5
STUDENT READY - Rural Work Experience Programme (Seri.) {RSWEP} (0+20)		
1.	Placement in Host plant production	0+4
2.	Placement in Grainage Technology	0+4
3.	Placement in Silk Product Technology	0+4
4.	Placement in Value Addition to Sericultural By-products	0+3
5.	Practical Extension Work in Villages	0+5

1. SEMESTER WISE COURSES

Semester – I

S.N.	Title of the Course	Credit Hours
1	Principles of Agricultural Resource Economics	1+1
2	Fundamentals of Rural Sociology, Educational Psychology and Constitution of India	0+2
3	Introductory Agriculture, Principles of Agronomy and Soil Management	2+1
4	Cultivation of Host Plants of Silkworms	1+1
5	Agricultural Microbiology	1+1
6	Plant Biochemistry	1+1
7	Comprehension and Communicative English	1+1
8	Introduction to Forestry	1+1
9	Fundamentals of Plant Propagation and Nursery Management	1+1
10	History, Development and Organization of Sericulture Industry	1+0
11	National Service Scheme *	0+1
12	Physical Education, Health Education and Recreation *	0+1
	Total	**10+12=22**

* Non -credit courses

Semester – II

S. N.	Title of the Course	Credit Hours
1	Crop Physiology	2+1
2	Mulberry Production and Management	0+1
3	Introduction to Computers and Application	1+1
4	Principles of Genetics	2+1
5	Water Management Including Micro- Irrigation	1+1
6	Morphology and Systematics of Silkworms	1+1
7	Fundamentals of Soil Science	2+1
8	Botany and Cytology of Host Plants of Silkworms	1+1
9	Insect Morphology and Systematics	2+1
	Total	**12+9=21**

Semester – III

S.N.	Title of the Course	Credit Hours
1	Introductory Plant Pathology and Nematology	1+1
2	Genetics and Breeding of Host Plants of Silkworms	1+1
3	Silkworm Anatomy and Physiology	1+1
4	Plant Biotechnology	1+1
5	Mulberry Silkworm Rearing	2+1
6	Environmental Science and Agro-Ecology	1+0
7	Physics and Chemistry of Fibres	1+0
8	Raw Silk Technology	2+1
9	Farm power, Renewable Energy, Surveying and Soil Water Engineering	2+1
10	Introduction to Apiculture	1+1
11	Pests of Silkworms & Management	1+1
	Total	**14+9=23**

Semester – IV

S. N.	Title of the Course	Credit Hours
1	Spun Silk Technology	0+1
2	Diseases of Host Plants of Silkworms	1+1
3	Cytology and Genetics of Silkworms	2+1
4	Applied Microbiology	1+1
5	Diseases of Silkworms & Management	2+1
6	Dry land Horticulture	1+1
7	Bi-voltine Sericulture	0+2
8	Pests of Crops and Stored Products and Management	2+1
9	Livestock and Fish Production Management	2+1
10	Fundamentals of Extension and Rural Development	1+1
	Total	**12+11=23**

Semester – V

S.N.	Title of the Course	Credit Hours
1	Agricultural Meteorology, Rainfed Agriculture and Watershed Management	1+1
2	Communication and Extension Methodologies for Transfer of Technology	2+1

3	Agricultural Statistics	1+1
4	Silkworm Breeding	2+1
5	Silkworm Seed Technology	2+1
6	Vanya Sericulture	2+1
7	Silk Throwing, Dyeing and Weaving	0+2
8	Pests of Host Plants of Silkworms and their Management	1+1
9	Resource Generation and Management in Sericulture	0+1
	Total	**11+10=21**

Semester – VI

S.N	Title of the Course	Credit Hours
1	Apparels in Sericulture Industry	0+1
2	Principles of Seed Science and Technology	2+1
3	Farming Systems, Organic farming and Sustainable Agriculture	2+1
4	Soil Fertility and Nutrient Management	1+1
5	Experimental Techniques in Sericultural Research	1+1
6	Seri-Business Management	1+1
7	Planning and Management of Silk Reeling Industry	2+0
8	Seri Bio-technology	2+1
9	Entrepreneurship Development in Sericulture Crop Protection	0+1
10	Commercial Silkworm Seed Production	0+1
11	Entrepreneurship Development in Sericulture	0+1
12	Management of Sericultural Machineries and Equipments	0+1
	Total	**11+11=22**

Semester – VII

S. N.	Title of the Course	Credit Hours
1	STUDENT READY: Experimental Learning programme	20(0+20)
	STUDENT READY ELP /HOT Modules	
I	Host Plant Production	0+20
II	Cocoon Crop Production	0+20
III	Silk Product Science	0+20
IV	Natural Resource Management	0+20

Semester – VIII

S.N	Title of the Course	Credit Hours
	Rural Work Experience Programme (Sericulture) 0+20	
1	Placement in Grainage Technology	0+4
2	Seri Clinic	0+4
3	Placement in Silk Product Technology	0+4
4	Placement in Value Addition to Sericultural By-Products	0+3
5	Practical Extension Work in Villages	0+5
	Total	**20(0+20)**

SYLLABUS

SERICULTURAL COURSES

1. DEPARTMENT OF HOST PLANT PRODUCTION

1. Cultivation of Host Plants of Silkworms 2(1+1)

Theory and Practical

Identification and use of garden implements. Soil sampling, land preparation and layout for planting. Propagation, pruning, manurial and fertilizer schedules, irrigation schedules, green manuring, weed control practices, harvesting under different planting systems of mulberry and other host plants. Leaf preservation. Herbarium preparation for Host plants and weeds.

Suggested Reading:

- Rangaswamy, G., Narsimhanna, M.N., Kasiviswanathan, K., Sastry, C.R. and Manjeet, S. Jolly, 1976. *Sericulture manual, mulberry cultivation*, vol.1, F FAO Agriculture Services Bulletin. Rome. P. 150.
- Seri Business Manual- A User's Guide, CSB, Bangalore
- Dandin, S.B. and Giridhar, K., 2010. *Hand Book of Sericulture Technologies*, Central Silk Board, Bangalore.
- Minamizawa, 1997. *Moriculture Scienceof mulberry cultivation*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, p.431.
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979., *Manuals on Sericulture*
- – *Non mulberry sericulture.* FAO, Rome, P.178.

2. Mulberry Production and Management 1(0+1)

Practical

Cultivation practices for mulberry commencing from planting to harvesting under pit and row systems in an area of six guntas so as to carry out all the operations such as weeding and other inter-cultivation practices. Maintaining cultivation sheet and recording observations on seasonal growth and development of mulberry. Pruning practices, fertilizer management, irrigation,

dry farming practices and leaf yield of mulberry. Economics of leaf production per unit area of mulberry under rainfed and irrigated conditions. Identification of non-cash inputs of mulberry cultivation. At the end of semester the students have to submit the report on the practices adopted.

Suggested Reading:

- Rangaswamy, G., Narsimhanna, M.N., Kasiviswanathan, K., Sastry, C.R. and Manjeet, S. Jolly., 1976, *Sericulture manual, mulberry cultivation*, vol.1, F FAO Agriculture Services Bulletin. Rome. P. 150.
- Seri Business Manual –a User's Guide, CSB, Bangalore,
- Dandin, S.B. and Giridhar, K., 2010, *Hand Book of Sericulture Technologies*. Central Silk Board, Bangalore.
- Minamizawa, 1997. *Moriculture Science of mulberry cultivation*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, p.431.

3. Experimental Techniques in Sericultural Research 2(1+1)

Theory

Development of sericulture research. Modern trends, concepts in sericulture research and their impact on productivity. Essence of research levels and methods of research. Review of literature. Aims and objectives of laboratory and field experiments. Selection of site for experiments. Sources of variation in experiments, uniformity trials and the interpretation of blocks. Factors considered in fixing treatments and in fitting experiments. Different types of experiments-varietal, cultural, manurial, irrigation, weed control, silkworm rearing, silkworm breeding, grainage, pests, diseases and silk technology. Experiments on mulberry and non mulberry host plants. Short and long duration trials. Maintenance of experimental records. Recording of observations, sampling techniques, tabulation, analysis and interpretation of results. Preparation of data for scientific papers and presentation of results. Scientific photography and preparation of transparencies for slide projector and overhead projector.

Practical

Types of laboratory and field experimentation. Selection of site and land allotment. Experiments on grainage, mulberry silkworm rearing and silk technology. Techniques for assessment of damage of pests, diseases and weeds among the host plants of silkworms. Assessment of soil fertility before experimentation and plot work. Techniques to record observations in mulberry and silkworms, growth and growth analysis in mulberry. Methods of measuring leaf area in mulberry. Calculation of measures of Central tendency and dispersion. Analysis of variance technique in computation of 'F' & 'T' tables for the analysis of data from a Completely Randomised Design (CRD), Randomised Block Design (RBD), Latin Square Design (LSD), simple factorial experiment and split plot design.

Suggested Reading:

- Srinivasa, S.C. and Sangya Srinivasa, 2014. *Fundamentals of Statistics*, Anmol publications Pvt. Ltd., New Delhi.
- Sundar Raj, S., Nagaraju, S., Venkataramu, K.N. and Jagannath, M.K., 1972. *Design and analysis of field experiments*. UAS, Misc. Series No.22, Bangalore.

4. Botany and Cytology of Host Plants of Silkworms 2(1+1)

Theory

Taxonomy and systematics of mulberry, botanical description of mulberry and primary host plants of tasar, eri and muga silkworms *viz*., *Terminalia*, Castor, Som and Soalu. Polyembryonic seed in mulberry. Mitosis and karyomorphological studies in host plants of silkworms. Micro and megasporogenesis and fertilization. Fruit seed development and parthenocarpy in mulberry.

Practical

Botanical description of mulberry, *Terminalia*, Castor, Som and Soalu. Anatomy of root, stem, leaf, fruit and seed in mulberry. Micro and megasporogenesis and fertilization in mulberry, squashing and smearing techniques in mulberry. Karyomorphology and idiogram in some host plants of silkworms.

Suggested Reading:

- Rangaswamy, G., Narsimhanna, M.N., Kasiviswanathan, K., Sastry, C.R. and Manjeet, S. Jolly., 1976. *Sericulture manual, mulberry cultivation*, vol.1, F FAO Agriculture Services Bulletin. Rome. P. 150.
- Minamizawa, 1997. *Moriculture Science of mulberry cultivation*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, p.431.
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979. *Manuals on Sericulture – Non mulberry sericulture.* FAO, Rome, P.178.
- Hisao Aruga, 1997. *Principles of sericulture*, Oxford and IBH Publishing Co. Pvt. Ltd., p.376

2. DEPARTMENT OF SERICULTURE CROP IMPROVEMENT

1. Genetics and Breeding of Host Plants of Silkworms 2(1+1)

Theory

Floral biology of host plants of silkworms, *viz*., mulberry, Terminalia, Castor, Som and Soalu. Germplasm sources, geographical distribution and exploration. Centres involved in crop improvement programme of host plants of silkworms. Conservation and role of germplasm in crop improvement. Inheritance of economic characters (quantitative and qualitative characters). Objectives and pre-requisites of breeding. Methods of breeding, viz., introduction and acclimatisation, methods of selection in mulberry. Hybridization, heterosis breeding, breeding methods for self and cross pollinated crops, backcross, population improvement, mutation breeding, polyploid breeding. Breeding for resistance to biotic and abiotic factors - drought, diseases, pests, salinity and alkalinity. Breeding for leaf quality. Evaluation and statistical approach for yield test in mulberry. Varietal multiplication and dissemination.

Practical

Study of floral biology of host plants of silkworms, seedling selection, techniques of hybridization, appliances necessary for breeding. Collection of pollen and artificial pollination, details of recording data, treatment with colchicine, techniques of induction of mutation.

Suggested Reading:

- Rangaswamy, G., Narsimhanna, M.N., Kasiviswanathan, K., Sastry, C.R. and Manjeet, S.Jolly.,1976. *Sericulture manual, mulberry cultivation*, vol.1, F FAO Agriculture Services Bulletin. Rome. P. 150.
- Singh, B.D., 1997. *Plant Breeding*: *Principles and Methods*. Kalyani Publishers, New Delhi. P. 702.
- Kundan Singh, *Essentials of plant breeding*
- Pundan Singh, 1992. *Genetic.* Kalyani Publishers, New Delhi, P. 509.

2. Cytology and Genetics of Silkworms 3(2+1)

Theory

Concepts and principles of genetics. Cell division, Oogenesis, spermatogenesis and fertilization. Structure and chemical composition of chromosome and nucleic acids. Genotype and phenotype, qualitative and quantitative traits. Laws of inheritance. Crossing over, categories of crossing over, mechanism of crossing over. Chromosomal maps, pleiotropy, penetrance and expressivity. Linkage. Phenotypic variance, Geneotypic variance, Heritability and Genetic advance. Genetic stocks of silkworms, morphological and bio-chemical traits, differentiation and development. Genetic basis for hormonal control. Genetics of cocoon colour. Sex determination in mulberry silkworm.

Suggested Reading:

- Anonymous, 1993, *Principles and Techniques of Silkworm Breeding*. ESCAP, UN, New York. Oxford & IBH
- Gardner, E.J., Simmons, M.J. and Snustad, D.P., 1991. *Principles of Genetics,* John Willey & Sons Inc., New York. P. 649.
- Hiratsuka, E., 1999. *Silkworm Breeding*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. P. 500.
- Jolly, M.S., Sen, S.K., Sonwalker, T.N. and Prasad G.K., 1979. *Non-Mulberry Silks.* FAO-Agricultural Service Bulletin, Rome. P. 178.
- Suomalainen, Esko, Saura, A. and Lokki, J., 1987. *Cytology and Evolution in Parthenogenesis*. CRC Press, Inc.: Boca Raton, Fl. P. 410.
- Kovalev, P.A., 1970. *Silkworm Breeding Stocks.* Central Silk Board, Bombay. P. 233.
- SARKER, D.D., 1998. *The Silkworm Biology, Genetics and Breeding.* Vikas Publishing House Pvt. Ltd., New Delhi. P. 338.
- SARIN, C., 1990. *Genetics.* Tata McGraw – Hill Publishing Co. Ltd., New Delhi. P. 528.
- Singh, B.D., 1997. *Plant Breeding*: *Principles and Methods*. Kalyani Publishers, New Delhi. P. 702.
- Sreeramareddy, G., 1998. *Silkworm Breeding*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Tazima, Y., 1964. *The Genetics of Silkworm*. Logos Press Ltd., London. P. 253.
- Tazima, Y., 1978. *The Silkworm*: *An important Laboratory Tool*. Kodansha Ltd., Tokyo, Japan. P. 307.

- Pundan Singh, 1992. *Genetic.* Kalyani Publishers, New Delhi, P. 509.
- Singh, B. D., 2012. *Fundamental of Genetics.* Kalyani Publishers, New Delhi. P. 719.

3. Silkworm Breeding 3(2+1)

Theory

History of silkworm breeding in Japan, China and India. Principles and objectives of silkworm breeding. Genetic basis for silkworm breeding programmes. Activities of silkworm breeding programme. Maintenance of breeds/stocks, 3- tier multiplication of parental stock with silk yield attributes. Hybridization: objectives, types, Problems in hybridization like inbreeding depression, lethal genes, *etc*. Heterosis: Genetic basis for heterosis, manifestation of heterosis, commercial exploitation of heterosis. Heterosis in different crossing systems. Silk improvement through Selection: Pure line selection Mass/bulk selection, Pedigree selection. Back cross breeding, inbreeding and line breeding. Parthenogenesis – definition, history, natural and artificial parthenogenesis, methods of induction of parthenogenesis. Mutation Breeding – historical account, spontaneous and induced mutations, classification of mutagens, effect of mutagens, mechanism of action of mutagens. Measurement of mutation frequency. Application, limitation and achievements of mutation breeding. Chromosomal aberrations. Ploidy breeding – heteroploid, autopolyploids, significance of polyploids. Breeding for stress tolerance: High temperature tolerant and disease tolerant breeds/hybrids, season and region specific hybrids. Concepts of breeding auto-sexing silkworm breeds. Authorization of parental breeds and their hybrids. Breeding of non-mulberry silkworms.

Practical

Study of breed characteristics of mulberry non-mulberry silkworms. Study of breed characteristics of non-mulberry silkworms. Procedure and maintenance of silkworm germplasm bank. Procedure for hybridization. Procedure for selection breeding. Assessment of variability (ANOVA). Estimation of heterosis. Artificial induction of parthenogenesis. Procedure for mutation breeding. Handling of mutated population. Artificial induction of mutagenesis in mulberry, Artificial induction of mutagenesis in silkworms, Induction of polyploidy in mulberry. Induction of polyploidy in silkworms. Visit to germplasm bank and silkworm breeding stations.

Suggested Reading:

- Anonymous, 1993. *Principles and Techniques of Silkworm Breeding*. ESCAP, UN, New York. Oxford & IBH
- Gardner, E.J., Simmons, M.J. and Snustad, D.P., 1991, *Principles of Genetics,* John Willey & Sons Inc., New York. P. 649.
- Hiratsuka, E., 1999, *Silkworm Breeding*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. P. 500.
- Jolly, M.S., Sen, S.K., Sonwalker, T.N. and Prasad G.K., 1979, *Non-Mulberry Silks.* FAO-Agricultural Service Bulletin, Rome. P. 178.
- Suomalainen, Esko, Saura, A. and Lokki, J., 1987, *Cytology and Evolution in Parthenogenesis*. CRC Press, Inc.: Boca Raton, Fl. P. 410.

- Kovalev, P.A., 1970. *Silkworm Breeding Stocks.* Central Silk Board, Bombay. P. 233.
- Sarker, D.D., 1998. *The Silkworm Biology, Genetics and Breeding.* Vikas Publishing House Pvt. Ltd., New Delhi. P. 338.
- Sarin, C., 1990. *Genetics.* Tata McGraw – Hill Publishing Co. Ltd., New Delhi. P. 528.
- Singh, B.D., 1997. *Plant Breeding*: *Principles and Methods*. Kalyani Publishers, New Delhi. P. 702.
- Sreeramareddy, G., 1998. *Silkworm Breeding*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Tazima, Y., 1964. *The Genetics of Silkworm*. Logos Press Ltd., London. P. 253.
- Tazima, Y., 1978. *The Silkworm*: *An important Laboratory Tool*. Kodansha Ltd., Tokyo, Japan. P. 307.
- Pundan Singh, 1992, *Genetic.* Kalyani Publishers, New Delhi, P. 509.
- Singh, B. D., 2012. *Fundamental of Genetics.* Kalyani Publishers, New Delhi. P. 719.

4. Seri Bio-technology 3(2+1)

Theory

Introduction to Biotechnology in sericulture, Principles and methods used in biotechnology, plant cell and tissue culture techniques in mulberry: history, different techniques and methods of tissue culture, principles of tissue culture, applications in mulberry, Micro-propagation; somatic embryogenesis, multiple shoot formation, somaclonal variations, synthetic seeds in mulberry, Production and uses of haploids: Anther culture, pollen culture, ovule culture, detection of haploids; applications of haploids in mulberry breeding, Embryo and endosperm culture, Protoplast culture in mulberry, Recombinant DNA technology and its applications in sericulture, Gene transfer methods and techniques using *Agrobacterium* in mulberry, selectable and scanable markers; *Bm*NPV vector, genomic organization of *Bm*NPV, biotechnological application for large - scale synthesis of recombinant proteins (valuable proteins) using BmNPV, Polymerase chain reaction (PCR): Gene amplification, application of PCR in seri biotechnology, Marker assisted breeding in improvement of host plants and silkworm, Immunology and serological techniques in silkworm disease diagnostics, Preservation of endangered non-mulberry silkworms through biotechnological approaches, IPR, patenting, WTO-GATT and bioethics, Overview of Nanotechnology and its applications in sericulture, Overview of Bioinformatics: Origin and definition, historical background, scope, importance and applications in sericulture improvement.

Practical

An introduction to biotechnology laboratory: Working principles of various equipments and instruments used, Sterilization techniques, Preparation of culture media, Study of PCR technique, Isolation and quantification of genomic DNA from mulberry leaves, Isolation and quantification of genomic DNA from silk glands, Protocol for various marker systems used in mulberry genome analysis, Protocol for various marker systems used in silkworm genome analysis, Study of length polymorphism using horizontal and vertical gel electrophoresis, Serological techniques in silkworm disease diagnostics, Gene transfer techniques in sericulture, Preparation of synthetic seeds in mulberry.

Suggested Reading:

- Singh, B.D., 2014, Plant Biotechnology, Kalyani Publishers, p.814

3. DEPARTMENT OF COCOON CROP PRODUCTION

1. History, Development and Organization of Sericulture Industry 1(1+0)

Theory

Origin and history of sericulture in the World, India and Karnataka. Features and importance of sericulture in the world. National and International Silk Organizations, Organizational set up in different countries including India. Development of sericulture through plans, World Bank Projects. Sericulture organization at State Level with reference to the planning and quality control, marketing, silk exchange, export–import policy and laws. Laws relating to the production of seed, cocoon, raw silk and transport. Price stabilization. Internal consumption. R & D institutes of CSB, State Govt. & Universities. Literature in Sericulture.

Suggested Reading:

- Abdul Aziz and Hanumanthappa, H.G., 1985. Silk Industry Problems & Prospects. Ashish Publishing House, New Delhi, p.129.
- Anonymous, 2010. Sericulture and Silk Industry Statistics. Central Silk Board, Bangalore, p.96.
- Hanumappa, H.G.,1993. Sericulture Society and Economy. Himalaya Publishing House, Bombay, p.140.
- Koshy, T.D., 2001. Silk Production and Export Management. A.P.H. Publishing Corporation, New Delhi, p.656.
- Sanjay Sinha, 1990. Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, p.103.
- Vekata Narasaiah, P., 1992. Sericulture in India. Ashish Publishing House, New Delhi, p.214.
- Seri Buisiness Manual - Farm Sector and Non-Farm Sector
- Indian Silk, Monthly Journal, Central Silk Board, Bangalore
- Annual reports of Central Silk Board and its research institutes.

2. Morphology and Systematics of Silkworms 2(1+1)

Theory

Introductory remarks on general insect morphology. Insect classification. Study of systematics of sercigenous insects. External morphology of different life stages of mulberry, tasar, muga and eri silkworms. Changes during moulting and ripening. Changes in pupal morphology with age.

Practical

Collection of sericigenous insects of sericultural importance. Preparation of slides of the structures of life stages of mulberry, tasar, muga and eri.

Suggested Reading:

- Chapman, R.F., 1973. The Insect – Structure and Function. The English University Press Ltd. London.
- Ganaga, G. and Sulochana Chetty, J., 1991. An Introduction to Sericulture. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. P.302.
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N., and Prasad, G.K., 1979. Non-Mulberry Silks. FAO – Agriculture Services Bulletin. Rome. P. 178.
- Krishnaswami, S., Narasimhanna, M.N., Suryanarayana, S.K. and Kumaraja, S., 1973. Silkworm Rearing, FAO Sericulture Manual -2. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. P.112.
- Mohan Rao, M., 1998. A Text Book of Sericulture, B.S., Publications. Hydrabad. P. 197.
- Tembhare, D.B., 1984. A text book of Insect morphology, Physiology and Endocrinology. S. Chand and Company, New Delhi.

3. Silkworm Anatomy and Physiology 2(1+1)

Theory

Digestive, circulatory, respiratory, excretory, nervous, reproductive and muscular systems of larva, pupa and adult of mulberry silkworm and comparative anatomy in non-mulberry silkworms. Physiology of digestion, respiration, circulation, excretion and reproduction. Silk glands and silk secretion.

Endocrinology, sensory physiology. Olfactory and gustatory stimuli of feeding. Sex attractants. Nutrition and host preference. Artificial diets. Effect of juvenile hormones and JH analogues on moulting, silk secretion and oviposition.

Practical

Dissection of larva and adult stages of silkworm species for all the internal systems. Study of pulse rate and reversal of blood flow during spinning in larvae. Artificial diets and their components.

Suggested Reading:

- Anonymous, 1956, *Silkworm Rearing and Diseases of Silkworm*. Mysore Silk. Association. Bangalore.
- Chapman, R.F., 1973. *The Insect - Structure and Function*. The English University Press Ltd. London.
- Gang A, G. and Sulochana Chetty, J 1991. *An Introduction to Sericulture*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. p. 302.
- Hamamura, Y., 2001. *Silkworm rearing on Artificial Diet*. Oxford & IBH Publishing Co. Pvt., New Delhi. p.287
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N., and Prasad, G.K., 1979. *Sericulture Manual Non-Mulberry Silks*. FAO Agriculture Services Bulletin. Rome. p. 178.
- Krishnaswami, S., Narasimhanna, M.N., Sljryanarayana, S.K. and Kumaraja, S., 1973. Sericulture Manual 2 - Silkworm Rearing, Vol.2, FAO, Rome, p.112.

- Reddy. D.N.R., Narayanaswamy, K.C., Manjunatha Gowda and Jayaramaiah. M., 2005. *Morphology and Anatomy of Silkworms*. CVG Books, Bangalore. p. 133.
- Mohan Rao, M., 1998. *A Text Book of Sericulture*, B.S., Publications. Hyderabad. p. 197.
- Morohoshl,S., 2000. *Development Physiology of Silkworms*. Oxford & IBH Publishing Co. Pvt., New Delhi. p.287.
- Pant, N.C. and Ghai, S., 1973. *Insect Physiology and Anatomy*. ICAR, New Delhi. p.276.
- Taz1ma, Y., 1978. *The Silkworm- An Important Laboratory Tool*. Kodansha Ltd. Tokyo. p.307. WIGGLESWORTH, V.B., 1966. *Insect Physiology*. Butler and Tanner Ltd., Frome and London. p. 134.

4. Vanya Sericulture 3(2+1)

Theory

Global production of non-mulberry silks, their scope and impact on the socio-economic conditions of tribals. Distribution of non-mulberry silk yielding insects and non-insects and their classification. Different types of voltinism and characterisation of different stages of tropical and temperate tasar, eri and muga silkwoms. Traditional and improved methods of temperate and tropical tasar, eri and muga rearing. Natural enemies and other problems in non-mulberry silk cocoon production. Economics of tasar, eri and muga culture. Recent developments in non-mulberry sericulture.

Practical

Study of host plants and life stages of different non-mulberry silkworms. Natural enemies of non-mulberry silkworms. Rearing of non-mulberry silkworms. Field visit for collection of non-mulberry silkworm stages.

Suggested Reading:

- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979. *Manuals on Sericulture – Non mulberry sericulture*. FAO, Rome, p.178.
- Thangavelu, K., 2000. *Lessons on Tropical Tasar*. Central Tasar Research and Training Institute, Ranchi, p.104.
- Gangawar, S.K., Kumar, R. and Srivastava, A.K., 2007. *Tasar Culture-Principles and Practices*, *Tasar host plants-Production, Protection and Improvement*, Vol.I. Central Tasar Research and Training Institute, Ranchi, p.259.
- Gangawar, S.K., Kumar, R. and Srivastava, A.K., 2008. *Tasar Culture-Principles and Practices,* Tasar Silkworm Biology,Vol.II. Central Tasar Research and Training Institute, Ranchi, p.238.
- Gangawar, S.K. R. and Gupta, V.P., 2010. *Tasar culture-Principles and Practices, Tasar Silkworm - Production*, *Protection and Improvement*, Vol.III. Central Tasar Research and Training Institute, Ranchi, p.346.
- Mohanthy, P.K., 1998. *Tropical Tasar Culture in India*. Daya Publishing House, New Delhi, p.152.
- Sannappa, B., Jayaramaiah, M., Govindan, R. and Chinnaswmy, K.P., 2002. *Advances in Ericulture*. Seri Scientific Publishers, Bangalore, p.143.

5. Mulberry Silkworm Rearing 3(2+1)

Theory

Biology of mulberry silkworm, popular polyvoltine & bivoltine breeds. Rearing houses and appliances. Importance of disinfection, care in handling and incubation of eggs and black- boxing. Environmental conditions for rearing of young and late age silkworms. Brushing, leaf selection for different instars, frequency and quantum of feeding. Care at moulting. Spacing of worms. Bed cleaning. Rearing practices for young and late age silkworms. Mounting of worms. Effective rate of rearing. Cocoon harvesting and sorting. Transporting and marketing of cocoons. Assessment of cocoon yield and quality. Leaf cocoon ratio and consumption indices. Planning for silkworm rearing suitable to different sized mulberry holdings, rearing house, equipment and labour availability. Shoot rearing and shelf rearing. Feed utilization and conversion efficiency. Nutritional requirement of silkworms, vis-à-vis, their availability in mulberry leaf. Different nutrients and their role in silkworm growth, development and silk production. Nutrient deficiency and its impact on silkworm biology. Nutrient supplements through mulberry leaf fortification. Maintenance of rearing records. Innovations and indigenous technology know how. Benefit cost ratio of silkworm rearing. Artificial diets and juvenile hormone analogues in practical sericulture.

Practical

Biology of Polyvoltine and Bivoltine silkworms. Popular breeds of silkworms Plan of rearing house. Rearing appliances. Disinfection. Incubation. Brushing. Leaf preservation. Chawki and late age rearing. Bed cleaning and Spacing. Bed disinfection, Rearing of popular silkworm hybrids and maintenance of rearing records. Planning of small and large scale silkworm rearings based on facilities, management of diseases and natural enemies.

Suggested Reading:

- Ganga, G., 2003. *Comprehensive Sericulture* - Silk rearing *Vol. 2*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Rajan, R.K. and Himantharaj, M.T., 2005. *Silkworm Rearing Technology*, CSB Publication, p.163.
- Ullal, S.B.and Narasimhanna, M.N., Manual on Sericulture, 2- Silkworm Rearing, FAO, Ro me
- M.C. Devaiah, K.C. Narayanaswamy and V.R. Maribashetty. *Advances in mulberry sericulture*
- Dr. G. Boraiah, *Lecturers on sericulture*, SBS Publishers, Bangalore.
- Dandin, S.B and Guptha.V.P. 2002, *Advances in Indian Sericulture Research*, CSR and TI, Mysore
- K. Minamizawa, 1997, *Moriculture-Science of mulberry cultivation*.
- Kamal Jaiswal, Sunil P. Trivedhi, B.N. Pandey and K.Tripati. *Mulberry sericulture*
- *problems and prospects*
- Seri business manual- A user guide, CSB Publications

- M. Madan Mohan Rao, Comprehensive Sericulture
- P. Kumaresan and G. Srinivasa, *Sericulture extension management and economics*
- Hand book of silkworm Rearing, Fuzi publishing Co. Ltd.
- Ganga, J. Sulochana Chetty, G., An Introduction to sericulture
- Hand book of practical sericulture, CSB
- Yasuji Hamamure, Silkworm Rearing on artificial diet (Translated from Japan)
- Mohammed Shemsuddin, Silkworm physiology, A concise text book

6. Silkworm Seed Technology 3(2+1)

Theory

Importance of quality silkworm seed in sericultural industry. Embryology of *Bombyx mori*, *Samia cynthia ricini* and *Antheraea mylitta.* Morphological and Biochemical changes in eggs of different silkworms during embryogenesis. Seed areas, special features of seed areas and seed cocoon transaction. Seed organization in India and abroad. Three tier system of egg production (P3, P2 and P1). Special features of parental silkworm rearing, Basic seed and industrial seed and standards for the same. Hill amelioration, marketing of seed cocoons, Grainage techniques and steps in hybrid dfl preparation. Small scale production of hibernating and non-hibernating eggs in loose forms and on egg sheets. Methods of termination of hibernation, acid treatment for hibernating eggs. Egg borne diseases and methods of elimination. Pebrine disease management at various levels. Incubation and preservation of DFLs till disposal. Standards for quality eggs. Preservation and handling of eggs, different hibernation schedules. Cost structure of a model grainage and a private grainage. Economics of egg production, factors economising the cost of production. Management of industrial grainages. Maintenance of records in grainages. Enumeration of seed legislation act.

Practical

Methods of embryo testing and preparation of permanent slides**.** Grainage plan and equipments, different grainage operations, procurement, transportation and preservation of seed cocoons, sexing, moth emergence, pairing, depairing, preparation of eggs on cards and as loose forms. Identification of good, dead, unfertile and hibernated eggs. Mother moth examination, disinfection of eggs. Acid treatment for hibernating eggs. Preparation of hybrid eggs. Visit to local grainages.

Suggested Reading:

- Ganga, G., 2003. *Comprehensive Sericulture* - Vol. 2. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Ganga, G. and Sulochana Chetty, J., 2001. *An Introduction to Sericulture*. Ashish Publishing House, New Delhi.
- Narasimhanna, M.N., 1988. *Manual on Silkworm Egg Production*. Central Silk Board, Bangalore.
- Dandin, S.B. and Giridhar, K., 2010. *Hand Book of Sericulture Technologies*, Central Silk Board, Bangalore.

- Tribhuwan Singh and Beera Saratchandra, 2004. *Principles and Techniques of Silkworm Seed Production*. Discovery Publishing House, New Delhi.
- Jayaswal, J., Giridhar, K., Somi Reddy, J. And Jagadish Prabhu, H., 2008, Mulberry Silkworm Seed Production. Central Silk Board, Bangalore.
- A Treatise on the Acid Treatment of Silkworm Eggs. Central Sericultural Research & Training Institute, Mysore.
- Indian Silk, Monthly Journal, Central Silk Board, Bangalore
- Annual reports of Central Silk Board and its research institutes.
- FAO Manuals on Silkworm Egg Production

7. Commercial Silkworm Seed Production 1(0+1)

Practical

Planning for egg production. Rearing of parental silkworm breeds. Preparation of grainage, working out the disinfectant solution required to disinfect the grainage building. Production of commercial silkworm eggs in egg sheets and as loose forms. Practicing of different methods of artificial hatching. Short experiments on principles of grainage technology- duration of mating, reuse of male moths, preservation of multivoltine pupa/moths/eggs. Visit to seed areas.

Suggested Reading:

- Narasimhanna, M.N., 1988, Manual on Silkworm Egg Production. Central Silk Board, Bangalore.
- Dandin, S.B. and Giridhar, K., 2010, Hand Book of Sericulture Technologies, Central Silk Board, Bangalore.

8. Diseases of Silkworms and Management 3(2+1)

Theory

Introduction and importance of silkworm diseases, Nature and extent of damages caused to sericulture due to biotic and abiotic factors. Infectious and non-infectious diseases of silkworms including non-mulberry silkworms. Koch's postulates. Non-infectious diseases including physical and chemical injuries, nutritional and genetic disorders. Important infectious diseases – pebrine, flacherie, muscardine and grasserie (*Bm*NPV), CPV, IFV: -Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and management. Cross infectivity of pathogens of crop pests to silkworms. Impact of insect crop pests on silkworm. Impact of biological pest control on sericulture. Infectivity techniques. Determination of LC50 and ET50.Disinfection and hygiene, disinfectants and their mode of action.

Practical

Study of gross pathology of different diseases, Effect of different insecticides on silkworms, Causal agents of infectious diseases &symptoms, Isolation and culturing of silkworm pathogens, Koch's postulates, Preparation of permanent slides, Infectivity techniques, Cross infectivity, Determination of LC50 and ET50,Silkworm breeds and instars susceptibility, Histopathological techniques, Patho-physiological techniques, Preventive measures of infectious diseases, Disinfection & hygiene.

Suggested Reading:

- Dandin, S.B. And Giridhar, K., 2010, Hand Book of Sericulture Technologies, Central Silk Board, Bangalore.p.427.
- M.C. Devaiah, K.C. Narayanaswamy, and V.R. Maribashetty Advances in mulberry sericulture,CVG Publication, pp.378-474.
- Krishnaswami, S., Narasimhanna, M.N., Sljryanarayana, S.K. And Kumaraja, S., 1973, Sericulture Manual 2 - Silkworm Rearing, Vol.2,FAO,Rome, P.112.
- Govindan, R., Narayanaswamy, T.K. and Devaiah, M.C., 1998, Priniciples of silkworm Pathology, Seri scientific Publishers, p.420.
- Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection, CSB, Bangalore, pp.1-324.

9. Pests of Silkworms and Management 2(1+1)

Theory

Introduction, meaning of pest, parasite, predator and hyperparasite, minor and major pests, confirmers and regulators. Concepts of pest management, ETL and EIL. Importance of silkworm pests including insect and non-insect pests. External morphology, biology, host parasite interactions, nature of damage due to different insect pests, uji flies, ants, dermestid beetles etc. Management practices *viz*., physical, mechanical, chemical, biological and Integrated Pest Management (IPM). Occurrence and nature of damage caused by non-insect pests like rats, squirrels, lizards, mites, nematodes, snakes, birds etc.

Practical

Study of different insect and non-insect pests. Uji fly life cycle, identification of pest damaged worms and cocoons, case studies. Management of Pests.

Suggested Reading:

- K.C Narayanaswamy & M.C Devaiah,1998, The Silkworm Uzifly, Zen Publishers, p.232
- Hand Book of Sericulture technologies – CSB publication
- www.csb.gov.in

10. Bivoltine Sericulture 2(0+2)

Practical

JICA method of Bivoltine rearing, three level disinfection, quality leaf selection, loose egg incubation and brushing, micro-climate management, rearing of single and double hybrids, using of artificial diets, JH and MH analogues. Mounting using revolving / plastic mountages, harvesting, sorting and packaging of cocoons and marketing.

Suggested Reading:

- Ganga, J. Sulochana Chetty, G., An Introduction to sericulture
- Rajan, R.K. and Himantharaj, M.T., 2005, Silkworm Rearing Technology, CSB Publication, p.163.

11. Resource Generation and Management in Sericulture Crop Protection 1 (0+1)

Practical

Generation and management of resources in Mulberry cultivation, Silkworm rearing, Silk reeling and post reeling. Management of raw material, man power, water and other inputs. Selection of quality planting material, Practicing of improved compost techniques, Vermicompost, Trenching and Mulching, Enriched compost like Bio-rich and Nutri-rich, Application of tank silt and its management, Manure and fertilizer use efficiency, Calculation of chemicals/fertilizers requirement, Utilization of stubbles, Weeds management and utilization of weeds, Intercropping, INM and IPM techniques, Management of drip, fertigation, Use of bio-digestor, vermi-wash, Use of treated drainage water, Silage preparation. Feed management in rearing, Labour, time and input managements, Fortification, moult and ripe worm management, Low cost rearing techniques, ITK, Raw material, manpower and power management in reeling and post reeling activities, Water quality and its management, Silk production management.

Suggested Reading:

- Kumaresan, P. and Srinivasa, G., 2005, Sericulture Extension management and Economics. CSB, Bangalore, p.487
- Seri business Manual – a user's guide CSB publication.

12. Entrepreneurship Development in Sericulture crop protection 1(0+1)

Practical

Assessment and monitoring of pest infestation, disease incidence and toxicosis in mulberry and silkworm rearing. IPM, INM, ICM in sericulture, Production of Neem based/plant based products, parasitoids, predators, microbial agents. Production of disinfectants.

Suggested Reading:

- www.csrtimys.res.in/
- Nataraju, B., Sathya Prasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection, CSB, p.412.
- Anonymous, 1990, Handbook on pest and disease control of mulberry and silkworm. United Nations, ESCAP, Thailand, p.88.

4. Department of Silk Product Science

1. Physics and Chemistry of Fibres 1(1+0)

Theory

History and classification of fibres and yarns, Synthetic and natural fibres-linen, cotton, wool and silk. Physical properties of fibres –tenacity, elongation, cohesion, heat resistance, electrical properties, resiliency, pliability, feltability, flamability, ageing resistance, abrasion resistance, density and specific gravity, physical structure, length, width of fibres. Polymer chemistry – macromolecules - cellulose, sericin, fibroin, synthetic fibres. Cellulose based and petrochemical based fibres. Chemical properties of fibres - reaction with acids, alkalies, metallic salts, dyes,

halogens etc. Mineral fibre : asbestos. Application of physical and chemical properties for inducing special effects in fabrics.

Suggested Reading:

- Koshy, T.D., 1990, Silk Exports and Development. Ashish Publishing House, p.255.
- Katharine Paddock Hess, 1959, Textile Fibres and their use(sixth edition). Oxford and IBH publishing Co., New Delhi, p.549.
- Sadov., F., Korchagin, M. and Natetsky, A., 1973, Chemical Technology of Fibrous Materials, Mir publishers, Moscow, p.668.
- Merrit Mathews, 1924, The textile fibres their physical, microscopic and chemical properties. John Wiley &Sons, Inc. London, Chapman and Hall, Limited, p.1053.
- Encyclopedia of textile fibre.

2. Raw Silk Technology 3(2+1)

Theory

Introduction- world raw silk production and present silk production in India, Cocoon formation, Physical characteristics of mulberry cocoon- colour, shape, wrinkles etc, Physical and chemical properties of silk-,effect of heat, electricity etc, Cocoon markets-its functions, method of transaction, method of fixing the cocoon price, Transportation of cocoons-care and handling, Cocoon testing and grading, Cocoon sorting-manual and mechanical method Different types of defective cocoons, Mulberry silk reeling process-steps involved in silk reeling, Cocoon stifling and methods, storage of stifled cocoons-sundrying, steam stifling, hot air drying, Cocoon cooking and its systems, - open pan, two pan, three pan, pressurised cooking method/circular cocoon boiling machine, mechanical cooking, brushing methods, Evolution of reeling machines. General principles in reeling, different reeling machin es-charakha, improved charakha, cottage basin/ domestic basin, multiend reeling machine, semi automatic and automatic reeling machine. Re-reeling and lacing, Silk examination, skeining, book and bale making, Storage and selling raw silk, silk exchange, Physical properties of Tasar, Muga, eri cocoon, Tasar cocoon reeling- stifling, cooking, reeling machines, Muga cocoon reeling- stifling, cooking, reeling machines, Eri cocoon cooking, spinning methods, Filature water engineering, comparative reeling efficiency of improved reeling machines. Marketing of silk, silk exchanges and price stabilization of silk. Objectives and advantages of raw silk testing and grading. Qualities of silk, major and minor characters of quality silk, equipments and facilities required for silk testing, silk testing and conditioning houses, BIS and ISA specifications of testing and grading of silk, condition test, winding test, size test, strength test, evenness, cleanness and neatness tests, cohesion test, standard tables for grading of silk. Computation of test results and grading of silk. Computerized and advanced testing machines.

Practical

Physical and commercial properties of cocoons. Physical and chemical nature of sericin and fibroin. Sorting of cocoons-defective cocoons, storage of cocoons, different systems of cocoon cooking, brushing, reeling of cocoons, study of parts of reeling machines, re-reeling of silk, silk examination and package. Tasar and Muga silk reeling. Visit to reeling establishments.

Suggested Reading:

- Ohja, N.G., and Panday, P.N., 2004, Silk Production, BPH Publishing Corporation, New Delhi, p.278, 20p.
- Anonymous, Wild Silks of India, Vol.II, CSB, Bangalore,
- Tamanna N. Sonwalkar, 1998,Handbook of silk technology, New India International(P) Ltd. New Delhi.
- D. Mahadevappa, V.G.Haliyal, D.G. Shankar and Ravindra N Bhandiwad, 2003, Mulberry silk reeling technology, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Yong-woo Lee, Silk reeling and testing manual by National Sericulture and Entomology Institute, Seoul, Republic of Korea.
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979, Manuals on Sericulture – Non mulberry sericulture.FAO, Rome, P.178.
- Krishnaswami, S., Madhava Rao, N.R., Suryanarayan, T.S. and Sundarmurthy, T.S., 1972, Sericulture Manual, Silk reeling, Vol.3, FAO, Rome, p.112.
- Chowdhury, S.N., Mulberry silk industry by Seri business manual – a user's guide by CSB.
- Wild Silks of India, Vol.II by CSB publication.
- Manual on Bivoltine silk reeling technology (2003) CSTRI, Bangalore.
- Kim, B., Rawsilk Reeling, Associated Business Centre Limited, Columbo, Srilanka, 273.

3. Planning and Management of Silk Reeling Industry 2(2+0)

Theory

Introduction, scope of silk reeling industry in India and Karnataka. Organization of silk reeling industry. Problems and prospects of silk reeling industry. Planning of silk reeling industry, location/place. Types of reeling machines. Demand for silk. Contributing factors for benefit - cost in Silk Reeling Industry. Management of silk reeling industry, raw material management like cocoons, fuel, water, man power, procurement skills, constraints, marketing, case studies of charaka, cottage basin and filature, managerial skills. Decision making. Business forecasting and operation. Training and Development. Wage payment plans, wage fixed based on nature of work, quality and quantity of work, incentives or bonus. Indian wage policy, methods of state regulation of wages. Wage incentives in Indian industry. Financial sources, types of loans, norms fixed for loans and repayment. Project proposals.

Suggested Reading:

- Kumaresan, P. and Srinivasa, G., 2005, Sericulture Extension management and Economics. CSB, Bangalore, p.487
- Ananthanarayan, S.K., Silk Reeling,
- Manual on Bivoltine silk reeling technology (2003)CSTRI, Bangalore
- Seri business Manual – a user's guide, CSB publication

4. Spun Silk Technology 1(0+1)

Practical

Spun Silk – Characters. Manufacturing of Spun silk. Systems of spun silk processing, silk wastes, pierced cocoons and Eri cocoons as raw material for spinning industry. Flow chart of spinning, spinning operations, procurement and storing of silk waste. Degumming, opening, Dressing, Drawing, Roving, Spinning, Gasing. Re-reeling and packaging of Spun silk. Hand spinning of cocoon wastes, Katia, Matka, Geecha silk. Equipments used in cottage spinning units - Takli, Natwa, Medleri charka, amber charaka, Das, Trivedi and Chowdary spinning wheels. Motorized cum pedal operated spinning wheel. Study of different types of silk wastes, different types of spun silks-Katia, Matka, Geecha, Noil, Machine spun silk, Machines used in spun silk industry. Study of different silk wastes. Raw silk waste, opened waste, combed / Dressed waste, sliver, Rovings. Processing of silk waste / Eri cocoons / pierced cocoons. Visit to Silk testing and grading units / spun silk industry.

Suggested Reading:

- Seri business Manual – a user's guide CSB publication
- Manual on Bivoltine silk reeling technology (2003) CSTRI, Bangalore
- Silk reeling – Sericulture Manual 3 (FAO)
- www.csb.gov.in

5. Silk Throwing, Dyeing and Weaving 2(0+2)

Practical

Silk throwing-winding, doubling, twisting-types of twisting. Steam setting of twisted yarn. Warping and yarn winding. Degumming of silk; Methods of degumming, water quality for wet processing. Bleaching and dyeing, classification of dyes, factors influencing dyeing, preparation of dye and methods of dyeing. Printing and methods of printing –block and screen printing. Weaving-loom and its structure, different types of looms, arrangement of yarn for simple weaving and design weaving. Textile Designing, Motifs for weaving and textile printing, silk / fabric finishing, silk knitting. Disposal of effluents. Study of different dyes, preparation of dyes, bleaching and dyeing of silk. Soap and soda method and enzymatic method, Visit to cottage-weaving sectors. Study of different types of looms and their characteristics.

Suggested Reading:

- Seri business Manual – a user's guide CSB publication
- Tamanna Sonwalkar, Silk reeling technology
- www.csb.gov.in

6. Apparels in Sericulture Industry 1(0+1)

Practical

Study of different types of yarns and fabrics and their classifications. Designs in fabrics, zaries blended fabrics. Caring of fabric, value addition in fabrics, Knitting, embroidery, embossing,

dyeing, printing, self designing. Designing, Blending, Chiffon, Satin, Creping, Mercerisation. Induction of tentering, Special effects in fabric by different levels of twisting, combination of twisted yarns, blending of silk with other yarns. Designing of silk fabrics. Weaving- plain designs, zari designs. Loading/ weightening of silk/fabric. Silk in upholstery and interior decorations. Zari making from silk. Silk fabrics – traditional kacheevaram, dharmavaram, arni, illakal, molkalmur, pochampalli, venkatagiri, banarasi, rajasthani, paithani etc. apparels from vanya silks, Caring of silk fabrics. Fashion design from silk-tie, glouse, cap, vanity bags etc.

Suggested Reading:

- Seri business Manual – AUser's Guide CSB publication
- www.csb.gov.in

7. Entrepreneurship Development in Sericulture 1(0+1)

Practical

Study of different byproduct produced from the wastes of mulberry cultivation, silkworm rearing, silk reeling. Improved methods of composting vermi composting, biogas production, mushroom culture using sericulture byproducts, Mulberry leaves - for Tea preparation and food items, Fruits – Jam, Jelly, Juice, Elixir, Wine etc. Rearing waste – Compost and vermi compost preparation. Use of compost culture in trenching and mulching. Mulberry stubbles for fuel production. Bio-gas, paper and mushroom production. Chlorophyll and Silage preparation. Bio-Crafts, Pupal provides Pupal oil production, usage of the same in production of animal feed, Paints and varnishes. Spun silk production, products preparation like carpets, cushions/pillows etc. Usage of Jot (Reeling waste) in Tyre industry, Twisting of Dupion Silk.

Suggested Reading:

- www.csb.gov.in
- www.inserco.org

5. BASIC SCIENCES AND HUMANITIES

1. Plant Biochemistry 2(1+1)

Theory

Biochemistry –Introduction and importance. Plant cell-Structure & organellar functions. Bio-molecules – Structure, Properties & reactions: amino acids, peptides and proteins, lipids, carbohydrates, nucleotides and nucleic acids. Enzymes – Factors affecting the activity, classification, immobilization and other industrial applications. Metabolism – Basic concepts, glycolysis, citric acid cycle, pentose phosphate pathway, b-oxidation of fatty acid, electron transport and oxidative phosphorylation. General reactions of amino acid degradation. Metabolic regulation. Secondary metabolites-terpenoids, alkaloids, phenolics.

Practical

Protein denaturation- heat, pH, precipitation of proteins with heavy metals, Estimation of crude protein, Estimation of protein by Lowry method; Enzyme assay; Extraction of nucleic acids; Extraction of oil from oilseeds; Estimation of crude fat; Estimation of iodine number and saponification value of an oil; Quantitative determination of sugars; Paper chromatography for the separation of sugars; Determination of phenols, chlorophyll, phosphorus and ascorbic acid.

Suggested Reading:

- Conn, E.E. and Stumpf, P.K. (1989). Outlines of Biochemistry, Wiley Eastern Ltd., New Delhi
- Mazur, A and Harrows, B. (1971). Textbook of Biochemistry. W.B. Sanders Publications, New Delhi
- Robert, C. B. (1983). Modern concepts in Biochemistry. Allyn and Bacon Inc. London
- William , H.E. and Daphne, C.E.(2005). Biochemistry and Molecular Biology, Oxford University Press.
- Sadasivam, S and Manickam, A. (2008). Biochemical methods, New age International (P) limited, Publishers
- Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry.* Freeman Publishers
- Narayanan L M. Biochemistry. Saras Publications
- Bose. Developments in Physiology Biochemistry & Molecular Biology of Plants Vol.-1. New India Publications.
- Voet, D and Voet J. G. 2004. Biochemistry 4th Edn. Wiley & sons Publishers. USA.
- Sadashiv, S and Manickam, A. 1996. Biochemical methods for Agricultural sciences. New age Interantional publishers, New Delhi.
- Voet, D. and Voet, J.G. 2004. (3rd edit). Biochemistry. John Wiley &Sons Incl.USA.
- Rameshwar, A. 2006. (3rd edit). Practical Biochemistry. Kalyani Publishers, NewDelhi.
- Buchanan, B. B., Gruissem, W. and Jones, R. L. 2002. Biochemistry and molecular biology of plants. 2nd edition. Blackwell publications, UK.

2. Introduction to Computers and Application 2(1+1)

Theory

Introduction to Computers, Types of computers, Characters of Computers, Organization of Computers, Operating system: DOS, UNIX and Windows, DOS Internal and External Commands, Unix basic Commands, Windows functional commands. Computer Networks: Introduction to Pure topologies and Hybrid topologies, Intranet and Internet communication systems, WORD: word processing, EXCEL: Electronic spreadsheet use, the built-in function with examples. Principle of programming: algorithm, flowchart, program, C-programming language-constants, variables, data types, operators and expressions, input, output operations, decision making and branching, arrays. Concept of Database, advantages and uses of database, creating database and simple queries using ACCESS. Concept of Power Point presentation.

Practical

Study of computer components; booting, shutdown of computer, practice internal DOS commands and editor commands. Practice assignments on C-programming language: operators and expressions, input, output operations, decision-making, branching and arrays. Practice WINDOWS: operating systems. Desktop commands and explore, creating folders and COPY, DELETE functions. Practice of WORDS: Creating, Editing, Saving, Creating TABLE, Split, Merge, alignments, formatting functions export to EXCEL. EXCEL: import table from WORD or create a table, function bar, using inbuilt functions, analysis of data. ACCESS: Creating data base, FORMS, QUERIES, REPORTS, use simple queries to analyse the data. POWERPOINT: Creating Slides on Power Point, transforming and add the animation to effective presentation.

Suggested Readings

- Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology.* Kalyani Publishers.
- Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.
- Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt. Ltd.
- Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI

3. Comprehension and Communicative English 2(1+1)

Theory

Reading comprehension-Scientific and general passages. Vocabulary development; Prefix and Suffix; Synonyms and Antonyms; words often confused. Homonyms and Homophones. Writing Skills-Mechanics of letter writing-business, official and personal letter. Preparation of curriculum vitae and job application; essay writing. Interview techniques: Purpose, settings, Physical makeup and manners, Poise, Functional Grammar; Agreement of subject and verb.

Practical

Listening Comprehension; Listening to short talks, lectures, speeches (scientific, commercial and general in nature). Spoken English: Importance of stress and intonation, sounds and phonetic symbols, vowels, consonants and diphthongs. Essentials of good conversation, oral exercises in conversation practice. Telephonic conversation, rate of speech, clarity of voice, speaking and listening politeness, telephone etiquette. Reading Skills: skimming, scanning, rapid reading. Presentation Skills: Features of oral presentation; body language, voice modulation, audience analysis, preparation of visual aids, Evaluation of presentation, practice of presentation using Power Point and LCD projector. Conducting mock interview-testing initiative, team spirit, leadership, motivation, group discussion, debates on current issues.

Recommended reading and for classroom use: Current English for Colleges by N. Krishnaswamy and T. Sriraman, Macmillan India Limited, Madras, 1995. Vocabulary Exercises based on TOEFL and GRE and other competitive exercise. A Dilemma- 'A layman looks at science' by Raymond B. Fosdich 'You and your English –Spoken English and Broken English' by G.B. Shaw. 'War minus shooting-the sporting spirit' by George Orwell.

Suggested Reading

- Balasubramanian T. 1989. A Text book of Phonetics for Indian Students. Orient Longman, New Delhi.
- Balasubrmanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
- Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
- Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
- Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
- Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
- Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.
- Carnegie, Dale. 2012. How to Win Friends and Influence People in the Digital Age. Simon & Schuster.
- Covey Stephen R. 1989. The Seven Habits of Highly Successful People. Free Press.
- Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. Human Communication: Motivation, Knowledge & Skills. Wadsworth.
- Verma, KC. 2013. The Art of Communication. Kalpaz.
- Dr. T. Bharati, Dr. M. Hariprasad and Pro. V. Prakasam, Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi.
- Wren and Martin, S. Key to High School English Grammar and Composition- Chand and Company Ltd., New Delhi
- Wren and Martin, S. High School English Grammar and Composition- Chand and Company Ltd., New Delhi
- Raymond Murphy, English Grammar in Use. Cambridge University Press
- The Official Guide to the TOEFL Test-IV Edition, Educational Testing Services. Mc Graw Hill, New Delhi.
- KrishnaMohanand, MeeraBanerjee, 1990. DevelopingCommunicationSkills. MacmillanIndiaLtd.

4. Agricultural Statistics 2(1+1)

Theory

Review of basic descriptive statistics (Frequency distribution, mean, variance, standard deviation etc.,).Probability: Definition and concept of probability; Binomial, Poisson and Normal Distribution and its properties; Introduction to Sampling: Random Sampling; the concept of Standard Error; Tests of Significance-Types of Errors, Null Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis; Large Sample Test-SND test for Means, Single Sample and Two Samples (all types); Small Sample Test for Means, Student's t-test for Single Sample, Two Samples and Paired t-test. F test; Chi-Square Test in 2x2 Contingency Table, Yate's Correction for continuity; Correlation: Types of Correlation and identification through Scatter Diagram, Computation of Correlation Coefficient 'r' and its testing. Linear Regression of

Y on X and X on Y. Inter-relation between 'r' and the regression coefficients, fitting of regression equations. Analysis of variance-one way and two way; Experimental Designs: Basic principles of Experimental Designs, Completely Randomized Design (CRD), Layout and analysis with equal and unequal number of observations, Randomized Block Design (RBD), Layout and analysis.

Practical

Computation of Arithmetic Mean, Variance, standard deviation and CV for Un-Grouped and Grouped data; Computation of simple probability; addition and multiplication rule; computation of Binomial and Poisson probabilities. Computation of probabilities using normal distribution. SND test for Means, Single Sample; SND test for Means, Two Samples; Student's t-test for single sample; student's t test for two sample ; paired t test and F test; Chi-Square Test in 2x2 Contingency Table, Yate's Correction for continuity; Computation of Correlation Coefficient 'r' and its testing; Fitting of regression equations-Y on X and X on Y; One way and two way analysis of variance. Analysis of Completely Randomized Design (CRD); Analysis of Randomized Block Design (RBD).

Suggested Reading:

- Gupta, S. C. and Kapoor, V. K. 2014. *Fundamentals of Mathematical Statistics*. Sultan chand and sons. New Delhi
- NageswaraRao,G.2007.*Statisticsfor AgriculturalSciences*. B.S. Publications,Hyderabad.
- Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad.
- Gupta, V.,2002. *Comdex Computer Kit*. DreamTechPress,NewDelhi.
- Parmar,A.Mathur,N.DeeptiP.U.andPrasanna, V. B., 2000. *Working with WINDOWS A Handson Tutorials*. Tata McGraw Hill Publishing Co., New Delhi.
- Bandari, V. B., 2012. *Fundamentals of Information Technology*. Pearson Education, New Delhi.
- *Fundamentals of Computers*. 2011. Pearson Education-ITL ESL, New Delhi

5. Physical Education, Health Education and Recreation 1(0+1)

Practical

Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules and regulations of important games, skill development in any one of the games, football, hockey, cricket, volleyball, badminton, throw ball, tennis. Participation in one of the indoor games, badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events, long jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-to-day activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience.

Suggested Reading:

- O.P. Aneja. Encyclopaedia of Physical education, sports and exercise science (4 volumes).
- Anil Sharma. Encyclopaedia of Health and Physical Education (7 Volumes).

- N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).
- Pintu Modak, O P Sharma, Deepak Jain. Encyclopaedia of Sports and Games with latest rules and regulations (8 volumes).
- Edwin F Bryant. Yoga sutrap of Patanjali.

6. National Service Scheme 1(0+1)

Practicals

NSS-Orientation of students in national problems, study of philosophy of NSS, fundamental rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, non-formal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition.

6. AGRICULTURAL AND ALLIED SUBJECTS

1. Introductory Agriculture, Principles of Agronomy and Soil Management 3(2+1)

Theory

Art, Science and Business of crop production, Basic elements of crop production; Factors affecting crop production; History of Agricultural Development; Ancient Indian Agriculture, Chronological stages of development of agriculture, Agricultural research and education with special reference to India and Karnataka. Contribution of agriculture and horticultural crops to national economy. Importance and scope of agriculture, horticulture, sericulture, animal husbandry and forestry as farming enterprises and relation to industry. Women in agriculture-Multifaceted roles and tasks, work stress factors. Soil factors, weather factors, ecology, crop distribution, adaptation and crop production centers. Factors affecting plant growth, dry and irrigated agriculture, farming system approach and value addition in agriculture. Agro-climatic zones of India and Karnataka; methods of crop production; Tillage-meaning, concepts and types of tillage, crops stand establishment, planting geometry and its effect on growth and yield. Classification of crops, selection of seed material. Importance of soil in crop production. Concepts of soil fertility and productivity and their improvement. Effects of tillage on soil physical properties and root growth. Requirement of ideal seedbed. Green manuring, manure and fertilizer management for different cropping systems. Fallowing-Advantages and limitation, Agronomic management for different soils. Agronomic management of problematic soils.

Practical

Area, production, productivity of important crops in World, India and Karnataka; Identification and classification of field crops; Factors affecting crop production; Seedbed preparation for field crops; Study of tillage implements; Methods and practice of ploughing; Practice of puddling; Study of seeding equipments and introduction of remote sensing; Different methods of sowing; Study of manures, fertilizers and green manure crops/seeds (including calculations); Study of inter-cultivation implements and practice; Study and practice of special implements; Preparation of FYM and compost; Methods of fertilizer application; Participation in ongoing field operations.

Suggested Reading:

- William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
- Arnon L. 1972. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.
- Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
- Gupta O P. 1984. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.
- Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
- Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers Ludhiana.

2. Water Management including Micro Irrigation 2(1+1)

Theory

Definition of irrigation; History of irrigation in India; Water resources -their exploitation; Scenario of irrigation in India-canal, tank, well and lift irrigation systems. Soil water relations; Introduction to basic terms in water management & irrigation; study of moisture constants and hydro dynamic relations; Measurement of soil moisture-different direct and indirect methods; Expressions of soil moisture and their mutual relations; Plant water relations-critical stages; Meaning and impact of water stress; Water availability & its relationship with nutrient availability and losses; Water management of crops-its definition, meaning, measurement and relevance in crop production; Concept of evapotranspiration and its measurement; Factors affecting water requirement; Study of water requirement of field crops and horticultural crops. Methods of irrigation-surface, subsurface, sprinkler and drip; Their types and efficiencies; Constraints and advantages of different methods; Efficiency of irrigation; methods to measure them. Quantitative estimation of irrigation water-direct and indirect methods; expressions of flowing water and their mutual relations; Concept of water use efficiency, its relevance and factors affecting it-methods to improve WUE. Assessment of irrigation requirement. Scheduling of irrigation-approaches and methods to schedule irrigation; Development of irrigation plans for individual farms and micro and macro commands. Suitability of irrigation water for irrigation-quality of water & its impact on growth, development and yield of crops. Irrigation control and water conveyance methods-their advantages & disadvantages; Concept of drainage-surface and subsurface methods of drainage. Irrigation practices of important field and horticultural crops.

Practical

Determination of soil moisture by direct and indirect methods-study of gravimetric, volumetric methods; Study of tensiometers, gauges, resistance blocks, moisture meters, rapid moisture meters, latest electronic devices; Study and determination of maximum water holding capacity, field capacity, permanent wilting point, bulk density and infiltration rates of soil; Concept of capillarity-its demonstration. Study of methods of flow measurement-expressions of flow; Study and use of weirs, orifices, parshall flumes, flow meters, aquameters. Study of surface irrigation methods-field layouts, their significance; Study of sub-surface irrigation methods; Study of sprinkler system-their types, wetting patterns, coverage and field methods to install sprinkler systems; Study of drip method of irrigation-their types and field methods to install them. Study

of water requirement of different crops. Study of various on-farm structures for irrigation control, drop structures-their demonstration; Study of drainage structures. Study and practice of various types of numerical problems in irrigation and water management.

Suggested Reading:

- Rao, Y.P. and Bhaskar, S.R. Irrigation technology. Theory and practice. Agrotech publishing Academy, Udaipur.
- Dilip kumar Mujmdar. Irrigation water management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
- S.V. Patil & Rajakumar, G. R., Water Management in Agriculture and Horticultural Crops. Satish serial publishing House, Delhi.
- Carr M. K. V. and Elias Fereres. Advances in Irrigation Agronomy. Cambridge University Press.
- Michael, A.M. Irrigation Theory and practice. Vikas publishing house Pvt, Ltd.
- Water Technology Centre. Water Requirement and irrigation management of crops in India. Indian Agrl. Research Institute, New Delhi.

3. Agricultural Meteorology, Rainfed Agriculture and Watershed Management 2(1+1)

Theory

Introduction–History and importance of rainfed agriculture in India and Karnataka. Weather and climate- Earth's atmosphere, composition and structure. Weather elements – Solar radiation, temperature, relative humidity, atmospheric pressure, wind, cloud formation and classification, precipitation and monsoon. Weather hazards and weather forecasting. Rainfall pattern and aberrant weather conditions of rainfed agriculture. Soil erosion-types, losses and conservation techniques (Mechanical Measures). Infiltration and run-off- In situ soil moisture conservation techniques (Agronomic measures). Tillage – Conservation tillage, fall ploughing and fallowing. Plant ideotypes- crops and cropping systems for drylands. Crop establishment techniques-contingency crop planning and midseason corrections. Use of mulches and anti transpirants. Soil fertility management in drylands- residue management. Watershed management- concepts and components. Water harvesting and recycling. Wastelands – types and management and alternate land use systems. Dryland practices and watershed management suggested for different agro-climatic zones of Karnataka.

Practical

Selection of site for Agro-met observatory; Measurement of sunshine and solar radiation; Measurement of air and soil temperature and relative humidity; Measurement of wind speed and wind direction; Measurement of rainfall and its analysis; Rainfall patterns in dryland regions of Karnataka; Measurement of evaporation and atmospheric pressure; Classification of climate and agro-climatic zoning; Preparation of isotherms, isohyets and isobars; Preparation of synoptic charts and crop weather calendars; Visit to crop weather observatory at GKVK; Estimation of soil loss – universal soil loss equation; Study on mechanical measures of soil erosion control; Study on *in situ* soil moisture conservation techniques for red soils; Study on *in situ* soil moisture conservation techniques for black soils; Study on *in situ* soil moisture conservation techniques for

dryland orchards; Study on effect of mulches on soil moisture and plant growth; Study of farm pond-construction and maintenance; Study of special implements used in dryland agriculture; Visit to operational research project of dryland and model watershed.

Suggested Reading

- A.K.Srivastava and P.K.Tyagi, 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
- D.Lenka, 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
- G.S. L.H .V.Prasad Rao, 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
- H.S.Mavi and Graeme J.Tupper, 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
- H.S.Mavi, 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- H.V.Nanjappa and B.K.Ramachandrappa, 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
- S.R.Reddy, 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.
- T.Yellamanda Reddy and G.H.Sankara Reddi, 2010. Principles Of Agronomy. Kalyani Publishers, New Delhi.

4. Farming Systems, Organic Farming and Sustainable Agriculture 3(2+1)

Theory

Sustainable agriculture- definition, concept, goals; factors affecting ecological balance- land degradation, water and air pollution, global warming, impact and amelioration; sustainable agriculture practices-natural farming, alternative farming, integrated farming. HEISA, LEISA and BIOFARMS. Farming systems– principles, concepts, components; cropping systems; sequential cropping, crop rotation, relay and ratoon cropping, multistorey cropping, filler and inter planting in orchards; Assessment of multiple cropping advantages; delineation of efficient cropping zones based on RYI and RSI and strategies for improving crop productivity in different zones; IFS models for dry, wet, wastelands and for different agro climatic situations. Organic farming-concept, definition, principles, components, scope, relevance in the present context; organic production requirement, permitted and restricted inputs in organic farming; biological intensive nutrient management, traditional and non-traditional additives in organic farming; Weeds, pests and diseases management practices in organic farming; Quality considerations, certification, accreditation, labeling, marketing and exports. Definition of precision agriculture scope and concept of precision agriculture, components of precision agriculture. Global Positioning System (GPS), Geographic Information System (GIS), Computer software model and remote sensing for aerial/satellite imagery. Site Specific Nutrient Management (SSM) for nutrient and irrigation management practices. Comparative yield, quality and farm profits under SSM practices V/s Uniform Rate Technology (URT) practices.

Practical

Assessment of multiple cropping advantages and sustainability; Preparation of cropping schemes for rainfed situations, Preparation of cropping schemes for irrigated situations; Preparation of IFS models for rainfed and irrigated lands; Preparation of IFS models for wet and wastelands; Recycling of crop residues in agriculture; Preparation of enriched compost and vermicompost; Composting industrial and urban biowastes; Resource allocation and management of dairy, poultry, piggery, sericulture as a component of IFS; Labour resource management, labour saving techniques, farm records and farm book keeping; Indigenous technical knowledge in organic farming; Preparation and use of botanicals in organic farming; Processing. Certification and accreditation in organic farming.

Suggested Reading

- A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
- Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
- A.C.Gaur. *Handbook of Organic farming and biofertilizers*.
- S.P. Palaniappan and K.Annadurai. 2010. *Organic farming – Theory and Practice*. Scientific Publishers. Jodhpur.
- U.Thapa and P. Tripathy. *Organic farming in India*- Problems and Prospects.
- G.K.Veeresh. 2006. *Organic farming*. Foundation Books. New Delhi.

5. Principles of Agricultural Resource Economics 2(1+1)

Theory

Economics: Meaning, Definition, Subject matter, Divisions of Economics, Importance of Economics; Agricultural Economics- Meaning, Definition; Basic Concepts: Goods, Service, Utility, Value, Price, Wealth, Welfare. Wants: Meaning, Characteristics, Classification of Wants, Importance. Theory of consumption: Law of Diminishing Marginal utility: Meaning, Definition, Assumption, Limitations, Importance. Consumers' surplus: Meaning, Definition, Importance. Demand: Meaning, Definition, Kinds of Demand, Demand schedule, Demand Curve, Law of Demand, Extension and Contraction Vs increase and Decrease in Demand. Engel's Law of Consumption. Elasticity of Demand: Types of Elasticity of Demand, Degrees of price elasticity of Demand, Methods of measuring elasticity, Factors influencing elasticity of Demand, Importance of Elasticity of Demand. Supply: Meaning, Definition, Law of supply, Supply schedule, Supply curve, Elasticity of supply and importance, Welfare Economics: Meaning, Pareto's optimality. National Income: Concepts, Measurement. Public Finance: Meaning, Principles. Public Resource: Meaning, Service Tax: Meaning, Classification of Taxes: Cannons of Taxation, Public expenditure: Meaning, Principles. Inflation: Meaning, Definition, Kinds of inflation. Role and Importance of Agriculture in Indian Economy. Significant Economic problems in Indian Agriculture. Natural Resource Economics: Meaning and concepts. Concept of Externality.

Practical

Law of Diminishing Marginal Utility, Consumers' surplus, Law of demand, Demand/supply, Demand/supply schedule, Demand/supply curve, Elasticity of demand/ supply methods of measuring elasticity, Engel's Law of Consumption, Economic importance of Factors of Production-Land, Labour, Capital, Organization (Management) etc.

Suggested Reading

- H L Ahuja. S. Chand and Company Limited. *Advanced Economic Theory*. Micro Economic Analysis.
- Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.
- Dewett, K.K. and Chand, A.1979. *Modern Economic Theory*. S.Chand and Co., New Delhi
- Dewett, K.K. and Varma, J.D. 1986. *Elementary Economics.* S.Chand and Co., New Delhi.
- Gupta RD & Lekhi RK. 1982. *Elementary Economic Theory*. Kalyani Publishers.
- Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.
- Jhingan, M.L. 2012. *Macro Economic Theory*. Vrinda publishers, New Delhi .
- Kotler Philip and Armstrong. *Principles of Marketing*. Prentice-Hall.
- SS Acharya and N L Agarwal. 2005. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd
- Sampat Mukherjee. 2002. *Modern Economic Theory*. New Age International.
- Subba Reddy, S., Raghu ram, P., Neelakanta Sastry T.V., Bhavani Devi. I., 2010, *Agricultural Economics*, Oxford & IBH Publishing Co. PrivateLimited, New Delhi
- Willium J. Stanton. 1984. *Fundamentals of Marketing*. Tata McGraw-Hill Publication, New Delhi.
- C.N. Sontakki. *Marketing Management*. Kalyani Publishers, New Delhi.
- John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. *International Business*, 15th Ed., Pearson Education
- Aswathappa. *International Business*. Tata McGraw-Hill Education, New Delhi
- Fransis Cherunilam. *International Business*: Text and Cases, 5th Ed. PHI Learning, New Delhi.
- Prasanna Chandra. Projects. Tata McGraw-Hill Publication, New Delhi
- John M. Nicholas. *Project Management for Business and Technology* – Principles and Practices. Pearson Prentice Hall
- Harold Kerzner. *Project Management – A System Approach to Planning, Scheduling, and Controlling.* CBS Publishers & Distributors.
- Prasanna Chandra. *Projects – Planning, Analysis, Selection, Financing, Implementation, and Review.* Tata McGraw-Hill Publishing Company Ltd.
- P. Gopalakrishnan and V.E. Rama Moorthy. *Textbook of Project Management*. Macmillan

6. Seri-Business Management 2(1+1)

Theory

Costs and production theory, importance of sericulture in rural, national and world economy. Special characteristics of sericulture visa-vis other agricultural enterprises. Economics

of Mulberry leaf production, Grainage, Chawki rearing, cocoon production, reeling, twisting, Dyeing and weaving. Break ever analysis: Risk and Uncertainty in Sericulture – Future trading speculation, Arbitrage and hedging, contract farming and supply chain management Institutional setup. CSB, Silk exchange, Karnataka silk, marketing Board and KSIC their organizations and functions. Externalities, linkages and market intelligence in sericulture. International trade in sericulture. AOTF-WTO Employment generation under different enterprises of sericulture. Management principles and functions. Organising, staffing, Directing, Motivation Ordering leading, Supervision, communication and control. Difference between Farm and Non-farm Management, Horizontal and vertical integration. Co-ordination in sericulture based industries – meaning – classification and feasibility. Analysis, Nature and scope of Business Management.

Capital Management in Trade and Sericulture industries, meaning, definition and scale of business finance. Sources of capitalization, asset utilization. Technology up gradation and replacement strategies. Management of production including human resources, machineries, marketing market segmentation, product life cycle. Pricing policy : meaning, price, differentiation. Project: Definition, project cycle, Appraisal and evaluation techniques, pay Back period, B:C ratio NPV and IRR. Sensitivity analysis. SWOT Analysis. Profit theories meaning definition, Normal profit, economic profit under total and marginal approach. Analysis of Business performance, solvency ratios, Liquidity ratios, Efficiency ratios and profitability ratios. Developing the marketing mi ie., 4 ps -product, price, promotion, place and brand. Planning: Meaning and definition, objectives, policies, strategies and procedures, rules and programmes.

Practical

Economics of Mulberry Production, Economics of Grainage and Chawki rearing, Economics of cocoon production, Economics of Reeling (Charaka, Cottage basin, Multiend), Economics of Twisting and Dyeing, Economics of Weaving, Evaluation of investment in Sericulture payback period, B:C ratio NPV and IRR, Visits to different institutions concerned to sericulture industries – Silk exchange, Grainage, KSIC, Reeling, Twisting dyeing and weaving units, Time series analysis silk prices, SWOT analysis, Study of value addition in sericulture products , Study of financing institutions, CB, SCB, RRB, NABARD, KSFC etc., Study of export and import of silk goods, Study of profit and loss statement of a firm, Economics of new innovations (strategic), Assignments presentation, Group discussion.

7. Farm Power, Renewable Energy, Surveying & Soil Water Engineering 3(2+1)

Theory

Introduction to Machinery and equipment in Mulberry cultivation, land preparation, primary and secondary tillage, Inter-cultivation, Mulberry harvesting and chopping machines. Designing and development of equipments for Pruning, Harvesting, Weeding, Drip designing, planning and Sprinkler irrigation, Water scheduling and conservation techniques, Root pruning methods, Mechanization in mulberry: management of ploughs, cultivators, sprayers, tractor, tiller, weeder, pruning machine, ITK in moriculture, Introduction to environmental engineering – psychometry. Renewable energy, sources of renewable energy, types advantages and limitations. Objectives of surveying types of surveyors, error, chains their types and uses. Ranging of chain lines. Soil erosion,

causes and effects of erosion. Erosion by water and wind factors affecting erosion. Methods of erosion control. Irrigation principles, practices and systems surface, subsurface, micro irrigations, Drip irrigation machinery and mechanism, design engineering of layout of drip irrigation for mulberry/host plant production.

Practical

Study of primary and secondary tillage equipments. Equipments and measuring instruments for temperature, humidity, light and wind. Mulberry harvesting and chopping machines. Study of machines in Mulberry cultivation. Regulation and maintenance of environmental conditions in silkworm rearing. Machineries in Silkworm rearing. Cocoon mixing, deflossing and riddling machines. Stifling machines. Cooking machines. Brushing machines. Study of charaka and cottage basin silk reeling machines. Multiend silk reeling machines. Study of automatic and semiautomatic silk reeling machines. Permeation and silk re-reeling machines. Silk testing equipments, silk throwing. Non-Mulberry silk reeling machines. Spun silk processing machines. Care and maintenance of machineries.

Suggested Reading

- Jagdishwar Sahay, Elements of Agricultural Engineering. Standard Publishers Distributors.
- T.P. Ojha andA.M. Michael. (2005) Principles of Agricultural Engineering (Volume - 1), Jain Brothers
- Manoj Kumar Ghoshal and Dhirendra Kumar Das, Farm Power,Kalyani Publishers.
- Surendra Singh. Farm Machinery Principles and Applications. ICAR Publications
- Roth / Field. Intro. Agricultural Engg.: Prob. Solving Appro., 2e. CBS PUBLISHERS & DISTRIBUTORS PVT. LTD.
- Surendra Singh & Verma. Farm Machinery Maintenance & Management. ICAR Publication.
- M.M. Pandey & Others. Handbook of Agricultural Engineering. ICAR publication.

8. Management of Sericultural Machineries & Equipments 1(0+1)

Practical

Designing and development of rearing houses and equipments, Low cost ventilation systems, Management of microclimate with indigenous techniques, gunny cloth, shade net, water pots, charcoal stoves, dusting devices, micro sprinklers. Designing and development of mountages and mounting sheds, Incubation, Leaf preservation and micro climate maintenance equipments and Chawki rearing equipments, Plant protection equipments, Late age rearing equipments, Innovation of disinfectants, organic and inorganic feed fortification, artificial diets, Refinement of ITK, Organic products for plant and silkworm protection. Designing and development of hand spinning devices, Repairs and management of reeling and throwing machines. Chawki rearing chambers. Permeation chambers-sophisticated testing equipments – Tasar and muga reeling machines. Silk twisting and throwing equipments. Structures for rearing equipments for harvesting and chopping mulberry leaves. Revolving mountages – cocoon stifling structures. Cocoon driers. Cocoon harvesting devices. Cocoon sorting machines-riddlers-deflossing machines. Cocoon cooking and brushing machines. Reeling machines – charaka, cottage basin domestic basins

filature basins – Automatic reeling basins-re-reeling machines. Permeation chambers. Boilers for production of steam design and planning filature and cotton basin units. Non-Mulberry cocoon reeling machines. Maintenance of machinery, Maintenance kits.

9. Insect Morphology and Systematics 3(2+1)

Theory

Entomology- Definition/meaning and its scope. History of entomology in India. Factors for insects adbundance. Character of the class Insecta, structure of typical insect. Structure and functions of body wall and its appendages, moulting process, body segmentation, structure of head, mouth parts, types of mouth parts, modifications of insect antennae. Structure of thorax, types of legs, wing venation, modifications and wing coupling apparatus. Structure of abdomen and its appendages, structure of ovipositor, structure of abdomen and its appendages, structure of ovipositor, structure of male and female genitalia. Sensory organs, Metamorphosis and diapause in insects. Types of larvae and pupae. An elementary knowldedge of internal systems and their functions-digestive, circulatory, excretory, respiratory, nervous, secretory (endocrine) and reproductive systems in insects. Types of reproduction in insects. Systamatics: Definition of Taxonomy, systematics, classification and its importance, Brief history of classification, Nomenclature definition, objectives, Guidelines for the Binomial nomenclature as indicated by ICZN. Definitions of Biotypes, species, sub species, genus, family, order, tribe, hierarchy, Taxonomic categories; Type concept in nomenclature, general classification of insects up to orders. Characteristics and general habits of economically important insect orders and families.

Practical

Study of phylum Arthropoda, study of insects with special reference to cockroach, study of immature stages of insects, modifications of insect appendges, types of insect mouth parts, dissection of digestive, circulatory including salivary glands, nervous and reproductive systems in insects, collecting and curating insects, and General classification of insects and study of wingless primitive insects (Collembola and Thysanura), Study of insect orders – Odonta, Blattodea, Mantodea, Isoptera, Orthoptera, Phthiroptera, Hemiptera (sub order Heteroptera and Homoptera), Thysanoptera, Coleoptera, Diptera, Siphonoptera, Lepidoptera and Hymenoptera.

Suggested Reading

- Awasthi, V.B. 1997. *Introduction to general and applied entomology*. Scientific Publishers, Jodhpur, 379 p.
- Borror, D.J., C.A. Triple Horn and N.F.Johnson. 1987. *An introduction to the study of insects (VI Edition)*. Harcourt Brace College Publishers, New York, 875p.
- Chapman, R.F. 1981. *The Insects: Structure and function*. Edward Arnold (Publishers) Ltd, London, 919p.
- Gullan, P.J. and Cranston, P.S. 2001. *The insects- An outline of entomology*, II edition, Chapman & Hall, Madras, 491p.
- Mani, M.S. 1968. *General entomology*. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 912p.

- Nayar, K.K., T.N.Ananthakrishnan and B.V. David. 1976. *General and applied entomology*, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.
- Richards, O.W. and R.G. Davies. 1977. *Imm's general text book of entomology*, Vol.1&2, Chapman and Hall Publication, London, 1345p.
- Romoser, W.S. 1988. *The Science of Entomology*, McMillan, New York, 449p.
- Saxena, S.C. 1992. *Biology of insects.* Oxford and IBH Publishing Co. Pvt Ltd, New Delhi, 366p.
- Srivastava, P.D. and R.P.Singh. 1997. *An introduction to entomology*, Concept Publishing Company, New Delhi, 269 p.
- Tembhare, D.B. 1997. *Modern Entomology*. Himalaya Publishing House, Mumbai,623p.
- Pedigo, L.P. 1999. *Entomology and pest management*. III Edition. Prentice Hall, New Jersey, USA, 691p.
- H. Lewin and Devasahayam. Practical manual of entomologyinsect and non-insect pests

10. Introduction to Apiculture 2(1+1)

Theory

History and development of Bee-keeping. How, when and where to start bee-keeping. Species of honeybees, their colony structure; morphology and anatomy, glandular system in relation to behaviour. Bee biology, caste determination, swarming and its prevention; robbing and its prevention. Age related activities of workers. Communication in honeybees. Queen rearing and multiplication of colony. Queenless colonies and their rectification. Seasonal management practices. Study of bees as pollinators, bee flora and pollination management. Pests and diseases of bees. Hive products and their uses. Poisoning of bees and its prevention. Economics of bee keeping.

Practical

Identification of honeybee species, their castes, comb structure and stages. Handling of bee colony and colony inspection. Study of beehives and bee keeping equipments. Dissection of worker bees to study different morphological and anatomical characteristics. Hiving of colony, management practices like feeding, dividing, uniting, prevention of swarming, robbing and absconding. Fixing comb foundation sheet, providing of super chamber; extraction, processing and testing of honey and other products. Study of bees as pollinators. Identification of bee flora. Identification of bee pests and diseases. Visit to important apiaries and bee keeping societies around the region.

Suggested Reading

- Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.
- Sunita, N.D, Guled ,M.B, Mulla S.R and Jagginavar,2003, Beekeeping
- Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
- Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).
- Paul DeBach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991).
- YA Shinde and BR Patel. Sericulture in India.

- Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd.
- M.L. Narasaiah. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.

11. Pests of Crops and stored Products and Management 3(2+1)

Theory

Distribution, biology, nature and symptoms of damage and management stratergies of insect and non-insect pests of rice, sorghum, maize, ragi, wheat, sugarcane, cotton, mesta, sunhemp, pulses, groundnut, castor, sesamum, safflower, sunflower, mustard, brinjal, bhendi, tomato, cruciferous and cucurbutaceous vegetables, potato, sweet potato, colacasia, moringa, amaranthus, chillies, mango, citrus, grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut, arecanut, tobacco, coffee, tea, turmeric, betelvine, onion, coriander, garlic, curry leaf, pepper, ginger and ornamental plants. Stored grain pests-coleopteran and lepidopteran pests, their biology and damage, preventive and curative methods.

Practical

Identification of pests of rice, sorghum, maize, wheat, sugarcane, cotton, pulses, Solanacceous and Malvaceous vegetables, Cruciferous and Cucurbitaceous vegetables, chilli, mango, citrus and sapota, their damage symptoms and management.

Suggested Reading

- Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.
- David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.
- Dhaliwal, G.S and Ramesh Arora, 1998. Principles of insect pest management. Kalyani Publisher, 297p.
- Dhaliwal, G.S and E A Heinrichs 1998. Critical issues in pest management. Common wealth publisher, New Delhi 287p.
- P. Srivastava, Dhamo K. Butani Pest management in vegetables – Part1. Researcho Book Centre, 1998
- K.P. Srivastava, Dhamo K. Butani Pest management in vegetables – Part-2. Researcho Book Centre, 1998
- David. V. Alford. Pest of fruit crops.
- Sathe. Recent trends in Biological pest control
- Bhargava and Kumawati. Pest of stored grains and their management
- G. S. Dhaliwal and Opender Koul. Bio pesticides and pest management
- A. M. Ranjith. Identification and management of Horticultural pest.
- Rachna and Benna kumari. Pest management and residual analysis in horticultural crop
- K. P. Srivastav and Y. S. Ahawat. Pest management in citrus
- Ramnivas sharma. Identification and management of horticulture pest.
- Opender Koul, G. S. Dhaliwal and S. S.Marwaha. Biopesticide and pest management
- Fryer. Insect pest of fruit crops

- V. P. S. Panwar. Agricultural insect pests of crops and their management
- T. V. Sathe. Pests of ornamental plants.
- A. S. Atwal. Agricultural pests of south Asia and their management
- Mark Vernon Slingerland and C. R. Crosby. Mnaual of fruit insects
- S. F. Hameed and S. P. Singh. Hand book of pest management
- K. K. Marwaha, K. H. Siddiqui and J. P. Singh. Hand book of crop pest control

12. Pests of Host Plants of Silkworms and their Management 2(1+1)

Theory

Concepts and principles of crop pest management, status of a pest. Biotic potential and environmental resistance. Insect and non-insect pests of Host Plants of mulberry and non-mulberry silkworms (Host plants of tasar, eri and muga silkworms namely *Terminalia* spp. Sal, Oak, Castor etc.) sequence of their appearance, duration, intensity, nature and symptoms of attack. Bioecology of pests, Management practices, measures of control. Pesticides residue problems, safety periods to be observed.

Practical

Study of various pests of host plants, their diagnostic characters, symptoms of damage and management measures to be adopted. Visit to crop fields to record the incidence of pests noticed and control measures, management practices suggested in each case, in addition to recording nature and symptoms of damage and estimation of losses. Collection of pests and affected samples of host plants of Silkworms.

Suggested Reading

- FAO, 1987, Manual on Sericulture Vol – I, FAO.
- S R Ullal and M N Narasimhanna, 1987, Handbook of Practical Sericulture, CSB, Bangalore
- Anon., 1975, Text Book of Tropical Sericulture, Japan Overseas Corporation Volunteers.
- Gupta S, Pradeep Kumar, Baig M and Govindaiah, 1990, Handbook on Pest and Disease Control of Mulberry and Silkworm – United Nations Publication (ESCAP), Bangkok, Thailand
- Ganga, G & J Sulochana Shetty, 1972, An Introduction to Sericulture, Oxford & IBH Pub.
- Handbook of Pests & Diseases of Mulberry and Silkworm, UNESCAP, Bangkok, Thailand
- Govindaiah, V K Gupta, D D Sharma, S Rajadurai and V Nishitha Naik, 2005, A Textbook of Mulberry Crop Protection, CSB, Bangalore.
- S B Chattopadyay, 1991, Principles and Procedures of Plant Protection, Oxford IBH Co. Pvt. Ltd.
- Khan M A, Dhar A, Zeya S B and Trag A R, 2004, Pests and Diseases of Mulberry and their management, BSMP Singh, Dehradun.

13. Fundamentals of Rural Sociology, Educational Psychology and Constitution of India 2(0+2)

Practical

Sociology and Rural Sociology: Meaning, Definition, Scope, Importance of Rural Sociology in Agricultural Extension: Indian Rural Society: Important characteristics, Differences between Rural and Urban communities; Social Groups: Meaning, Definition, Classification, Factors considered in formation of groups; Social Stratification- Meaning, Definition, Bases for stratification, Forms of Social stratification- Characteristics and Differences between Class and Caste Systems; Cultural concepts: Culture, Customs, Folkways, Mores, Taboos and Rituals: Meaning and Definition; Social Values: Meaning, Definition and Types; Social Institutions: Meaning, Definition, Major institutions- Family, Village Panchayat and Co-operatives- their Functions and Role in Agricultural Extension; Social Organizations- Meaning, Definition and their types; social control- Meaning, Definition, Need of social control and means of social control; social change-meaning, definition, Nature of Social change, Dimensions of social change and factors of social change; Leadership-Meaning, Definition, Classification and Role of leaders in Agricultural Extension. Psychology and Educational Psychology: Meaning, Definition, Scope and Importance of Educational Psychology in Agricultural Extension. Experiment: Introduction to experimental psychology. Intelligence: Meaning, Definition, Types, Factors affecting intelligence and Importance of intelligence in Agricultural Extension. Experiment: 1 Non-verbal test (RPM). 2. Verbal test (GMAT). Personality: Meaning, Definition, Types, Factors influencing Personality and its Role in Agricultural Extension. Experiment:1.Eysenk personality inventory; 2.Edward's personality inventory. Teaching- Learning process: Meaning and Definition of Teaching, Learning, Learning experience and Learning situation, Elements of learning situation and its characteristics; Principles of learning and their implication for Teaching. Experiment: 1. Associative learning; 2. Trial and error learning. Attitudes: Meaning, Definition, Factors influencing and their Role in Agricultural Extension; Experiment: Attitude measurement. Meaning, Preamble and Characteristics of Constitution of India; Fundamental Rights and Duties; Directive Principles of State Policy; Constitutional provisions for welfare of SCs and STs, Minorities, Women and Children; Union Executive: President, Vice-President, Prime Minister, Council of Ministers-Powers and Functions; Parliament and Supreme Court of India-Powers and Functions; State Executive: Governor, Chief Minister, Council of Ministers; Legislature and Judiciary: Powers and Functions; Electoral Process; Human Rights Commission-Structure, Powers and Functions.

Suggested Reading

- Chitambar, J.B. 1973. Introductory rural sociology. John Wilex and Sons New York.
- Desai, A.R. 1978. Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. Ed.
- Doshi, S.L. 2007. Rural sociology.Rawat Publishers, Delhi.
- Jayapalan, N. 2002. Rural sociology, Altanic Publishers New Delhi.
- Sharma, K.L. 1997. Rural society in IndiaRawat Publishers, Delhi.

14. Fundamentals of Extension and Rural Development 2(1+1)

Theory

Education – Meaning, Definition, Types – Formal, Informal and Non-formal Education and their Characteristics. Extension Education and Agricultural Extension – Meaning, Definition, Concepts, Objectives and Principles. Rural development – Meaning, Definition, Concepts, Objectives, Importance and Problems in rural development. Developmental programmes of pre-independence era – Sriniketan, Marthandam, Gurgaon experiment and Gandhian constructive proprogramme. Development programmes of Post Independence era, Firka Development, Etawah – Pilot project and Nilokheri Experiment. Community Development Programme – Meaning, Definition, Concepts, Philosophy, Principles, Objectives, Differences between Community Development and Extension Education, National Extension service. Panchayat Raj system – Meaning of Democratic – Decentralization and Panchayat Raj, Three tiers of Panchayat Raj system, Powers, Functions and Organizational setup. Agricultural Development Programmes with reference to year of start, objectives & salient features – Intensive Agricultural District Programme (IADP), High Yielding Varieties Programme (HYVP), Institution Village Linkage Programme (IVLP), Watershed Development Programme (WDP), National Agricultural Technology Project (NATP), ATMA, ATIC. Social Justice and Poverty alleviation programmes – Integrated Tribal Development Agency (ITDA), Integrated Rural Development Programme (IRDP), Swarna Jayanthi Gram Swarojgar Yojana (SGSY), Prime Minister Employment Yojana (PMEY). New trends in extension, privatization. Women Development programmes – Development of Women and Children in Rural Areas (DWCRA), SHG/ Stree Shakt Yojana; Reorganized extension system (T&V System) – Salient features, Fortnight Meetings, Monthly workshops, Linkages, Merits and Demerits, Emergence of Broad Based Extension (BBE). Raitha Samparka Kendras (RSK's). Entrepreneurship Development: Assessing overall business environment in the Indian Economy. Over view of Indian Social, Political and Economic Systems and their implications for decision making by individual entrepreneurs. Globalization and emerging business / entrepreneurial environment concept of Entrepreneurship: entrepreneurial, managerial characteristics; managing an enterprise: motivation and Entrepreneurship Development: Importance of Planning, Monitoring, Evaluation and follow up; managing competition; Entrepreneurship Development Programme: SWOT analysis, generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs) / SSIs. Export and Import policies relevant to Agriculture Sector. Venture capital. Contract farming and joint ventures, Public – Private partnership. Overview of Agri-inputs industry. Characteristics of Indian Agricultural Processing and Export Industry. Social Responsibility of business. ICAR TOT programs - National demonstrations, ORPs, Lab-to-Land programme, KVK's. Recent Advances in Rural Development Programmes-MGNAREGA, Krishi Bhagya.

Practical

Visits to a village and kissan mandal to study the ongoing development programmes. Visits to Panchayat Raj Institutions to study the functioning of Gram Panchayat (GP) & Zilla Praja Parishad (ZPP). Visit and study the District Rural Development Agency (DRDA). Participation in Bimonthly workshops of Training and Visit (T & V) System. Visit to Watershed Development

Project area. Visit to a village to study the Self Help Groups (SHGs) of DWCRA. Visit to a voluntary organization to study the developmental activities. Organizing PRA techniques in a village to identify the agricultural problems. Review of selected case studies. SWOT Analysis of Selected Entrepreneurs / Enterprises.

Suggested Reading

- Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O. P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
- Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
- Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship And Communication Skills*, Kalyani Publications.
- Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
- Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.

15. Communication and Extension Methodologies for Transfer of Technology 3(2+1)

Theory

Communication –Meaning, Definition, Models, Elements and their characteristics, types and barriers in communication. Extension Programme, Planning- Meaning, Definitions of Planning, Programme, Project, Importance, Principles and Steps in Programme Development Process, Monitoring and Evaluation of Extension Programmes. Extension Teaching Methods-Meaning, Definition, Functions and Classifications. Individual Contact Methods – Farm and Home visit, Result Demonstration, Field Trials-Meaning, Objectives, Steps, Merits and Demerits. Group Contact Methods-Group Discussion, Method Demonstration, Field Trips – Meaning, Objectives, Steps, Merits and Demerits. Small Group Discussion Techniques – Lecture, Symposium, Panel, Debate, Forum, Buzz Group, Work Shop, Brain Storming, Seminar and Conference. Mass Contact Methods- Campaign, Exhibition, Kissan Mela, Radio and Television-Meaning, Importance, Steps, Merits and Demerits. Factors influencing the selection of Extension Teaching Methods and Combination (Media Mix) of Teaching Methods. Innovative Information Sources – Internet, Cyber Cafes, Video and Tele Conferences, Kissan Call Centres, Consultancy Clinics. Agricultural Journalism – Meaning, Scope and Importance, Sources of News, Types, Merits and Limitations. Innovation – Decision Process- Elements, Adopter Categories and their characteristics, Factors influencing Adoption Process. Capacity building of Extension Personnel and Farmers- Meaning, Definition, Types of Training, Training of Farmers, Farmwomen and Rural Youth - FTC and KVK.

Communications Skills: Structural and Functional Grammar: Meaning and Process of Communication, Verbal and Non-Verbal Communication; listening and note taking, writing skills, oral presentation skills; field diary and lab. Record; indexing, foot note and bibliographic procedure. Reading and Comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group Discussion, Organizing Seminars and Conferences.

Practical

Stimulated exercises on communication. Identifying the problems, Fixing the priorities and selecting the most important problem for preparation of a project. Developing a project based on identified the problem in a selected village. Organization of Group Discussion and method demonstration. Visit to KVK/FTC. Planning and writing of scripts for Radio and Television. Audio-visual Aids - meaning, importance and classification. Selection, planning, preparation, evaluation and presentation of visual aids. Planning and preparation of Visual Aids-Charts, Posters, Flip chart, Flash cards, Flannel graphs, Over Head Projector (OHP) Transparencies, Power Point Slides, Planning and Preparation of Agricultural Information materials – leaflets, folder, pamphlet, News stories, success stories. Handling of public address equipment (PAE) system. Still camera, video camera and Liquid Crystal Display (LCD) projector. Listening and note taking, writing skills, oral presentation skills: field diary and lab record: indexing, foot note and bibliographic procedures. Reading and Comprehension of general and technical articles, precise writing, summarizing; individual and group presentations.

Suggested Reading

- Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
- Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
- Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship And Communication Skills*, Kalyani Publications.
- Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
- Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.
- M Hilaris Indian agriculture and information: Soundari, New century Publications, 2011and communication technology (ICT)

16. Agricultural Microbiology 2(1+1)

Theory

History of microbiology: Spontaneous generation theory, Germ theory of disease, Protection against infections, Metabolism in bacteria: ATP generation, chemoautotrophy, photo autotrophy, respiration, fermentation, Bacteriophages: structure and properties of Bacterial viruses – Lytic and Lysogenic cycles: viroids, prions. Bacterial genetics; Gene Expression; Genetic recombination: transformation, conjugation and transduction, genetic engineering, Plasmids, episomes, genetically modified organisms. Soil Microbiology: Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting.

Practical

General instructions- Familiarization with instruments, materials, glassware etc., in a microbiology laboratory. Practice of aseptic methods- Evaluation of aseptic technique with Nutrient both tubes- Evaluation of aseptic technique with a Nutrient agar plate. Methods of sterilization and preparation of media, preparation of nutrient broth, nutrient agar plates, nutrient agar, slants and nutrient agar stabling- Sterilization of glassware by Dry heating- Sterilization of nutrient broth by Filtration. Planting methods for Isolation and Purification of bacteria- Isolation of bacteria by Enrichment using Streak plate method- Checking of purity of a bacteria by staining methods and Biochemical tests- Morphological examination of bacteria by simple and Differential staining- Different biochemical tests for identification of bacterial culture. Enumeration of bacteria- Enumeration of bacteria by Stain slide method- Enumeration of bacteria by Most Probable Number method- Enumeration of bacteria by Pour plate method and Spread plate method. Experiments in soil Microbiology- Study of rhizosphere and phyllosphere microflora- Isolation of Nitrogen fixing bacteria from soil – Isolation of Phosphate Solubilizing Microorganisms. Isolation and characterization of microorganisms in composts.

Suggested Reading

- Rangaswamy, G, 1992. *Agricultural Microbiology*, PHI Publication,
- N.S. Subbarao, 1999.*Soil Microbiology* - Oxford and IBH publishing Co Pvt Ltd,
- R.M. Aggarwal, 2013.*Soil Microbiology* - Wisdom Press/Dominant Publishers and Distributers,
- Singh and Purohit, 2008.*Biofertilizer Technology*, Agrobios,
- Shalini Suri, *Biofertilizers and Biopesticides*, 2011. APH Publishing Corporation,

17. Applied Microbiology 2(1+1)

Theory

Applied areas of Microbiology. Role of microbes in fermentation and Industry. Microbiology of Water: Microorganisms in fresh and marine water. Potability of water and waste water treatment processes. Microbiology of food: microbioal spoilage and principles of food preservation. Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases. Biodegradation, Bioremediation,

Biogas production, Biodegradable plastics, Plant-Microbe interactions. Biology and cultivation of Mushroom: Introduction to mushroom, fungi, Morphology and classification, edible and poisonous mushrooms, cultivation of different types of mushrooms.

Practical

Determination of microbiological quality of water- MPN method of water analysis- Potability of water- Examination of water for coli form bacteria; Spoilage microorganisms in food- Isolation and examination of spoilage causing microorganisms in fruits and vegetables-Role of microorganisms in vegetable fermentation- Yeast fermentation of fruits for preparation of wine; Study of beneficial microorganisms in agriculture- Mass production of biofertilizers- Study of antagonistic activity of microorganisms against plant pathogens-Isolation of *Bacillus thuringiensis* and its activity on insects- Study of symbiotic interactions in plants; Study of biodegradation of organic matter- Isolation of lignocellulose microorganisms- Preparation of microbial enriched composts- Experiment on Biogas production; Experiments on mushroom cultivation- Different types of edible and non – edible mushrooms and their identification- Preparation of spawn- Cultivation of *Pleurotus* and *Agaricus* mushrooms.

Suggested Reading

- Frazier, *Food Microbiology*,1987.McGraw- Hill Education Pvt Ltd
- Pelzer, *Food Microbiology*,1998 McGraw- Hill Education Pvt Ltd
- Bibek Ray, 2005.*Fundamentals of Food Microbiology*, CRC Press
- Martin and Moss, 2008.*Food Microbiology*, RSC Publishing

18. Livestock and Fish Production Management 3(2+1)

Theory

Place of livestock in the national economy, different livestock development programmes of Govt. of India. Important exotic and Indian breeds of cattle, buffalo, sheep, goat and swine. Measures and factors affecting fertility in livestock, reproductive behaviour like oestrus, parturition, farrowing etc. Milk secretion, milking of animals and factors affecting milk yield and composition. Selection and breeding of livestock for higher milk and meat production. Feeding and management of calves, growing heifers and milch animals and other classes and types of animals, housing principles, space requirements for different species of livestock. Disease control measures , sanitation and care, breeding, feeding and production records. Breed characteristics of poultry, their methods of rearing, breeding, feeding and management, incubation, hatching and brooding, vaccination and prevention of diseases, preservation and marketing of eggs, its economics and keeping quality. Cost of production of milk, economical units of cattle, buffalo, sheep, goat and swine. Fisheries resources of India, commercial important fishes and their production.

Practical

Identification, handing and restraining of animals; Judging and culling; Feeding and ration formulation; Hatching, housing and management of poultry; Visit to livestock farms and Economics of livestock production. Field visit to fresh water fish farm to study fish production technology.

19. Plant Biotechnology 2(1+1)

Theory

Concepts of Plant Biotechnology- History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement- Totipotency and Morphogenesis, Nutritional requirements of *in-vitro* cultures; Techniques of In-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, applications. Somaclonal variation: Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, culture, manipulation and fusion; products of somatic hybrids and cybrids. Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer- gene cloning-direct and indirect method of gene transfer-transgenic plants and their applications. Blotting techniques- DNA finger printing – DNA based markers- RFLP, AFLP, RAPD, SSR and DNA Probes.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants ;Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening/ Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques-direct methods; Demonstration of Gene transfer techniques-indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis techniques. Restriction enzymes for digestion of DNA.

Suggested Reading

- Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
- Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co., Meerut.
- Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, inc. USA.
- Gautam V K, 2005. *Agricultural Biotechnology*. Sublime Publications
- Thomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. *Molecular markers and Plant biotechnology*, New Publishers, New Delhi.
- Purohit, S.S., 2004. *A Laboratory Manual of Plant Biotechnology* 2nd Edn. Agribios, India.
- Singh, B.D. 2012.*Plant biotechnology*. Kalyani publishers, Ludhiana
- Bilgrami, K.S. and Pandey, A.K.1992. *Introduction to biotechnology*. CBS Pub. New Delhi
- Gupta, P.K. 1994. *Elements of biotechnology*. Rastogi Pub. Meerut.
- Chahal, G.S. and Gosal, S.S.2003. *Principles and procedures of plant approaches breeding Biotechnological and conventional*. Narosa Publishing House, New Delhi

20. Crop Physiology 3(2+1)

Theory

Introduction, importance in Agriculture. Growth and development- Definition-determinate and indeterminate growth, Monocarpic and polycarpic species with examples. Measurement of

growth, Growth analysis, Growth characteristics, Definitions and mathematical formulae. Crop water Relations: Physiological importance of water to plants, water potential and its components, measurement of water status in plants. Transpiration, significance, Transpiration in relation to crop productivity, Water use efficiency, WUE in C_3 C_4 and CAM plants. Factors affecting WUE. Photosynthesis: Energy synthesis, Significance of C_3 , C_4 and CAM Pathway, Relation of photosynthesis and crop productivity, Translocation of assimilates, Phloem loading, apoplastic and symplastic transport of assimilates, source and sink concept, photorespiration, Factors affecting photosynthesis and productivity, Methods of measuring photosynthesis, Dry matter partitioning, Harvest index of crops. Respiration and its significance: Brief account of growth, respiration and maintenance respiration. Alternate respiration- measurement of respiration Nutriophysiology: Definition-Mengel's classification of plant nutrients-Physiology of nutrient uptake – Functions of plant nutrients-Deficiency and toxicity symptoms of plant nutrients-Foliar nutrition-Hydroponics. Plant growth regulators- occurrence-Biosynthesis-Mode of action of auxins, Gibberellins, Cytokinis, ABA, Ethylene. Novel plant growth regulators, Commercial application of plant growth regulators in agriculture. Photoperiodism and Vernalization in relation to crop productivity: Senescence and abscission- Definition – Climateric and non-climacteric fruits-Hormonal regulation of fruit ripening. Post harvest physiology- Seed dormancy-Definition-types of seed dormancy- Advantages and disadvantages of seed dormancy-causes and remedial measures for breaking seed dormancy.

Practical

Preparation of solutions; Growth analysis: Calculation of growth parameters; Methods of measuring water status in plant tissue; Measurement of water potential by Chardakov's method; Measurement of absorption spectrum of chloroplastic pigments and fluorescence ; Measurement of leaf area by various methods; Stomatal frequency and index-Measurement of respiration rate; Leaf anatomy of C_3 and C_4 Plants. Transpiration measurement; imbibitions of seed; Breaking seed dormancy; (a) Chemical method (b) Mechanical method; Seed viability and vigour tests; Effect of ethylene on ripening, Influence of Auxin on rooting.

Suggested Reading

- Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.
- Taiz, L. 2010. *Plant Physiology*. SINAUR. USA.
- Zeiger. 2003. *Plant Physiology*. PANIMA. New Delhi.
- Edward E. Durna. 2014. *Principles of Horticultural Physiology*. CABI, UK.
- Delvin, R.M.1986. *Plant Physiology*. CBS. Delhi.
- Richard, N. Arteca. 2004. *Plant Growth Substances*. CBS. New Delhi.
- Jacobs, W. P. 1979. *Plant Hormones and Plant Development*. Cambridge Univ. London.
- Basra, A.S. 2004. *Plant Growth Regulators in Agriculture & Horticulture*. HAWARTH press. New York.
- Lincoln Taiz and Eduards Zeiger (5th Edition). *Plant physiology*
- Noggle G.R and Fritz T.G. *Introductory Plant Physiology*
- Carl fedtke. *Biochemistry and Physiology of Herbicide Action*

- Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. *Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation*

21. Introduction to Forestry 2(1+1)

Theory

Definition of Forest and Forestry, importance, History, Forestry Education and Research in India, various branches in forestry. National Forest Policy of 1894, 1952, 1988: Indian Forest Act-1927: Karnataka Tree Preservation Act: Forest Conservation Act-1980: The Environment (Protection) Act-1986: Indian Wildlife Preservation Act-1972: Amendments to Environment (Protection) Act-1999. Forest wealth in India: Forest productivity. Deforestation: Various causes and implications, desertification, afforestation, reforestation. Indian wildlife and management. National parks and sanctuaries, endangered species; Forest ecosystem, natural forests and their formation, succession and zonation, limiting factors: climax vegetation, types of natural forests and their distribution. Food chain, natural forests, V/s man-made forest. Social forestry and its branches: Extension forestry, urban forestry, recreation forestry. Farm-forestry: Agro-forestry methods, woodlot system etc., and their management, windbreaks and shelterbelts: different types of waste lands and their reclamation through afforestation and joint forest management.

Practical

Identification of important trees, seeds and seedlings: Study of nursery techniques- Trench and mound plantation, pit plantation: Study of different types of plantations: Visit to agro-forestry and farm forestry plots: Measurement of volume of standing trees: Study of wood formation: study of wood specimens and non-timber forest products. Visit to a nearby National Park and forest.

Suggested Reading

- Beazley, M. 1981. The International Book of Forest. London
- Champion and Seth. 1968. Forest types of India.
- Grebner, D.L., Bettinger, P. and Siry, J.P. 2012. *Introduction to Forestry and Natural Resources*. Academic Press. 508p (Google eBook).
- Khanna, L.S. 1989. *Principles and Practice of Silviculture*. Khanna Bandhu, New Delhi.
- Mitchell Beazly.1981. *The International Book of the Forest*. Mitchell Beazly Publishers, London.
- Mather, A.S. 1990. *Global Forest Resources*. Belhaven, London
- Persson, R. 1992. *World Forest Resources*. Periodical Experts, New Delhi.
- Westoby, J. 1991. *Introduction to World Forestry*. Wiley, 240p.

22. Environmental Science and Agro ecology 1(1+0)

Theory

Introduction to Environmental Science, Bio-geochemical cycles; O and Water Cycles Global warming or green house effect on enhanced carbon dioxide levels on productivity of ecosystems. Air pollution- industrial pollution of air and its consequences on the ecosystem. Impact on ozone layer. Effect of UV-B radiation on plant ecosystem. Water pollution - Industrial effluents, domestic

effluents, pesticide pollution. Aquatic ecosystems- types and management. Environmental impact assessment, pollution indicator species, Biological diversity and loss of biodiversity and their causes, Approaches to conserve biological diversity.

Suggested Reading

- Bharucha Erach. 2005. *Text Book of Environmental Studies for Undergraduate Courses*. University Grants Commission, University Press, Hyderabad.
- Sharma J P. 2003. *Introduction to Environment Science*. Lakshmi Publications.
- Chary Manohar and Jaya Ram Reddy. 2004. *Principles of Environmental Studies*. BS Publishers, Hyderabad.
- Kaul S N, Ashuthosh Gautam. 2002. *Water and Waste Water Analysis*. Days Publishing House, Delhi.
- Gupta P K., 2004. *Methods in Environmental Analysis* – Water. Soil and Air. Agro bios, Jodhpur.
- Climate change, 1995. *Adaptation and mitigation of climate change* - Scientific Technical Analysis Cambridge University Press, Cambridge.
- Husain Majid, 2013. *Environment and Ecology: Biodiversity*, Climate Change and Disaster Management. Online book.

23. Principles of Genetics 3(2+1)

Theory

Cell division; Mitosis-stages and significance; meosis- stages and significance; differences between mitosis and mneosis. Crossing over- mechanism and factors affecting it. Introduction to genetics, brief historical background. Mendel's laws of inheritance and exception to the laws. Multiple alleles-pleiotropism-penetrance and expressivity, Gene action-intra-genic interaction-complete, incomplete/partial dominance and co-dominance; intergenic interaction (Epistatis)-digenic interaction, type with examples. Linkage: types, detection, estimation and exploitation, sex linkage- sex limited and sex influenced traits, sex determination, mechanism with examples. Introduction to quantitative genetics, quantitative traits and qualitative traits and differences between them, multiple factor hypothesis. Cytoplasmic inheritance- its characteristic features and differences between chromosomal / nuclear and cytoplasmic inheritance, maternal effect. DNA and its structures, functions, types models of replication and repair. RNA and its structures, function and types. Central dogma of molecular biology; transcription, translation, genetic code, its features.Gene regulation-Lac operon as a model. Chromosome structure, morphology - karyotype and ideogram. Ultrastructure of cell and cell organelles and their functions. Chromosomal aberrations - numerical (Euploidy with examples: wheat, tobacco, cotton, Brassica and Aneuploidy) and structural (deletion, duplication, inversions and translocations) aberrations. Mutation- its characteristic features/salient features of mutagens and their classification with examples. (CLB technique may be omitted).

Practical

Microscopy (Light microscopes and electron microscopes); Preparation and use of fixatives and stains for light microscopy; Preparation of micro slides and identification of various stages of mitosis; Preparation of micro slides and identification of various stages of meiosis; Problems on

Monohybrid ratio and its modifications & multiple alleles; Problems on Dihybrid ratio. Statistical testing of segregation of traits as per Mendelian Principles, χ^2 test and its application. Solving problems on digenic interaction.Problems solving on digenic interaction continued; problems on polygenic inheritance and gene mapping. Solving problems on autosomic and sex linkage.

Suggested Reading

- Gardner E J, Simmons M J & Snustard D P. *Principles of Genetics (VIII Edn)*. John Wiley & Sons, Newyork.
- Strickberger. *Genetics*. Macmillan Publishing Company, Newyork.
- William D. Stansfield. *Theory and Problems of Genetics (3rd Ed)*. Schaum's Outline series - McGraw-Hill Inc.
- Benjamin Lewin. *Genes (II edn)*. John Wiley & Sons, New York.
- Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.
- Swanson & Webster. *The Cell (V edn)*. Prentice Hall of India Pvt.Ltd, New Delhi
- Norman,V.Rothwell. *Understanding Genetics (IV Ed.)*. OxfordUniversity Press, Oxford.
- Sinnut, Dunn &Dobzhansky. *Principles of Genetics XIX reprint*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Griffiths, Miller, Suzuki Lewontin&Gelbart. *An introduction to Genetic Analysis (V Ed.)*. W.H.Freeman& Company, Newyork
- Robert Schieif. *Genetics & Molecular Biology (1986)*. The Benjamin/cummings publishing Co, Inc, California.
- Loewy & Siekevitz. *Cell Structure & Function (II Ed.)*. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
- Stent & Calendar. *Molecular Genetics (II Ed.)*. CBS Publishers, New Delhi
- Singh B D. *Fundamentals of Genetics*. Kalyani Publishers, New Delhi
- Srivastava & Tyagi. *Selected Problems in Genetics (Vol.1-3)*. Anmol Publications Pvt.Ltd, New Delhi
- Khanna VK. *Genetics–Numerical Problems*. Kalyani Publishers, New Delhi.
- Farook& Khan. *Genetics &Cytogenetics (I Ed.)*. Premier Publishing House,
- Hyderabad.
- Shukla. *Cell Biology (2001)*. Dominant publishers, New Delhi
- George Acquaah. *Principles of Plant Genetics and Breeding*. Blackwell
- B .D Singh. *Fundamental of Genetics*. Kalyani. India

24. Fundamentals of Plant Propagation and Nursery Management 2(1+1)

Theory

Importance and scope of plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy (scarification & stratification) internal and external factors, nursery techniques, apomixes – mono-embrony, polyembrony, chimera & bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, nursery (tools and implements), use of growth regulators in seed and vegetative propagation, methods and techniques of cutting, layering, grafting and budding

physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery.

Practical

Media for propagation of plants in nursery beds, pot and mist chamber. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, buddings and grafting etc.Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. labeling and packing of nursery plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, , glasshouse, polyhouse shadenet and their maintenance. Top grafting, bridge grafting and nursery management. Nutrient and plant protection applications in nursery.

Suggested Reading

- Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. *Plant Propagation- Principles and Practices (7th Edition)*. PHI Learning Private Limited, New Delhi-110001
- T.K.Bose, S.K.Mitra, M.K.Sadhu, P. Das and D.Sanyal. *Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3rd Revised edition).* Naya Udyog, 206, Bidhan Sarani, Kolkata 700006.
- Guy W. Adriance and Feed R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).
- S. Rajan and B. L. Markose (series editor Prof. K.V.Peter). *Propagation of Horticultural Crops-Horticulture Science Series vol.6.* New India Publishing Agency, PitamPura, New Delhi-110088.

25. Dry land Horticulture 2(1+1)

Theory

Introduction and scope of dry land horticulture. Definition & history of dry land farming in World and India. Area, production, productivity of dryland crops. Cropping pattern, rainfall pattern and distribution. Features of dry land areas and crops. Strategies for dry land crops. Systems of planting. Production technology of dry land crops – Mango, Cashew, Jack, Sapota, Tamarind, Wood apple, Jamun, Guava, Carambola, Amla, Sitaphal, Fig, Ber, Karonda, drumstick. Soil and Water conservation Techniques and practices in orchards, mulches. Integrated Nutrient and Water Management, drip and pitcher irrigation. Employment potential, income generating Agro based enterprises (Dairy, Poultry, Sericulture, Piggery, Sheep and Goat farming) crop protection, yield attributes and quality. Dry land horticulture as an alternate strategy. Propagating material for dry land condition, green houses. Problems and prospectus of dry land horticulture. Economics of dry land orcharding.

Practical

Study of special features of crops for dry land horticulture, Layout systems in dry land horticulture, Study of soil management practices, Study of water conservation methods, Study of different mulches, Study of cropping pattern ,Study of Agro-climatic zones, Study of propagation methods, Study of *In-situ* grafting and top working, Study of antitranspirents in field condition, Visit to watershed areas, Study of the growth and performance of dry land crops – visit to different orchards, Visit to orchards – study of water harvesting techniques, Visit to orchards – study the field problems.

Suggested Reading:

- Chundawat, B.S. 1990. *Arid Fruit Culture*. Oxford and IBH, New Delhi.
- P.L. Taroj, B.B. Vashishtha, D.G.Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency.

26. Introductory Plant Pathology and Nematology 2(1+1)

Theory

Introduction, scope and objectives of plant pathology. Importance of plant diseases. History and development of plant pathology. Definition and concept of plant diseases. Causes of plant diseases viz., biotic, abiotic and plant viruses with representative examples of diseases caused by them. Symptoms of plant diseases. General characteristics of plant pathogens viz., Prokaryotes: their classification according to Bergey's manual of systematic bacteriology. Classification of fungi. Classification of viruses, mollicutes and nematodes. Growth and reproduction of plant pathogens and replication of plant viruses. Liberation/ dispersal of plant pathogens and survival of plant pathogens. Types of parasitism and variability in plant pathogens.

Practical

Study of laboratory equipments. Study of symptoms of plant diseases caused by fungi, viruses, bacteria, nematodes and mollicutes. Collection and preservation of plant disease specimens. Study of morphology of fungi, viruses, bacteria, nematodes and phytoplasma. Study of life cycle of major groups of fungal pathogens viz., Oomycota, Ascomycota (including Deuteromycetes and Basidiomycota).Macroscopic and microscopic examination of plant pathogens, including staining techniques for bacteria. Preparation of culture media and sterilization. Different methods of isolation and purification of fungi, bacteria, viruses and extraction of nematodes. Study of different methods of artificial inoculation or transmission and proving Koch's postulates for different plant pathogens. Study of liberation of fungal spores. Study of micrometry and camera Lucida. Field visit to get acquainted with disease symptoms.

Suggested Reading

- Upadhyay, K.D and Dwivedi, K. 1997. *A text book of plant nematology*. Amman Publishing House Aman publishing house, Meerut
- Vasanth Raju David, B. 2001. *Elements of economic entomology*. Popular book Depot, Chennai.

- Gopal Swaroop and Das Gupta 1986.ICAR, New Delhi. *Plant Parasitic Nematodes of India Problems and Progress*.
- Nair, M.R.G.K. 1975. *Insects and Mites of Crops in India*. ICAR, New Delhi
- Metcalf, R.L and Luckman, W.H. 1982. *Introduction to Insect pest management.* Wiley Inter Science Publishing, New York.
- Butani, D.K. 1984. *Insects and Fruits*. Periodical Expert Book Agency, New Delhi
- E.I.Jonathan, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, *Agricultural Nematology*. TNAU, Coimbatore.

27. Diseases of Host Plants of Silkworms 2(1+1)

Theory

Economic importance, symptoms, causes, epidemiology, disease cycle/life cycle and integrated management of diseases of *Morus alba, Ricinus communis, Manihot utilisima, Michilius champaka, Zizypus* spp., *Machilus bombycina, Shorea robhusta, Ailanthus* spp., and other hosts of silkworms. Epidemiology, development of epidemics, disease forecasting; crop loss assessment. Principles and methods of plant disease management: Avoidance of the pathogen: Choice of geographical area, selection of field and planting stock. Exclusion: Plant quarantine regulations and inspections, Post entry quarantine. Eradication: Cultural and physical methods of eradication and inoculum reduction. Biological methods: Crops rotation, use of trap crops, plant and plant products, use of biological control agents, their mass multiplication mechanisms of biocontrol. Breeding for disease resistance: Types of resistance, Development of resistant varieties, induced resistance. Protection chemical methods: Nature, classification, mode of action and formulations of fungicides, bactericides antibiotics and nematicides; methods of applications of chemicals. Application of biotechnology in plant disease management. Effect of plant protection chemicals on the health of silkworms and silk yields and approaches in minimizing their residual toxicity.

Practical

Study of symptoms, etiology and life cycle/disease cycle of the diseases of *Morus alba, Ricinus communis, Manihot utilisima, Michilius champaka, Zizypus* spp., *Quarcus* spp., *Machilus bombycina, Shorea robhusta, Ailanthus* spp., and other hosts of silkworms. Study of fungicides, bactericides, nematicides and methods of applications. Isolation, mass multiplication of Biocontrol agents and their bioassay. Study of plant protection equipments. Evaluation of plant protection chemicals against pathogens of silkworm host plants. Testing the residual toxicity of plant protection chemicals on silkworm health and silk output. (Submission of 15 well preserved disease specimens and 15 semi-permanent slides depicting different plant pathogens).

28. Principles of Seed Science and Technology 3(2+1)

Theory

Quality seed and its importance in agriculture; difference between seed and grain, concept of seed quality; seed technology-definitions, objectives and its role in increasing agricultural production; seed improvement programmes in India and Karnataka; Reproductive process in crop plants- sexual and asexual reproductive, apomixes, seed formation and development; general principles of seed production, seed replacement and multiplication rates, generation system of

seed production- breeder seed, foundation seed, certified seed and truthful seeds; Maintenance of genetic purity, causes for varietal deterioration, male sterility concepts and its use in hybrid seed production; Nucleus and Breeder seed production of newly released and established varieties of self pollinated crops like rice, wheat, soybean, chickpea, pigeon pea, rapeseed, mustard etc; inbred and non-inbred lines; Foundation and Certified seed production of maize hybrids, single and double cross hybrids; hybrid seed production of sunflower, sorghum, pearl millet and rice using male sterility system; Latest released hybrids, their parentage, characteristics; seed production of wheat, rice, soybean, grams, sunflower, pigeon pea, groundnut, castor, cotton etc., seed production in some important vegetables like onion, brinjal, chillies, tomato, bhendi and gourds etc. Certification- it's concepts, role and goals, seed certification agencies, certified and truthfully labelled seeds, minimum certification standards for self and cross pollinated crops, field and seed inspection, its objectives; Seed Act and Seed Rules; Seed Legislation and Seed Law Enforcement, Seed Control Orders, Seed Policies, Seed Bills, WTO, IPR, PBR in India and recent development in Indian Seed Industry, Seed quality regulations; seed processing-cleaning, grading, seed treatment methods, bagging and storage-factors affecting seed quality in storage, orthodox and recalcitrant seeds, storage pests and disease control; seed testing-principles and methods of sampling, purity analysis, seed moisture, germination, viability and vigor; cultivar purity testing-ODV, electrophoresis and grow-out tests for seed genetic purity, seed health etc; seed dormancy causes and breaking methods; seed marketing, organizations, seed pricing, promotion of quality seeds and seed marketing strategies etc.

Practical

Study of reproductive systems in crop plants-floral biology, pollination and fertilization; classification of seeds based on their usage, preparation of seed album; study of seed structure in monocots and dicots; study of seed production in major crops- MS lines, pollen shedders, off-types, emasculation and pollination techniques; study of seed processing equipments- plan and layout; study of seed testing equipments, seed testing methods- seed sampling, seed purity test, seed moisture, seed germination tests, seed viability and vigor, seed health tests etc., seed dormancy breaking methods; Visit to seed production plots, seed processing plants, public and private seed enterprises.

Suggested Reading

- Thompson,J.R.1979.*An introduction of seed technology* .Leonard Hill, London
- Agrawal, P.K.and Dadlani, M.1986.*Techniques in seed science and technology*. South Asian Publishers, New Delhi.
- Agrawal, P.K.1994. *Principles of seed technology*. ICAR publication, New Delhi.
- Agrawal, R.L.1996. *Seed Technology*. Oxford & IBH Publication Co., New Delhi.

29. Fundamentals of Soil Science 3(2+1)

Theory

Soil- Pedological and edaphalogical concepts. Soil Science-scope and branches of soil science. Earth spheres and composition of earth crust. Minerals-classification, formation and properties of silicate and non silicate minerals, Rocks-classification, formation and properties

of igneous, sedimentary and metamorphic rocks. Weathering-type, factors of weathering, products of weathering; Soil formation-soil forming factors and soil forming processes. Soil profile-master horizons, subordinate horizons. Soil physical properties-Soil texture-classification of soil separates, properties of soil separates, Particle size analysis- Stokes law-assumptions and limitations, textural classes. Soil structure-classification, soil aggregates, evaluation of soil structure, significance. Pore space-types, factors affecting porosity, manipulation. Bulk density and particle density- relationships, factors, significance and manipulation. Soil colour-factors, attributes and significance. Soil consistency-forms, factors, limits and significance. Soil crusting- factors and significance. Soil temperature-thermal properties of soils, flow of heat, soil temperature regimes, influence of soil temperature on plant growth. Soil air-composition, gaseous exchange, influence of soil air on plant growth. Soil water-classification, potentials, soil moisture constants, movement of soil water, infiltration, percolation, hydraulic conductivity. Soil survey- types and methods. Soil classification-systems of classification. Soil taxonomy-advantages, structure, formative elements, diagnostic horizons, keys to soil orders. Soils of Karnataka and India.

Practical

Study of general properties of minerals; Study of minerals-silicate and non-silicate minerals; Study of rocks-igneous, sedimentary and metamorphic rocks; study of a soil profile; Collection and processing of soil for analysis; Study of soil texture-feel method, mechanical analysis; Determination of bulk density, particle density and soil porosity; Determination of soil colour; Study of soil structure and aggregate analysis; Determination of soil moisture, Determination of soil moisture constants-field capacity; water holding capacity; Study of infiltration rate of soil; Study of soil temperature.

Suggested Reading:

- Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.
- Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
- Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.
- Biswas, T.D. and Mukharjee, S.K., 2015. *Text Book of Soil science*. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
- Brady, N.C., 1995. *The Nature and properties of Soils*. Macmillan Publishing Co, New York.
- Ghildyal, B.P. and Tripathi, R.P., 1987. *Soil Physics*. Acad. Press. New York.
- Kolay, A.K., 1983. *Basic concepts of Soil Science*. Wiley Eastern Ltd., New Delhi
- Brady, N. C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition), Pearson Education, New Delhi.
- Foth, H.D., 1991. *Fundamentals of Soil Science* (8th Edition), John Wiley & Sons, New Delhi.
- Das, D .K., 2011. *Introductory Soil Science* (3rd Edition), Kalyani publisher, Ludhiana (India).
- Khan, T. O. 2013 Forest Soils: *Properties and Management*. Springer International Publishing, Switzerland

- Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
- Gupta, P.K. 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
- Jaiswal, P.C. 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson, M. L. 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher

30. Soil Fertility and Nutrient Management 2(1+1)

Theory

Plant nutrients - classification and sources; Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting availability of major, secondary and micro nutrients to plants. Measures to overcome deficiencies and toxicities. Soil fertility- different approaches for soil fertility evaluation; Soil testing for available nutrients; Critical levels of different nutrients in soil. Plant analysis- total and rapid tissue tests- critical levels of nutrients in plants; DRIS method; Deficiency symptoms-indicator plants. Biological method of soil fertility evaluation. Soil test based fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions. Integrated plant nutrient supply system and its management.

Practical

Analytical Instruments- principles, calibration and applications; Estimation of available nitrogen, available phosphorous, available potassium and available sulphur in soil; Estimation of exchangeable calcium and magnesium in soil, Estimation of available micronutrients in soils; Preparation of plant samples for analysis; Estimation of nitrogen, phosphorus and potassium in plants.

Suggested Reading:

- Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers.* Agri. Horticultural Publishing House, Nagpur.
- Tandon HLS, 1994. *Fertilizers Guide.* Fertilizers Development Consultation Organization, New Delhi..
- Seetharaman S, Biswas B C, Yadav D S and Matheswaru S. Usage 1996. *Hand Bookon Fertilizers*. Oxford and IBH Publishing Company, New Delhi.
- The fertilizer Association of India, Shaheed Jit singh marg, New Delhi, 1985. Fertilizer control order
- Ranjan Kumar Basak , 2000. *Fertilizers A Text book.* Kalyani publishers, New Delhi.
- British Crop Production Council, U.K., 1995. The Pesticide Manual, A – World Compendium.
- Sree Ramulu US, 1991. *Chemistry of Insecticides*. Oxford and IBH Publishing and Fungicides Company, New Delhi.
- Nene Y L and Thapliyal P N, 1991. *Fungicides in plant disease control*. Oxford and IBH Publishing company, New Delhi.

- Havlin *et al.* 2014. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (8th Edition), PHI Learning Pvt. Ltd., Delhi.
- Binkley, D. and R. Fisher, 2012. *Ecology and Management of Forest Soils* (4th Edition), John Wiley & Sons Singapore Pvt. Ltd., Singapore
- Reddy M. V., 2001. *Management of Tropical Plantation Forests and Their Soil Litter System-Litter, Biota and Soil Nutrient Dynamics*, Science Publishers, U. S.
- Khan, T. O., 2013. *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland
- Brady, N. C. and Weil, R. R., 2010. E*lements of the Nature and Properties of Soils* (3rd Edition.), Pearson Education, New Delhi
- Das, D .K., 2011. Introductory Soil Science (3rd Edition), Kalyani Publisher, Ludhiana (India).
- Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. Indian Society of Soil Science, IARI, New Delhi.
- Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
- Gupta, P.K., 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
- Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson, M. L., 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher
- J. Benton Jones, Jr., 2012. *Plant Nutrition and Soil Fertility Manual* (2nd Edition), CRC Press, USA.
- Mengel, *et al.,* 2001. *Principles of Plant Nutrition* (5th Edition), Springer
- Kanwar, J.S. (Ed).,1976. *Soil Fertility: Theory and Practice*, ICAR, New Delhi
- Bear, F.E.,1964. *Chemistry of the Soil.* Oxford and IBH Publishing Co., New Delhi
- Richards, L.A., 1968. *Diagnosis and Improvement of Saline and Alkaline soils*. Oxford & IBH Publishing Co. New Delhi (USDA Hand Book No.60)
- Chopra, S. Cand Kanwar, J.S.,1976. *Analytical Agricultural Chemistry*. Kalyani Publishers, Ludhiana.
- Tisdale, S.L. Nelson, W.L. and Beaton, J.D., 1993. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York
- Yawalkar, K.S. Agarwal, J.P. and Bokde, S.,1977. *Manures and Fertilizers*. Agri-Horticultural Publishing House, Nagpur
- Seetharamaan, S. Biswas, B.C. Maheswari, S. and Yadav, D.S., 1986. *Hand Bookon Fertilizers Technology*. The Fertilizers Association of India, New Delhi

STUDENT READY
EXPERIENTIAL LEARNING PROGRAMME (ELP)+RSWE 40(0+40)

Practical

Students will practically gain hands on expertise for a semester in host plant production, cocoon crop production, silk product science and natural resource management. In one semester students will be placed ingrain age, seri clinic, silk product technology centre, silk by produce value addition and rural extension work in sericulture command areas.

I. EXPERIENTIAL LEARNING PROGRAMME (ELP)

A student has to register for 20 credits with major load (0+15 Sericulture) being in one area / module and the rest from another module (elective 0+5) in the seventh semester.

Module-I Host Plant Production

1. Mulberry and Non-Mulberry Host Plant Nursery Management 5(0+5)

Practical

Maintenance of popular mulberry and non-mulberry varietal stock: acquainting with popular mulberry varietal stock, weeding and inter-cultivation, irrigation, nutrient management, pest management. Preparation of nursery: procurement of seed, sand, red earth and manure, preparation of pot mixture, preparation of raised nursery beds, filling in of poly cover with pot mixture. Selection and preparation of planting material: harvesting the shoots for raising nursery, stalling of planting material, preparation of cuttings, treatment of cuttings, planting in nursery beds and in poly cover. Nursery management: watering, weeding, nutrient management, pest management. Economics of nursery management: cost factors and their estimates, price fixation, sales and returns, benefit to cost ratio, preparation of viable project proposals.

Suggested Reading:

- Rangaswamy, G., Narsimhanna, M.N., Kasiviswanathan, K., Sastry, C.R. and Manjeet, S. Jolly., 1976. *Sericulture manual, mulberry cultivation*, Vol.1, F FAO Agriculture Services Bulletin. Rome. P. 150.
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979. *Manuals on Sericulture – Non mulberry sericulture.* FAO, Rome, P.178.

2. Host Plants Production Technology for Mulberry and Non-mulberry silkworms 5(0+5)

Practical

Separate gardens for chawki and late age silkworm rearing: Systems of planting in mulberry and non-mulberry, chawki - variety and area of chawki garden, Late age - variety and area of late age garden, suitability of varieties for silkworm rearing. Planting system, Irrigation, INM and IPM in mulberry: Wider spacing and paired row spacing, drip irrigation layout for mulberry, frequency and quantum of irrigation, integrated nutrient management, weeding, management of pests. Inter-cultivation and intercropping in mulberry: Inter-cultural operations, raising suitable intercrops. Harvesting and preservation of mulberry leaves: Leaf harvesting and pruning skills in chawki garden, leaf harvesting and pruning skills in late age garden, preservation of harvested leaves, estimation of leaf yield. Economics of mulberry production: Inputs and their costs, price fixation, sales and returns, benefit cost ratio.

Suggested Reading

- Rangaswamy, G., Narsimhanna, M.N., Kasiviswanathan, K., Sastry, C.R. and Manjeet, S. Jolly., 1976. *Sericulture manual, mulberry cultivation*, vol.1, F FAO Agriculture Services Bulletin. Rome. P. 150.

- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979. *Manuals on Sericulture – Non mulberry sericulture.*FAO, Rome, P.178.

3. Value Addition to Mulberry and Non-Mulberry by products 5(0+5)

Practical

Sources of biomass: Collection of waste from mulberry garden and rearing house, separation and preparation of hard (Stumps and stubbles) and soft waste (leaves and silkworm excreta), collection of green biomass from other sources. Conversion of the collected biomass: Procedure for Indore, Bangalore, Japanese and vermin-composting methods, planning and construction of structures for composting, filling and sealing of compost pits and their maintenance, Collection and storage of compost. Production of enriched compost: Enrichment of compost, Addition of microbial cultures to hasten conversion, increase nutrient content and act against soil pathogens. Effective use of sericultural waste: Utilization in biogas production, Utilization in mushroom production and other purposes.

Suggested Reading:

- Govindan, R., Ramakrishna Naika, Sannappa, B. and Chandrappa, D., 2005. *Progress of Research in organic Sericulture and Seri Byproducts Utilization*, Seri Scientific Publishers, p.231.
- Bongale, U.D., 2002, *Reshme Udhimmeyalli moulya vrudhigagi upa uthpannagala balake* (in Kannada).KSSR&DI, Thalaghattapura, p.101.
- Indian Silk Monthly Journal, CSB

4. Farm Mechanization 5(0+5)

Practical

To study advantage of farm mechanization & its limitations. Different agriculture operations which can be mechanized during crop production. Operation of different farm implements/ machinery and their attachments. To acquaint with different tractors manufactures in the country. Care and maintenance of tractors Daily, weekly, monthly & yearly. Operation of different types of ploughs available for crop production, MB plough and others. Care & maintenance of ploughs operation of Chisel plough & Subsoiler. Operation of different types of harrows in the agriculture operation care and maintenance. Different types of cultivators used in crop production, care and maintenance. Operation of different seed drills, bullock drawn/ Tractor drawn Operation of harvester, mowers, care & maintenance. Operation of Thresher suitable for different crops care and maintenance and adjustment. Visit to Custom Hiring centre and acquaint with the system of operation and find out the feasibility of starting a custom hiring centre under self employment programme.

Suggested Reading

- Dandin and Giridhar, 2010, *Handbook of Sericultural technologies*, CSRTI, CSB, Mysore,p.
- www.csrtimys.res.in/
- cstri.res.in/
- www.ctrtiranchi.co.in/

Module-II Cocoon Crop Production 20(0+20)

a) Seri-Clinic5 (0+5)

Practical

Soil health diagnosis, INM practices to improve the soil and plant health, identification of deficiency symptoms in mulberry and acquainting with remedial measures. Diagnosis of pest and diseases of silkworm and acquainting with remedial measures. Assessment of quality of the inputs-leaf and DFLs. Survey of problematic mulberry garden and rearing houses and find out the remedies for the cause. Assessment of toxicity, their nature, level and suggest remedies. Development of INM and IDPM schedules for management of Nutrition and pest and diseases in mulberry.

Suggested Reading:

- *Seri business Manual* – a user's guide CSB publication
- Nataraju, B., Sathya Prasad, K., Manjunath, D. and Aswani Kumar, C.,2005, *Silkworm Crop Protection*, CSB, p.412.

b) Bivoltine Silkworm Rearing technology 5(0+5)

Practical

Garden management for quality mulberry leaf production, INM in mulberry, harvesting index, harvesting and preservation of leaf. Disinfection of rearing house and appliances, hygiene measures in rearing house. Procurement of quality DFLs, incubation, block boxing, calculation of hatching percentage, brushing, chawki rearing. Management of rearing environment, manipulation of environment at different conditions, handling of equipment and machinery in environment management. Late age silkworm rearing: feed management, spacing, bed management, feed additives in INM of silkworms, moult management. Disease management, bed disinfection, early identification of diseases symptoms and prophylactic measures to check the diseases spread. Identification of ripe worms, picking, mounting, maintenance of environment in mountage shed, harvesting, sorting, grading and marketing of cocoons. Calculation of B/C ratio, planning of rearing operations and project preparations.

Suggested Reading:

- Rajan, R.K. and Himantharaj, M.T. ,2005, *Silkworm Rearing Technology*, CSB Publication,p.163.
- Ganga, J. Sulochana Chetty, G., *An Introduction to sericulture*

c) Non-Mulberry Silkworm Rearing Technology 5(0+5)

Practical

Rearing of tasar, eri, muga silkworms – incubation of eggs, chawki rearing, lateage silkworm rearing (indoor and outdoor rearing techniques), mounting, harvesting of cocoons, Marketing of non-mulberry cocoons, collection of different eco-races and maintenance of non-mulberry germplasm.

Suggested Reading:

- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979, *Manuals on Sericulture – Non mulberry sericulture.*FAO, Rome, P.178.
- Thangavelu, K., 2000, *Lessons On Tropical Tasar. Central Tasar Research and Training Institute*, Ranchi, P.104.
- Gangawar, S.K., Kumar, R. And Srivastava, A.K., 2007, *Tasar Culture-Principles and Practices, Tasar host plants-Production,Protection and Improvement*, *Vol.I.* Central Tasar Research and Training Institute, Ranchi, p.259.
- Gangawar, S.K., Kumar, R. And Srivastava, A.K., 2008, *Tasar Culture-Principles and Practices, Tasar Silkworm Biology*,*Vol.II*. Central Tasar Research and Training Institute, Ranchi, p.238.
- Gangawar, S.K. R. And Gupta, V.P., 2010, *Tasar culture-Principles and Practices, Tasar Silkworm - Production, Protection and Improvement*, *Vol.III*. Central Tasar Research and Training Institute, Ranchi, p.346.
- Mohanthy, P.K., 1998, *Tropical Tasar Culture in India.* Daya Publishing House, New Delhi, p.152.
- Sannappa, B., Jayaramaiah, M., Govindan, R. and Chinnaswmy, K.P., 2002, *Advances in Ericulture.* Seri Scientific Publishers, Bangalore, p.143.

d) Value Addition to Grainage and Rearing Byproducts 5(0+5)

Practical

Selection of by products, assessment of quality and price fixing, sorting and grading based on its end use convertibility. Improving quality of by products (raw material) by subjecting to different treatments, cleaning, drying, removal of stains, dyeing and preservation of the raw material. Analysis of the raw material based on their size, shape and hardness and using them for preparing different value added products- vases, bouquets, interior decoration material, garlands, door curtains etc. Further utilization of waste generated during preparation of crafts. Calculation of benefit cost ratio and assessment of product price, marketing techniques, advertisement techniques, entrepreneurial techniques to establish this as a cottage industry. Bio craft enterprising marketing strategies, exploration of different sources for production of bio crafts. Brain storming and creative learning in bio crafts.

Suggested Reading:

- Govindan, R., Ramakrishna Naika, Sannappa, B. and Chandrappa, D., 2005, *Progress of Research in organic Sericulture and Seri Byproducts Utilization*, Seri Scientific Publishers, p.231.
- Bongale, U.D., 2002, *Reshme Udhimmeyalli moulya vrudhigagi upa uthpannagala balake* (in Kannada).KSSR&DI, Thalaghattapura, p.101.
- *Indian Silk* Monthly Journal, CSB.

Module-III Silk Product Science (0+20)

1. Raw Silk and Spun Silk Production Technology 5(0+5)

Practical

Planning and designing of reeling unit, assessment of quality and price fixing, cocoon procurement, preservation of cocoons, stifling, sorting, cooking, brushing of cooked cocoons, Reeling, re-reeling, lacing, silk examination and package of raw silk, quantification of silk production, quality assessment of raw silk, economics of reeling and preparation of project proposals for charaka, cottage basin and maintenance of records.

Suggested Reading:

- Ohja, N.G., and Panday, P.N., 2004, *Silk- Silk Production*, BPH Publishing Corporation, New Delhi, p.278, 20p,
- Anonymous, *Wild Silks of India*, Vol.II, CSB, Bangalore,
- Tamanna N. Sonwalkar**,** 1998**,** *Handbook of silk technology***,** New India International(P) Ltd. New Delhi.
- D. Mahadevappa, V.G.Haliyal, D.G. Shankar and Ravindra N Bhandiwad, 2003, *Mulberry silk reeling technology***,** Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. P.
- Yong-woo Lee, *Silk reeling and testing manual by National Sericulture and Entomology Institute*, Seoul, Republic of Korea.
- Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979, *Manuals on Sericulture – Non mulberry sericulture.*FAO, Rome, P.178.
- Krishnaswami, S., Madhava Rao, N.R., Suryanarayan, T.S. and Sundarmurthy, T.S., 1972, *Sericulture Manual, Silk reeling*. Vol.3**,** FAO, Rome,p.112.
- *Seri business manual* – a user's guide by CSB
- *Wild Silks of India, Vol.II* by CSB publication
- *Manual on Bivoltine silk reeling technology* (2003), CSTRI, Bangalore p.122.

2. Entrepreneurship Development in Post silk Technology 5(0+5)

Practical

Selection of raw silk, sorting grading and preservation of raw silk. Winding of silk, doubling, twisting and steam setting, twist. Single yarn twisting, dupion twisting, Different intensity of twisting, Weft yarn twisting, warp yarn twisting. Warping of the yarn: Preparation of sectional warp and ball warp, re-reeling and arrangement of yarn on roller (roller warping). Acquaint skills in dyeing: Selection of dye, understanding of dye chart and mixing of dyes, single dye application, multiple dye application (Tie and dye) finishing of the dyed yarn, dehydration and preservation of dyed silk.

Suggested Reading

- *Seri business Manual* – a user's guide CSB publication
- cstri.res.in/

3. Entrepreneurship Development in products technology 5(0+5)

Practical

Introduction to the weaving, selection of raw silk, procurement, Preparation of raw silk yarn, arrangement of looms: pit loom, frame loom, Power loom, self designed, Jacquard looms, dobby operation. Weaving of the fabric, designing of the fabric, plain or designed weaving, zari work, Hand working on plain fabrics understanding of the Jacquard designs. Finishing of the fabric: Normal finish packaging of sarees, dress material starch, chemical finishing of the fabric tautening, ironing. Marketing of the fabric, project preparation and calculation of B/C ratio in weaving.

4. Entrepreneurship Development in Silk Apparel Technology 5(0+5)

Practical

Designs in fabrics, zaries blended fabrics. Caring of fabric, value addition in fabrics, Knitting, embroidery, embossing, dyeing, printing, self designing. Designing, Blending, Chiffon, Satin, Creping, Mercerisation. Induction of tentering, Special effects in fabric by different levels of twisting, combination of twisted yarns, blending of silk with other yarns. Designing of silk fabrics. Weaving- plain designs, zari designs. Loading/ weightening of silk/fabric. Silk in upholstery and interior decorations. Zari making from silk. Silk fabrics – traditional kacheevaram, dharmavaram, arni, illakal, molkalmur, pochampalli, venkatagiri, banarasi, rajasthani, paithani etc. apparels from vanya silks, Caring of silk fabrics. Fashion design from silk-tie, glouse, cap, vanity bags etc. Visit to KSIC, CSTRI and Jharcraft and private silk apparel designers.

Suggested Reading

- *Seri business Manual* – a user's guide CSB publication
- cstri.res.in/

Module-IV Natural Resources Management 20(0+20)

1. Soil Health Clinic 5(0+5)

Practical

Principles of analytical chemistry, Maintenance and handling of instruments used in soil health clinic, Good laboratory practices, requirements for establishing soil health clinic; sampling techniques-soil, plant, water, manure, fertilizer and amendments; Processing/ preparation of samples; Physical properties of soils-Mechanical analysis of soil; soil texture by feel method; bulk density and pore space of soil, soil colour; Physico-chemical properties of soil-pH, EC and cation exchange capacity of soil; Chemical properties-Organic carbon, available nutrient status in soil, Interpretation of soil test results and recommendation; Visual diagnosis of nutrient deficiency symptoms in plants; Plant analysis for nutrient contents, interpretation and recommendations.

Quality assessment of manure, fertilizer and amendments; Visits to soil health laboratories, NBSS & LUP, Bangalore, Pollution Control Board lab, fertilizer factories, compost production units KCDC and farmers' fields.

Suggested Reading:

- Piper, P.S., *Soil and plant analysis*
- Page, A.L., Miller, R.M., and Keeney, D.R., *Methods of soil analysis*

2. Problematic Soils and their Management 5(0+5)

Practical

Study of soil and water resources of Karnataka and India; Collection and preparation of soil, irrigation water, waste water samples; Study of soil profile; Study of physical constraints in soils-Soil crusting: measurement of crust strength; Soil compaction: Study of hard pans in fields; Acid soils-Determination of soil pH, EC, Organic carbon, nutrient status, forms of acidity, Estimation of extractable aluminium and CEC, Lime requirement methods; assessment of quality of liming materials; Salt affected soils-determination of pH, EC, Organic carbon, nutrient status, CEC, cations and anions, ESP, SAR, Determination of gypsum requirement of alkali soils and assessment of quality of gypsum; Quality of irrigation water-determination of pH, EC, cations and anions, SAR, RSC and interpretation of results; Use of waste water for agriculture-Determination of pH, EC, anions, Cations; Determination of DO, BOD and COD; Visits to problematic soil areas-to see the fields affected by salinity, sodicity, acidity and control measures taken up; Visits to soil health laboratories, NBSS & LUP, Bangalore.

3. Integrated Farming Systems 5(0+5)

Practical

Visit to successful surrounding IFS farms, cultivation of crops, maintenance and production of livestock/subsidiary enterprise (location specific). Harvest, post harvest and preparation of produce for market. Quantification and recycling of location specific crop/livestock residues. Working out nutrient flow efficiency in the linked components. Practice of labour and resource management, labour saving techniques. Indigenous technical knowledge in IFS, Farm records and farm book keeping. Economic analysis of IFS.

4. Water Management (Watershed, Micro-irrigation, Problematic Water) 5(0+5)

Map reading-reading of toposheets, aerial photos, reading satellite images, interpretation of map data and ground verification of data, Delineation of watershed. Survey-data collection tabulation and interpretation. Manual delineation, delineation by GIS. Construction of farm pond. Selection of site, design criteria- designing farm pond. Field activity-digging of pond, lining, inlet and outlet finishing. Cost estimation, evaluation. Construction of check dam. Selection of site. Calculation of runoff, Silting criteria, designing check dam. Construction of check dam, visit to 2-3 check dam. Cost estimation, evaluation of efficiency. Drip irrigation. Discharges-calculation: assessment of discharge. Designing of drip-data collection; pressure

regulation; discharge distribution. Growing a crop on 10 gunta by each student-field installation of drip system. Uniformity evaluation. Evaluation of system-WUE and economic assessment Maintenance problems. Sprinkler irrigation. Suitability studies pressure/ discharge regulations. Designing and planning of sprinkler system Matching the system with crop needs. Field installation of system. Evaluation of different sprinklers: assessment of uniformity coefficient distribution efficiency. Economic analysis. Maintenance problems. Problematic water and land suitability. Land irrigability classes. Analysis of water quality- saline, sewage bore well, surface water etc. evaluation for irrigation. Recycling of effluents for irrigation. Treatment of water.

II. RURAL WORK EXPERIENCE PROGRAMME (SERICULTURE) {RSWE} 20 (0+20)

a. Placement in Grainage Technology 4(0+4)

Practical

The students will be involved in various aspects of egg production and grainage management: Silkworm egg production, planning and execution. Procurement of seed cocoons. Selection, sorting and preservation of seed cocoons. Sexing, synchronisation of moth emergence, pairing and depairing of moths. Preparation of layings on egg cards and loose egg preparation. Processing and preservation of eggs. Pebrine inspection. Acid treatment of bivoltine eggs. Working out the economics of egg production. Price fixation and disposal of DFLs. Organisational setup, labour management and maintenance of records. Visit to local LSPs to observe transactions and technical procedure followed and working out cost –benefit ratio of egg production with LSPs. Organizational set up of seed production in Karnataka. Note: Placement will be conducted in Govt. Grainage/CSB Grainage/Private Grainage.

b. Seri clinic 4(0+4)

Practical

Soil health diagnosis, INM practices to improve the soil and plant health, identification of deficiency symptoms in mulberry and acquainting with remedial measures. Diagnosis of pest and diseases of silkworm and acquainting with remedial measures. Assessment of quality of the inputs-leaf and DFLs. Survey of problematic mulberry garden and rearing houses and find out the remedies for the cause. Assessment of toxicity, their nature, level and suggest remedies. Development of INM and IDPM schedules for management of Nutrition and pest and diseases in mulberry.

c. Placement in Silk Product Technology 4(0+4)

Practical

The students will be involved in various aspects of silk product science. Cocoon testing and grading, sorting manual and mechanical defective cocoons. Silk reeling, cocoon cooking and stiffling. Reeling –Charakha. multiend reeling, semi automatic and automatic reeling machines. Silk examination, skeining book and bale making, storage testing and grading. Silk throwing and

winding, wraping, degumming, bleaching, dyeing and printing. Textile designing, motifs, knitting. Disposal of effluents. Note: Placement will be conducted in Govt. Grainage/CSB Grainage/Private Grainage.

d. Placement In Value Addition to Sericultural By-Products 3(0+3)

Practical

The students will be involved in various aspects of silk product science. Cocoon and mulberry crafts and handicrafts. Composting and enriched vermicomposting using sericulture waste. Note: Placement will be conducted in Govt. Grainage/CSB Grainage/Private Grainage.

e. Practical Extension Work in Villages 5(0+5)

Practical

The students will camp in the villages and work with farmers. Conducting general meetings in the villages regarding programmes to be conducted by the students in the villages. Collection of data from farmers, extension personnel and institutions i.e., general information about the villages and detailed information from contact farmers. Analysis of data and identification of the problems /gaps. Conducting farm and home visits for greater acquaintance with farmers. Conducting group discussion meetings based on the problems identified and new technologies of sericulture to be practiced. Conducting method / result demonstrations to teach the skills to prove the worthiness of technologies to the farmers based on problems and needs.

MINIMUM STANDARDS FOR ESTABLISHING OF COLLEGE OF SERICULTURE

SERICULTURE

1. **Degree Nomenclature :** B.Sc. (Hons) Sericulture
2. **Eligibility Criteria :**10+2/ Intermediate with PCMB (P- Physics, C-Chemistry, M-Mathematics, B-Biology) from a recognized board/university
3. **Medium of Instruction**: English
4. **Minimum Intake :** 40 students per year

1. Departments /Sections

1. Department of Host Plant Production
2. Department of Sericulture Crop Improvement
3. Department of Cocoon Crop Production
4. Department of Silk Product Science
5. Basic Sciences and Humanities

2. Faculty Requirements For Department/Section

Sl. No.	Department/Section	Faculty			Total
		Professor	Associate Professor	Assistant Professor	
I.	**Department of Host Plant Production (A+B)**	**1**	**2**	**13**	**16**
	A. Core Courses:	**1**	**1**	**2**	
	B. Allied Courses:	**-**	**1**	**11**	
	1. Agronomy	-	-	2	
	2. Agricultural Microbiology	-	-	1	
	3. Soil Science and Agril. Chemistry	-	-	1	
	4. Crop Physiology	-	-	1	
	5. Farm Machinery and Engineering	-	-	1	
	6. Horticulture	-	-	1	
	7. Agricultural Entomology	-	1	1	
	8. Plant Pathology	-	-	1	
	9. Seed Science & Technology	-	-	1	
	10.Forestry and Environmental Science	-	-	1	

Sl. No.	Department/Section	Faculty			Total
		Professor	Associate Professor	Assistant Professor	
II.	**Department of Sericulture Crop Improvement (C+D)**	**1**	**1**	**4**	**6**
	C. Core Courses:	1	1	2	
	D. Allied Courses:	-	-	2	
	1. Plant Biotechnology	-	-	1	
	2. Genetics and plant breeding	-	-	1	
III.	**Department of Cocoon Crop Production (E+F)**	**1**	**2**	**5**	**8**
	E. Core Courses:	**1**	**2**	**5**	
	F. Allied Courses:	**-**	**-**	**-**	
IV	**Department of Silk Product Science**	**1**	**1**	**6**	**8**
	G. Core Courses:	**1**	**1**	**4**	
	H. Allied Courses:	**-**	**-**	**2**	
	1. Mechanical Engineering	-	-	1	
	2. Textile Engineering	-	-	1	
V.	**Basic Science and Humanities**	**-**	**1**	**9**	**10**
	1. Agricultural Extension	-	1	1	
	2. Agricultural Economics	-	-	1	
	3. Agricultural Statistics	-	-	1	
	4. Animal Science	-	-	1	
	5. Biochemistry	-	-	1	
	6. Computer Education	-	-	1	
	7. English	-	-	1	
	8. Physical Education	-	-	1	
	9. Asst. Librarian	-	-	1	
	Grand Total (I to V)	**04**	**07**	**37**	**48**

7. Administrative and Supporting Staff for Department / Section

Department/ Section	Steno/PA/ Computer Operator	Assistant	Attendant / Messenger	Clerk	Laboratory Assistant / Attendant	Field staff* (Can be outsourced)
Department of Host Plant Production	1	07	07	-	14	10
Department of Sericulture Crop Improvement	1	02	02	-	04	04
Department of Cocoon Crop Production	1	02	02	-	04	08
Department of Silk Product Science	1	02	02	-	04	04
Basic Science and Humanities	1	04	02	-	03	02
Total	**05**	**17**	**15**	**-**	**29**	**28**

8. Faculty Expertise

Department/Section	Faculty Expertise	
	Core	**Associated**
Department of Host Plant Production	• Host plant cultivation, production and management. • Host plant botany, cytology, genetics and breeding • Host plant physiology • Host plant protection	• Agronomy • Plant Biotechnology • Soil Science and Agril. Chemistry • Crop Physiology • Farm Machinery and Engineering • Forestry and Environmental Science • Horticulture • Agri. Entomology • Plant Pathology • Seed Science & Technology • Genetics and plant breeding
Department of Cocoon Crop Production	• Silkworm Rearing • Vanya sericulture • Silkworm egg production • Silkworm protection	• Agricultural Microbiology • Animal Science • PlantBiochemistry • Agri. Economics
Department of Sericulture Crop Improvement	• Silkworm cytology, genetics and breeding • Silkworm Morphology and Systematic • Silkworm Anatomy and Physiology	• Biotechnology • Applied Microbiology • Seri Biotechnology • Seri Biochemistry • Seri Physiology

Department of Silk Product Science	• Silk reeling and post reeling technology • By-products and value addition • Spun silk production • Industrial Machinery	• Business management • Mechanical engineering • Textile engineering • Silk weaving and wet processing
Basic Sciences, Humanities and Social Sciences		• Agricultural Extension • Agricultural Economics • Seri. Business Management • Agricultural Statistics • Computer sciences, • English • Physical Education

9. Manpower Requirements

Manpower	Number
Dean (Seri.)	01
A. Establishment	
Personal Secretary to Dean (Seri.)	01
Superintendent (Administration)	01
Superintendent (Accounts)	01
Superintendent (Academics)	01
Assistant Examination coordinator	01
Steno / Computer Operator	02
Attendants/Messengers	02
Clerical Staff / (LDC)	03
AE / AEE	02
Electrician	01
Store Keeper	01
Driver (Heavy Vehicle- 2) & (Light Motor vehicle - 4)	06
Security, Sanitation, garden maintenance and Landscaping	04
B. Library	
Shelf Assistants	01
Clerk	01
C. Student Welfare	
Assistant Director of Student Welfare	01

Manpower	Number
D. Hostel (Boys + Girls)	
Wardens	02
Clerk (LDC)	02
Cooks	02
Asst. cooks	04
Care taker	02
Attendants	10
Security, Sanitation and Landscaping	07
Total	**59**

10. Central/Department/Section Laboratories (As Per Requirement of The Teaching And Research Work Of The College)

Department/Section	Laboratory
Department of Host Plant Production	1. Host plant Fields 2. Agronomy Fields 3. Horticulture Fields 4. Agril. Microbiology Lab 5. Plant Pathology lab 6. Agril. Engineering Lab 7. Soil Science and Agril. Chemistry lab 8. Agril. Entomology lab 9. Plant Physiology lab
Department of Cocoon Crop Production	10. Silkworm Pathology lab 11. Grainage lab **Field labs** 12. Silkworm rearing house. 13. Commercial silkworm rearing house 14. Chawki rearing house 15. Genetics & breeding lab
Department of Sericulture Crop Improvement	16. Biotechnology lab 17. Biochemistry lab 18. Host plant breeding lab 19. Silkworm breeding lab
Department of Silk Product Science	20. Silk Reeling lab 21. Raw Silk testing Lab 22. Silk dyeing & Printing Lab 23. Silk weaving Lab 24. By-product value addition Lab
Basic Sciences, Humanities and Social Sciences	25. Audio-Visual Lab 26. Computer Lab 27. Sports ground

11. Land Requirements

Main Building and Hostels	06 ha
Field Area	30 ha
Play ground	04 ha
Total	**40 a**

12. Floor Space Requirement

A. CENTRAL FACILITY

No.	Details	Number of rooms	Dimensions (ft)
1.	Dean office	1	20×24
2.	PA room	1	20×12
3.	Committee room with video conferencing facility	1	20×48
4.	Admin. Staff rooms	3	20×36 each
5.	Examination cell	1	20×12
6.	Evaluation room	1	20×36
7.	Faculty room	25	20×12each
8.	Placement cell	1	20×48
9.	Smart Lecture rooms	4	Seating Capacity - 50
10.	Auditorium	1	Seating Capacity – 300
11.	Library/Book bank	1	30×72
12.	Examination hall	1	Seating Capacity - 60
13.	AE / AEE	1	20×12
14.	Multipurpose room	1	20×36
15.	Laboratories	20	30×48 each
16.	Hostel	2	UG & PG (Boys& Girls) Accommodating 3 students in a room
17.	Generator shed	1	20×36
18.	Canteen	1	20×12 (Kitchen) & 20×36 (Setting room)
19.	Toilets	-	4 sets each (Girls & Boys)
20.	Parking space	As per requirement (APR)	For college & hostels
21.	Vehicles Officer car Staff car/Jeep Bus Mini bus Ambulance	 1 2 1 1 1	

B. DEPARTMENT / SECTION

S. No.	Details	Number of rooms	Dimensions
1.	Office of the Head of the Department	5 (for 5 departments)	20×24each
3.	Faculty room	25	As specified in Sl. No. 8
4.	Rooms for Research Scholars	4 (for 4 departments)	20×24 each
6.	Smart Lecture cum seminar room	2	Seating capacity – 50 each
7.	Laboratories (No. of laboratories&Field labs as per requirement and include UG teaching laboratory		
8.	Department of Host Plant Production	6	30 x 60 (one) 30 x 40 (Five)
9	Department of Cocoon Crop Production	2	30 x 60 (one) 30 x 40 (one)
10	Department of Sericulture Crop Improvement	4	30 x 60 (Four)
11	Department of Silk Product Science	5	30 x 60 (one) 30 x 40 (four)
12	Basic Sciences, Humanities and Social Sciences	2	30 x 60 (Two)
13	Field labs for Agronomy, Host plant cultivation, Horticulture, Rearing houses, Chawki rearing house, Sports ground & Green house / poly house / glass house	As Per Requirement	

13. *Equipment Facilities: Central Teaching and Research Laboratories

A. Centralized Instrumentation Laboratories

Sl. No.	Name of Equipment	Number
1.	Laminar air flow chamber	1
2.	Shaker and Incubator	1
3.	Autoclave	1
4.	pH meter	1
5.	Mirco and macro balances	1 each
6.	Agarose Gel electrophoresis unit (Horizontal)	1
7.	PAGE- electrophoresis unit (Vertical)	1
8.	Gel Documentation Unit	1
9.	ELISA reader	1
10.	Microscopes (simple, compound and stereo)	1

11.	BOD incubator	1
12.	Cold room	1
13.	Liquid Nitrogen Plant	1
14.	Liquid Nitrogen Flask	2
15.	Ice maker	1
16.	High Speed Centrifuge	1
17.	High speed cooling centrifuge	1
18.	Double Distillation unit with RO	(As per requirement)
19.	Computers	4
20.	Table top Centrifuge	1
21.	Micropipettes (0.2-5ml)	1
22.	Hot air oven	2
23.	PCR unit	2
24.	Water bath	1
25.	Pestle & Mortar	10
26.	Micro oven	2
27.	Dissection microscope	5
28.	Compound microscope	5
29.	Megaphones	1
30.	Amplifier	1
31.	Handy cam	1
32.	Camera	1
Any other equipment as per requirement		

B. Equipment in the Department Laboratories (additional specialized equipment may be required depending on the mandate of the institute).

Sl. No.	Name of the Equipment	Number of units x Divisions	Total Number	Departments using
1.	Tractor	1x1	1	HPP
2.	Tiller	1x1	1	HPP
3.	Secateurs	10x1	10	HPP
4.	Looping Shear	2X1	2	HPP
5.	Brush Cutter	1X1	1	HPP
6.	Sprayer	2X1	2	HPP

7.	Battery operated knapsack sprayer	2x1	2	HPP
8.	Sprayers	5x1	5	HPP
9.	Mulberry cutting preparation machine	1x1	1	HPP
10.	Mulberry stem crushing machine	1x1	1	HPP
11.	Screw auger	1x1	1	HPP
12.	Tube auger	1x1	1	HPP
13.	Other farm implements for cultivation	As per requirement		
14.	Laminar flow	1x2	2	HPP+CCP
15.	Autoclave	1x2	2	HPP+CCP
16.	Spectrophotometer	1x2	2	HPP+CCP
17.	Flame photometer	1x2	2	HPP+CCP
18.	Insect collection box	10x2	20	HPP+CCP
19.	Dissection microscopes	5x2	10	HPP+CCP
20.	Compound microscopes	5x3	15	HPP+CCP+SCI
21.	Acid treatment bath	2x1	2	CCP+SCI
22.	Chawki rearing stands	10x2	20	CCP+SCI
23.	Plastic trays	50x2	100	CCP+SCI
24.	Feeding stands	5x2	10	CCP+SCI
25.	Leaf chopping board	2x2	4	CCP+SCI
26.	Knives	2x2	4	CCP+SCI
27.	Leaf chamber	2x2	4	CCP+SCI
28.	Ant wells	50x2	100	CCP+SCI
29.	Room heater	8x2	16	CCP+SCI
30.	Atomizer	2x2	4	CCP+SCI
31.	Humidifier	4x2	8	CCP+SCI
32.	Leaf collecting basket	8x2	16	CCP+SCI
33.	Electrical balance	2x2	4	CCP+SCI
34.	Power sprayer	2x2	4	CCP+SCI
35.	Mask	2X2	4	CCP+SCI
36.	Rotary mountages	150x2	300	CCP+SCI
37.	Cocoon harvester	10x2	20	CCP+SCI

38.	Cocoon cutting machine	2x2	4	CCP+SCI
39.	Plastic mountages	150x2	300	CCP+SCI
40.	Deflossing machine	1x2	2	CCP+SCI
41.	Plastic incubation frames	20x2	20	CCP+SCI
42.	Mountage deflossing machine	5x2	10	CCP+SCI
43.	Digital hygrometers	4x2	8	CCP+SCI
44.	Cellules	500x2	1000	CCP+SCI
45.	Small rearing cages with trays	25x2	50	CCP+SCI
46.	Cocoon deflossing machine	1x2	2	CCP+SCI
47.	Cocoon drying machine	1x1	1	SPS
48.	Cocoon cooking machine	1x1	1	SPS
49.	Cocoon reeling machine (either multiend reeling machine or Semi-automatic with denier detecting system)	1x1	1	SPS
50.	Silk re-reeling machine	1x1	1	SPS
51.	Vacuum permeation device	1x1	1	SPS
52.	Cocoon assorting machine	1x1	1	SPS
53.	By-product treating machine	1x1	1	SPS
54.	Silk skein twisting machine	2x1	2	SPS
55.	Silk book making machine	2x1	2	SPS
56.	Seri plane winding machine	1x1	1	SPS
57.	Illumination equipment for inspection	1x1	1	SPS
58.	Denier scale	4x1	4	SPS
59.	Rewinding test machine (10 bobbins)	1x1	1	SPS
60.	Boiler	1x1	1	SPS

61.	Mechanical tools	1x1	1	SPS
62.	Water testing kit	1x1	1	SPS
63.	Spinning wheel	1x1	1	SPS
64.	Weaving unit (Hand loom and power loom)	1 each	2	SPS
65.	Serigraph	1x1	1	SPS
66.	Cohesion tester	1x1	1	SPS
67.	Tenacity and elongation testing machine	1x1	1	SPS

NB: HPP - Host Plant Production; CCP- Cocoon Crop Production; SCI- Sericulture Crop Improvement; SPS - Silk Product Science

Annexure I

Background and Summary of discussions

The Indian Council of Agricultural Research vide Office Order No. F.No.Edn.5/1/2013-EQR dated July 10, 2013 constituted the Fifth Deans' Committee on Higher Agricultural Education in India under the chairmanship of Prof. R B Singh with the following Terms of Reference:

I. Defining UG & PG degrees for general market needs and for specialist jobs and uniformity in UG and PG degree nomenclature
II. Restructuring of UG programmes for increased practical and practice contents.
III. Central assistance for strengthening of higher agricultural Education
IV. Guidelines for assessing training needs and performance of teaching faculties.
V. Reforms in governance of SAUs
VI. Developing a Model DPR for establishment of a college

Summary of discussions in Fifth Dean's Committee meeting held on 22nd August, 2014.

The first meeting of the Committee was held on 22nd August, 2014 to deliberate on terms of reference of Fifth Deans' Committee, to discuss on baseline issues before the Committee and to Identify discipline wise conveners/co-conveners and discussion on their mode of working.

Prof. R. B. Singh, the Chairman mentioned that the task of the Committee is extremely important as its recommendations will result in the development of national human resource capital in the field of agriculture and allied sciences. It was felt that highest priority to agriculture is required for the alleviation of hunger, under nutrition and poverty. It was a general consensus that the country needs creation of skilled, talented, entrepreneurial human resource and knowledge pool, especially of young graduates, along the value chain. Thus course curricula for Agricultural Sciences and their delivery systems should be so designed that the graduates produced become job providers rather than job seekers. Their skill, scale and speed should harness demographic dividends, meet the fast growing demand for quality products and democratically promote inclusiveness. In other words, our educational system and course curricula must be designed and geared to ensure excellence, relevance and high quality of products, zero environment footprint, climate resilience, high efficiency, and competitiveness. In doing so, the voices of the farmers, industry, corporate sector, NGOs, Civil Society, scientists, teachers and, of course, students must be heard and duly internalized in the curricula.

The Committee endorsed the Terms of Reference given to it by the ICAR. It formulated and adopted a work schedule, constituted discipline-wise sub-committees and agreed on needed workshops and meetings.

The Committee reviewed the baseline issues addressed by the Fourth Deans' Committee and found that the issues are equally valid even today. The Fourth Deans' Committee had comprehensively addressed all these issues and made specific recommendations. Recognizing that the issues before the Fourth Deans' Committee were equally relevant even today, the

Committee retained them, often recapitulated, along with some of the new issues that it had identified, as listed below:

1. Rising unemployment and poor employability of the graduates.
2. Fast degrading natural resources and increasing negative effect of climate change.
3. Declining quality of students, poor quality of education due to obsolete and inadequate equipment, laboratory, farm and library facilities, leading to knowledge-deficit all along the value-chain particularly in new emerging areas.
4. Declining quality and depleting number of faculty members, lack of faculty competence in frontier and emerging areas, limited emphasis on refresher training, faculty improvement and incentives.
5. Extensive inbreeding and lack of adequate skill, entrepreneurship and experiential learning.
6. System's inability to take full advantage of modern tools of management for efficient governance.
7. Dwindled faculty in SAUs with majority chunk of the posts remaining vacant due to financial crunch.
8. Curriculum and curriculum delivery not changed keeping in view global technology development.
9. Lack of linkage of curriculum to employment in private agribusiness and processing industries and meeting the demands of extension.
10. Existing curricula are short in informing and sensitizing the students and faculty about seriousness of the stubbornly high incidences of hunger, under nutrition, poverty, inequality, fast degrading natural resources- land, water and biodiversity and high vulnerability to climate change.
11. Inadequate and declining investment and financial resources in agricultural universities/ colleges; unmindful splitting of agricultural universities, and poor resource planning.
12. Indifference to the needs of women, especially women students, scientists and farmers, increasing irrelevance of Home Science colleges and curricula.
13. Poor governance, widening disconnect amongst education, research and extension, isolation from international exposure, and lack of evaluation, accountability and incentive system.

The Committee identified Conveners and Co-conveners for each discipline. Considering the large number of Colleges and diversified courses in Agriculture, the Committee agreed to identify one Convener and five Co-conveners under agriculture.

The Committee agreed on the following procedure to be adopted by the Conveners:

The Deans of all colleges to hold meetings with their faculty and discuss the changes/ suggestions/improvements over the curricula recommended by the Fourth Deans Committee. Representatives of students, farmers, corporate sector, civil society organisations and other stakeholders may also be invited for the meeting for their valuable inputs.

It was suggested to consult the reports of the following Committees while formulating/ suggesting revisions:

I. "Human Capital Requirements in Agriculture and Allied Sciences", by NAARM, Hyderabad (soft copy of the report will be made available).
II. Report of the review committee (Chairman Prof. R. B. Lal) Qualification and Degree Nomenclature" (available on ICAR website).
III. Report of the ARS Review Committee (Chairman Dr R.S. Paroda) available on ICAR website.
IV. Report of the IV Deans' Committee on Agricultural Education in India (available on ICAR website).
V. Reports on new and restructured post graduate curricula & syllabi published by Education Division.
VI. Reports on Minimum Standards for Higher Agricultural Education uploaded by Education Division (available on ICAR website).

The Conveners and Co-conveners were requested to co-ordinate and hold a workshop of the Deans of all the colleges of their discipline, deliberate the suggestions made by different Deans and prepare a draft report of their discipline. Considering large number of Agricultural Colleges, it was suggested to hold region wise workshops to have productive deliberations.

Summary of discussions in Fifth Dean's Committee meeting held on 11 – 13 February, 2015.

After having completed the task at college level, the Convener & Co-conveners of all the disciplines convened meetings of Deans of their respective disciplines to finalize the recommendations based on the recommendations framed at the college/zonal level.

A workshop of the Committee Members/Conveners/Co-conveners was held in Delhi from 11 to 13 February, 2015. Discipline-wise reports prepared were presented in this workshop. Some of the Common Action Points emerged out of the discussions held in the workshop are listed below:

It was a general consensus that total credit hours for a UG Degree across the disciplines should not exceed 168 (including the cafeteria/ optional courses).

Semester–wise list of courses with credit hours be listed for each discipline highlighting the changes suggested over the Fourth Deans' Committee.

The cafeteria/ elective/ optional courses need to be customized according to the regional requirements.

It was agreed by all to have Students READY Programme for 6 months duration by integrating both RAWE/ in-plant training and Experiential Learning modules preferably in VII semester so that the students are in campus during the VIII semester.

Internships/ in house trainings, if any, may be accommodated in the semester breaks.

The degree nomenclatures (both UG and PG) need to be uniform across the country in harmonization with the Minimum Standards of Higher Agriculture Education for the respective disciplines prepared by the Education Division, ICAR.

Assignments/ seminars need to be made compulsory for all the students.

Some courses like Environmental Studies and Disaster Management (as per UGC guidelines-core module for under graduate courses of all branches of higher education), Communication Skills and Personality Development, Information and Communication Technology, Entrepreneurship Development and Business Management, Agricultural Informatics and Economics and Marketing need to be cross-listed and suitably made a part of the curriculum/ syllabus for all the degree courses.

Based on the points raised above, the Members/Conveners/ Co-Conveners conducted meetings to finalise the draft recommendations.

The Hon'ble Prime Minister on 25th July,2015 launched the Student READY programme with the following components:

I. Experiential Learning - 24 Weeks
II. Rural Agricultural Work Experience - 10 weeks
III. In Plant Training/ Industrial Attachment - 10 Weeks

In view of the launch by the Hon'ble Prime Minister, it was decided to hold meetings of Members/Conveners/Co-conveners and some Special Invitees in Education Division, ICAR to design the Student READY programme for each discipline. The meetings were held in the months of August and September, 2015. The salient action points emerged during these meetings included:

- The emphasis should be given to Experiential Learning and RAWE programme. The Student READY programme should be made for one complete year devoting VII semester to RAWE and VIII semester to Experiential Learning/Hands on Training (HOT).
- All courses would be accommodated in the first six semesters.
- There should be cross-listed common courses as detailed above.

Summary of discussions in Fifth Dean's Committee meeting held on 23 – 24 November, 2015.

A meeting of Members/Conveners/Co-conveners/Special Invitees was held on November 23-24, 2015 at New Delhi and draft reports including Student READY were presented. The following observations were made:

1. The newly Introduced 11 optional courses, in the discipline of Agriculture, for the interested students to strengthen capabilities in the desired areas should be replaced with elective courses.
2. Condition of optional courses being offered to only those students having OGPA of > 7%, as suggested by the convener for Agriculture, should be dropped to make the evaluation pattern uniform.

3. The convener for Horticulture and Sericulture was requested to revise the Student READY programme as whole one year duration allotted for total 6 components under the program was divided between RAWE (6 months for 2 modules) and Industrial attachment (6 months) including educational tour, while other components were missing and duration for industrial attachment was considered to be too long.
4. The courses on Environmental Science and Marketing and Cost Analysis, proposed by the Convener Horticulture & Sericulture, were suggested to be replaced by Environmental Science & Disaster Management and Agro Economics and Marketing, respectively.
5. It was suggested that all optional courses listed in Sericulture be made regular and in place of two separate courses as Silkworm Host Plant Genetics & Breeding and Silk Worm Genetics & Breeding, be merged and titled as Sericulture Genetics and Breeding.
6. Proposal of Convener, Food Science & Technology, for change of degree nomenclature from B. Tech (Food Technology) to B. Tech (Food Processing Technology) was not agreed and it was decided to retain the present nomenclature. Computer Programming course was suggested to be deleted from Food Science & Technology.
7. Summer Training as a part of Student READY programme in Agriculture Engineering was suggested to be named as Skill Development Training. It was also suggested that time distribution among Student READY components of Agricultural Engineering be revised to allot 4 months (instead of 2) for student project and industrial training and Experiential Learning to be of 2 months each. It was further suggested that all Agricultural Engineering colleges should have Experiential Learning Units and in case these units are lying useless outsourcing of these units, could be a good option to generate money from them throughout the year. Courses on Megatronics, Hightech. Cultivation and E-sensoring were also suggested to be introduced in Agricultural Engineering
8. The under graduate programme in Biotechnology structured by the Convener, Biotechnology, besides core courses in biotechnology, included some foundation courses on Agriculture, Animal Sciences, Basic Sciences, Soft Skills, Gender and Socioeconomic issues, and also Skill & Entrepreneurship Development component. In order to deliver the rigorous practical skill and entrepreneurial exposure, the developed programme has majority of the courses upto the sixth semester, with 7th and 8th semesters devoted exclusively for giving professional skills in selected combination of biotechnology modules and entrepreneurship development in biotechnology under 'Student READY' programme.
9. It was suggested that swimming be made as credit course in Fisheries Sciences. RAWE was suggested to be placed after 2nd and 3rd year rather than 1st and 2nd year. EL was suggested to be taken up before Industry Attachment/Training. Food Chemistry and Fish in Nutrition was suggested to be revised to Food Chemistry and Fish in Human Nutrition.
10. It was observed that employability and entrepreneurship are major problems in forestry. Indian Council of Forestry may be requested to look into the matter with student feedbacks. Apiculture be included within Agroforestry. Realistic assessment of the forestry graduates employability is necessary as Agroforestry students have no reservations in Forestry jobs, which is a major cause of concern among Forestry students.

11. The fact that, student employability in the Dairy Technology from NDRI is 100%, and demand is for even much, was appreciated by the whole house. Title of the course Computer & Software Applications was suggested to be changed as Computer Software Applications. The condition of Hindi (1+0) course made mandatory for students, not offered hindi at matric level, was suggested to be ignored as Hindi has been made mandatory till matric level throughout the country. Members appreciated the efforts to highlight the success story of Dr. Kurien and Amul and to create Kurien Chair as a mark of respect to the father of White Revolution in India.
12. Committee expressed serious concern over non-employability of Home Science discipline graduates and post graduates and few students opting for UG and PG programs. It was unanimously decided to split UG Home Science into two i.e B.Sc. Community Science & B.Sc. Human Nutrition & Dietetics of total 4 years duration, with 2 years assigned for common courses and next 2 years for specialized courses.
13. A presentation was made by Dr M Murugan, Dean, College of Poultry Production Technology on newly started course B. Tech (Poultry Production Technology). The members were of the view that this course may not be included into the Fifth Deans' Committee Report considering the following facts:

I. The course does not include the whole management, including Poultry diseases which narrows the employment scope of these graduates.
II. It is not clear whether it comes under the purview of VCI or Agriculture.
III. It needs to be clarified that whether it is a Production Technology & Management, or a supplementary/alternative to Veterinary Sciences in AUs.
IV. Some members were of the view that since Poultry is a part of Livestock Production and Management (LPM), which itself is a part of Veterinary Sciences, this course may be offered only as diploma and not a degree.
V. The employability of the students although quite good but is only in private poultry industry. The further scope for implementing this course in other AUs should be contemplated only after analyzing the student employability in view of probable clashes with Veterinary Sciences graduates.

14. Special Session on Agriculture Marketing & Co-operation or Economics & Marketing: The UG courses in Agriculture Marketing & Co-operation or Economics & Marketing are being offered in the states of Andhra Pradesh, Gujarat and Tamil Nadu. The concerned colleges are not ready to agree upon a common nomenclature for UG degree considering expected future complications for the graduates who are presently being satisfactorily employed in their respective states. In view of this and considering the fact that there is neither core faculty for Agribusiness Management nor good employment opportunities for the agribusiness graduates passed from the SAUs, it was decided not to include in this report.
15. It was a general consensus that the Deans' Committee should frame minimum standards and course curricula to meet requirement of the employers. Faculty Development Programmes also need to be framed properly for the better outcome from the Deans' Committee.

16. Some members were of the view that, in order to create a fair evaluation system and to make the students more accountable towards their studies, paper setting should be done by external faculty and evaluation should be made by the faculty, other than those teaching the subject.
17. Since Veterinary Sciences is under the control of Veterinary Council of India (VCI), the nomenclature of UG degree in Veterinary Sciences is decided by the VCI. There is a fixed nomenclature for the departments in Veterinary Sciences, hence, there is no scope of deliberations on nomenclature and other issues in Veterinary Sciences.

Annexure II

List of Members of Fifth Deans Committee

S. No.	Name	Expert
1.	Dr. R.B. Singh President, National Academy of Agricultural Sciences, NASC Complex, DPS Marg , New Delhi-110 012	Chairman
2.	Dr. Sivanna Dean, College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore-560 065 (Karnataka)	Member (Agriculture) Upto 6/8/15
3.	Dr. Jatinder Kumar Dean, College of Agriculture, Pantnagar	Member (Agriculture) w.e.f. 7/8/15
4.	Dr. Ashwini Kumar Goel Dean, Agricultural Engineering, CCSHAU	Member (Agriculture Engineering)
5.	Dr. J.P. Sharma Dean, College of Horticulture, DYSPUH, Solan, (Himachal Pradesh)	Member (Horticulture) Upto 6/8/2015
6.	H.B. Lingaiah Dean, College of Horticulture, UAS, Bangalore	Member (Horticulture) w.e.f. 7/8/15
7.	Dr. T.V. Satyanarayana In charge, Faculty of Home Science, Acharya N.G. Ranga Agricultural University, Hyderabad-522 030 (Andhra Pradesh)	Member (Food Science &Technology)
8.	Dr. S.A. Asokan Dean, Madras Veterinary College, Tamil Nadu Veterinary & Animal Sciences University, Chennai	Member (Veterinary Science)
9.	Shri N.G.Jayasimha	Member (Veterinary Science) w.e.f. 16/1/2015
10.	Dr. Manilal Valliyate	Member (Veterinary Science) w.e.f. 16/1/2015
11.	Ms. Gauri Maulekhi	Member (Veterinary Science) w.e.f. 16/1/2015

S. No.	Name	Expert
12.	Dr. K.M. Shankar Dean, College of Fisheries, KVAFSU, Kankanady, Mangalore – 575 002 (Karnataka)	Member (Fisheries Science)
13.	Prof. P. Durairasu Dean, Forest College and Research Institute, TNAU, Mettupalayam – 641 301(Tamil Nadu)	Member (Forestry) Upto 19/10/14
14.	Dr. K. Sudhakara Dean, College of Forestry,KAU, Thrissur	Member w.e.f. 20/10/14
15.	Dr. Rita S. Raghuvanshi Dean,College of Home Science, G.B. Pant University of Agriculture & Technology, Pantnagar-263 145 (Uttarakhand)	Member (Home Science)
16.	G.R. Patil Dean & Joint Director, National Dairy Research Institute Karnal-132 001	Member (Dairy Technology) Upto 6/8/2015
17.	Dr. Narsimha Murthy Dean, Dairy Science, Hebbal, Bangalore	Member (Dairy Technology) w.e.f 7/8/2015
18.	Dr. G.S. Dasog, Dean, College of Agriculture, University of Agriculture Sciences, Dharwad-580 005 (Karnataka)	Member (Agriculture Marketing and Cooperation)
19.	Dr. H S Dhaliwal, Dean, College of Agriculture, Punjab Agricultural University,Ludhiana-141 004 (Punjab)	Member (Biotechnology)
20.	Dr. G Venkateshwarlu Assistant Director General (EQR), ICAR, Krishi Anusandhan Bhawan-II, Pusa, New Delhi-110 012	Member Secretary

List of Special Invitees

S. no.	Name	Discipline
1.	Dr. (Mrs.) Anurag Chadurvedi, Deam, College of Home Science PJSTSAU, Hyderabad	Home Science
2.	Dr. R.K. Majumdar, Associate Professor, College of Fisheries, Tripura	Fisheries
3.	Dr. A. Arunachalam, Principal Scientist ICAR, Head Quarter	Forestry
4.	Prof. P.K. Srivastava, Principal, College of Forestry, Navsari Agriculture University, Navsari	Forestry
5.	Dr. S.K. Kanawjia, Principal Scientist and Academic Coordinator, NDRI, Karnal	Dairy Technology

Annexure III

Conveners and Co-Conveners of Different Disciplines

Agriculture

Convener: Dr. J. Kumar, Dean, College of Agriculture, GBPUAT, Pantnagar

Co-convener (North): Dr. J P Sharma, Dean, College of Agriculture, SKUASTJ, Jammu

Co-convener (South): Dr. H. Shivanna, Dean, College of Agriculture, GKVK, Bengaluru (up to 29/7/2015); Dr H Khader Khan, Dean, Agriculture, UAS, Bengaluru (w.e.f. 30/7/2015)

Co-convener (East): Dr. Srikant Das, Dean Faculty of Agriculture, BKVV, Mohanpur, West Bengal

Co-convener (West): Dr. S R Maloo, Dean, Rajasthan College of Agriculture, MPUAT, Udaipur

Co-convener (Central): Dr. S K Rao, Dean Faculty of Agriculture, JNKVV, Jabalpur

Horticulture & Sericulture

Convener: Dr. H B Lingaiah, Dean, College of Horticulture, UHSVHS campus, Bengaluru

Co-convener: Dr. A K Pandey, Dean, College of Horticulture & Forestry, CAU, Pasighat, Arunchal Pradesh

Agricultural Engineering

Convener: Dr. Ashwani Kumar Goel, Dean, College of Agri. Engg. CCSHAU, Hisar

Co-convener: Dr. P A Turbatham, Dean, Faculty of Agri. Engg. MPKV, Rahuri

Food Science & Technology

Convener: Dr. D C Joshi, Dean, College of Food Processing Technology, & Bio-Energy AAU, Anand

Co-convener: Dr. B V S Prasad, Assoc. Dean, College of Food Science & Technology, Bapatla

Veterinary and Animal Sciences

Convener: Dr. S A Asokan, Dean, Madras Veterinary College, TNVASU, Chennai

Co-convener: Dr. S K Garg, Dean, Mathura Veterinary College, UPPDDUPCVVV, Mathura

Fisheries Sciences

Convener: Dr. K M Shankar, Dean, College of Fisheries, KVAFSU, Kankanady, Mangalore

Co-convener: Dr. (Mrs.) Asha Dhawan, Dean College of Fisheries, GADVASU, Ludhiana

Forestry

Convener: Prof. P. Durairasu, Dean, Forest College and Research Institute (upto 01/10/2014); Dr. K. Sudhakara, Former Dean, College of Forestry, KAU, Thrissur (w.e.f 02/10/2014)

Co-convener: Dr. K. Sudhakara, Former Dean, College of Forestry, KAU, Thrissur

Home Science

Convener: Dr. Rita S Raghuvanshi, Dean, College of Home Science, GBPUAT, Pantnagar

Co-convener: Dr. Sumati Rekha Malhotra, Dean, College of Home Science, CSKHPKVV, Palampur

Dairy Technology

Convener: Dr. G R Patil, Dean & Joint Director, NDRI, Karnal (upto 29/7/2014);

Dr. Narasimha Murthy, Dean, Dairy Science, UAS, Hebbal, Bengaluru, (w.e.f. 30/7/2014)

Co-convener: Dr. R R B Singh, Dean (Dairy Technology), Faculty of Dairy Tech., BAU, Patna

Agriculture Marketing, Business and Cooperation

Convener: Dr. H S Vijay Kumar, Director Education, UAS, Dharwad

Biotechnology

Convener: Dr. H S Dhaliwal, Dean, College of Agriculture, PAU, Ludhiana

Co-convener: Dr. Anil Sirohi, Dean, College of Biotechnology, SBBPUAT, Modipuram, Meerut

भाकृअनुप
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