CATALOGUE OF
UNDERGRADUATE COURSE
B. Tech. (Agricultural Engineering)
2024

ANGRAU

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY

Lam, Guntur - 522 034

Empowering young minds through innovation and team work

Dr. N. T. R. College of Agricultural Engineering, Bapatla

College of Agricultural Engineering, Madakasira

Dr. R. Sarada Jayalakshmi Devi
Vice - Chancellor

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FOREWORD

It gives me immense pleasure to present the Course Catalog for the B. Tech (Agricultural Engineering) programme of Acharya N. G. Ranga Agricultural University (ANGRAU), developed in accordance with the VI Deans Committee recommendations of the Indian Council of Agricultural Research (ICAR).

Agricultural Engineering plays a vital role in enhancing the efficiency and sustainability of Indian agriculture, which supports nearly 55% of the population and contributes about 18% to the national GDP. The updated curriculum integrates modern technologies and practical orientation across five major disciplines - Farm Machinery and Power, Food Processing, Irrigation and Drainage, Soil and Water Conservation Engineering and Agro Energy.

Agricultural Engineering plays a pivotal role in transforming the agricultural sector through the application of engineering principles to enhance productivity, sustainability, and resource-use efficiency. The curriculum emphasizes competency-based learning and outcome-oriented education, integrating modern technological advancements such as Agricultural Informatics and Artificial Intelligence, precision agriculture, renewable energy applications, automation, and data-driven farm management.

This Course Catalog serves as a comprehensive guide for students, faculty, and other stakeholders, providing detailed information on course structure, content, credit distribution, and practical components. It reflects the University's continuous efforts to align its academic programmes with national standards, global trends, and emerging needs of the agricultural sector.

I am confident that this curriculum will not only enrich the learning experience of students but also equip them with the necessary technical knowledge, professional skills, and ethical values to become competent agricultural engineers contributing to sustainable agricultural development and rural prosperity.

I commend the Faculty of Agricultural Engineering & Technology, curriculum development committee members, and all contributors for their dedicated efforts in preparing this catalog.

I wish all the students and faculty members great success in their academic and professional pursuits.

R. Sarada Jayalakshmi Devi
Vice - Chancellor

Dr. A. Mani
Dean of Agril. Engineering & Technology

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ANGRAU

PREFACE

It is with great pleasure that I present the Course Catalogue for the B.Tech. (Agricultural Engineering) program offered by the Faculty of Agricultural Engineering & Technology, Acharya N. G. Ranga Agricultural University (ANGRAU). This catalogue provides students with a clear academic roadmap that reflects the evolving technological, environmental, and developmental priorities of Indian agriculture.

The curriculum is developed in full accordance with the VI Dean's Committee of the Indian Council of Agricultural Research (ICAR), ensuring academic uniformity and global relevance. It is also aligned with the National Education Policy (NEP 2020), emphasizing experiential learning, multidisciplinary exposure, and enhanced skill development to strengthen employability. By integrating core engineering sciences with applied agricultural disciplines, the program prepares graduates to address emerging sectoral challenges with competence and innovation.

Agriculture remains central to India's economy, contributing about 17% to national output and providing livelihoods to nearly 46% of the workforce. As the country moves toward greater food security, climate resilience, and technological advancement, Agricultural Engineers play a critical role in improving productivity, reducing post-harvest losses, strengthening micro-irrigation adoption, and driving digital and automation-led transformations. The growing need for precision farming, resource-efficient irrigation, renewable energy integration, and advanced food processing reinforces the demand for highly skilled professionals in this discipline.

The B.Tech. (Agri. Engg.) program at ANGRAU addresses these priorities through a balanced combination of classroom instruction, practical training, and technology-driven learning across key domains such as Precision Agriculture, Farm Machinery and Power, Soil and Water Conservation Engineering, Smart Irrigation Systems, Food Process Engineering, Renewable Energy Systems, Robotics, Drones, Artificial Intelligence, Machine Learning, and Remote Sensing & GIS. This comprehensive framework equips students to engineer sustainable and scalable solutions across the agricultural value chain.

Students benefit from state-of-the-art laboratories, modern mechanization facilities and advanced ICT tools for modelling, sensing, and automation. ANGRAU's strong national and international collaborations further enhance exposure to global best practices in digital agriculture, water management, and agri-innovation. Major research and infrastructure projects supported by ICAR, DST, NABARD, and state agencies enrich hands-on learning and foster interdisciplinary engagement.

This catalogue reflects ANGRAU's commitment to developing technically proficient, innovative, and socially responsible Agricultural Engineers capable of contributing to sustainable development and rural prosperity. I am confident that the information provided will guide students as they plan their academic journey and explore opportunities in this dynamic and impactful field.

I extend my best wishes to all aspiring students as they begin a fulfilling and meaningful career in Agricultural Engineering.

A. Mani

A. Mani
Dean Faculty of Agril. Engg& Technology

DETAILED LECTURE OUTLINES

(as per VI Deans' Committee Recommendations)
B. Tech. (Agricultural Engineering)
2024

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YEAR WISE AND SEMESTER WISE DISTRIBUTION OF CREDITS AMONG DIFFERENT DEPARTMENTS

S. No.	Department	First Year		Second Year		Third Year		Fourth year		Credit Hours		
		I	II	I	II	I	II	I	II	Theory	Practical	Total
1	Farm Machinery and Power Engineering			211 2+1	212 2+1	311 2+1	312 2+1			8	4	12
2	Processing and Food Engineering			221 2+1	222 2+1	321 3+1	322 1+1	421 2+1		10	5	15
3	Irrigation and Drainage Engineering					331 2+1	332 3+1	431 1+1		6	3	9
4	Soil and Water Conservation Engineering			241 2+1	242 2+1 243 2+1			441 2+1		8	4	12
5	Renewable Energy Engineering				251 2+1		351 2+1			4	2	6
6	Basic Engineering	161 1+2 162 0+2 163 2+1	164 0+2 165 0+2 166 2+1	261 2+1 262 1+1	263 1+1 264 2+0	361 1+1 362 2+0 363 2+1	364 2+1 365 2+1 366 2+1	461 0+2 462 2+0 463 2+1		26	21	47
7	Agricultural Sciences	171 3+1 172 2+1	173 2+1 174 1+1	271 2+1 272 2+1 273 2+1	274 2+1 275 2+1	371 1+1		471 1+1		20	11	31
8	FRSP	101 3+1								3	1	4
9	Deeksharambh& Physical Education	101 0+2NG 102 0+1	103 0+1	201 0+2						0	4+2NG	4 + 2NG
10	Skill Enhancement (SRDY)		181 0+8			381 0+1 382 0+2NG	383 0+1	481 0+3	482 0+4 483 0+8	0	25	25+2NG
11	Elective Courses								9	6	3	9
12	Online Courses/ MOOC											6
	Total	20 (11+9) +2NG	21 (5+16)	25 (15+10)	25 (17+8)	20 (13+7) +2NG	22 (14+8)	20 (10+10)	21 (6+15)	91	83	174+6+4NG

Table: Credits Allocation Scheme of UG Agricultural Engineering program (Credit hours)

Semester	Core Courses (Major/ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non Gradial courses	Online Courses/ MOOC
I	12	4[2]	3[6]	1[4]	-	-	20	2[1]	
II	2	3[5]	3[3]	2[7] + 1[8] + 2[9]	8	-	21	-	
Post-II	-	-	-	-	-	10[10]	-	-	
III	23	-	-	2[11]	-	-	25	-	
IV	22	3[12]	-	-	-	-	25	-	
Post-IV	-	-	-	-	-	10[13]	-		
V	18	-	-	2[14]	-	-	20	2[15]	6
VI	22	-	-	-	-	-	22	-	
VII	17	-	-	-	-	3	20	-	
VIII	9*	-	-	-	-	12	21	-	
Total	**125**	**10**	**6**	**10**	**8**	**15**	**174**	**4**	**6**

(1) *Deeksharambh*(Induction-cum-Foundation Course)

(2) Crop Production and Protection Technologies

(3) Agricultural Informatics

(4) NCC-I/ NSS-I

(5) Farming Based Livelihood Systems;

(6) Environmental Studies and Disaster Management

(7) Communication Skills

(8) NCC-II/ NSS-II

(9) Computer Programming and Data Structures

(10) Internship (only for those opting for an exit with UG-Certificate)

(11) Physical Education, First Aid and Yoga Practices

(12) Entrepreneurship Development and Business Management

(13) Internship (only for those opting for an exit with UG-Diploma)

(14) Personality Development

(15) Study tour

*Includes the Elective courses.

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY
Faculty of Agricultural Engineering & Technology
B. Tech. (Agricultural Engineering)

Department-wise distribution of credit load

S. No.	Name of Department	Credits
1	Farm Machinery and Power Engineering	12(8+4)
2	Processing and Food Engineering	15(10+5)
3	Irrigation and Drainage Engineering	9(6+3)
4	Soil and Water Conservation Engineering	12(8+4)
5	Renewable Energy Engineering	6(4+2)
6	Basic Engineering	47(26+21)
7	Agricultural Sciences	31(20+11)
8	FRSP	4(3+1)
9	Deeksharambh & Physical Education	4(0+4) +2NG
10	SRDY	25(0+25) +2NG
11	Elective Courses	9
12	Online Courses/ MOOC	6
	Total	174+6+4NG

Department-wise distribution of courses

S.No.	Course No.	Title of the Course	Credits
		Farm Machinery and Power Engineering	
1	FMPE 211	Farm Machinery and Equipment-I	3(2+1)
2	FMPE 212	Farm Machinery and Equipment-II	3(2+1)
3	FMPE 311	Tractor & Automotive Engines	3(2+1)
4	FMPE 312	Tractor Systems & Controls	3(2+1)
		Total	**12(8+4)**
		Processing and Food Engineering	
1	PFEN 221	Engineering Properties of Agricultural Produce and Food Science	3(2+1)
2	PFEN 222	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3(2+1)
3	PFEN 321	Food and Dairy Engineering	4(3+1)
4	PFEN 322	Post-harvest Engineering of Horticultural Crops	2(1+1)
5	PFEN 421	Food Quality and Safety	3(2+1)
		Total	**15(10+5)**
		Irrigation and Drainage Engineering	
1	IDEN 331	Ground water, Wells and Pumps	3(2+1)
2	IDEN 332	Irrigation and Drainage Engineering	4(3+1)
3	IDEN 431	Sprinkler & Micro Irrigation Systems	2(1+1)
		Total	**9(6+3)**

S.No.	Course No.	Title of the Course	Credits
		Soil and Water Conservation Engineering	
1	SWCE 241	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
2	SWCE 242	Watershed Hydrology	3(2+1)
3	SWCE 243	Soil and Water Conservation Engineering	3(2+1)
4	SWCE 441	Watershed Planning and Management	3(2+1)
		Total	**12(8+4)**
		Renewable Energy Engineering	
1	REEN 251	Renewable Energy Sources	3(2+1)
2	REEN 351	Bio-energy Systems: Design and Applications	3(2+1)
		Total	**6(4+2)**
		Basic Engineering	
1	AEBE 161	Surveying and Levelling	3 (1+2)
2	AEBE 162	Workshop Technology and Practice	2 (0+2)
3	AEBE 163	Basic Electrical Gadgets and Instruments	3 (2+1)
4	AEBE 164	Engineering Drawing	2 (0+2)
5	AEBE 165	Computer Programing and Data Structures	2 (0+2)
6	AEBE 166	Agricultural Informatics and Artificial Intelligence	3 (2+1)
7	AEBE 261	Engineering Mechanics	3(2+1)
8	AEBE 262	Soil Mechanics	2(1+1)
9	AEBE 263	Theory of Structures	2(1+1)
10	AEBE 264	Building Construction and Cost Estimation	2(2+0)
11	AEBE 361	Strength of Materials	2(1+1)
12	AEBE 362	Theory of Machines	2(2+0)
13	AEBE 363	Heat and Mass Transfer	3(2+1)
14	AEBE 364	Sensors, AI and Robotics in Agriculture	3(2+1)
15	AEBE 365	Agricultural Structures & Environment Control	3(2+1)
16	AEBE 366	Thermodynamics, Refrigeration and Air conditioning	3(2+1)
17	AEBE 461	Engineering Graphics and Design	2(0+2)
18	AEBE 462	Machine Design	2(2+0)
19	AEBE 463	Electrical Machines	3(2+1)
		Total	**47(26+21)**
		Agricultural Sciences	
1	AEAS 171	Crop Production and Protection Technologies	4 (3+1)
2	AEAS 172	Environmental Studies and Disaster Management	3 (2+1)
3	AEAS 173	Farming Based Livelihood Systems	3 (2+1)
4	AEAS 174	Communication Skills	2 (1+1)
5	AEAS 271	Engineering Mathematics-I	3(2+1)
6	AEAS 272	Engineering Physics	3(2+1)
7	AEAS 273	Engineering Chemistry	3(2+1)
8	AEAS 274	Engineering Mathematics-II	3(2+1)

S.No.	Course No.	Title of the Course	Credits
9	AEAS 275	Entrepreneurship Development and Business Management	3(2+1)
10	AEAS 371	Personality Development	2(1+1)
11	AEAS 471	Agricultural Statistics and Data Analysis	2(1+1)
		Total	**31(20+11)**
		FRSP	
1	FRSP 101	Introduction to Agricultural Engineering	4 (3+1)
		Total	**4(3+1)**
		Deeksharambh& Physical Education	
1	COCA 101	Deeksharambh	2 (0+2) NG
2	COCA 102	NSS- I/ NCC- I	1 (0+1)
3	COCA 103	NSS-II/ NCC- II	1 (0+1)
4	COCA 201	Physical Education, First Aid, Yoga Practice and Meditation	2(0+2)
		Total	**4(0+4) +2NG**
		SRDY	
1	SRDY 181	Skill Enhancement	8 (0+8)
2	SRDY 381	Seminar	1(0+1)
3	SRDY 382	Study tour	2(0+2) NG
4	SRDY 383	Case Study	1(0+1)
5	SRDY 481	Project-I	3(0+3)
6	SRDY 482	Project-II	4(0+4)
7	SRDY 483	In-plant training/ Research Internship	8(0+8)
		Total	**25(0+25) +2NG**
		Elective Courses	
	Elective courses		9
		Total	**9**
		Online Courses/ MOOC	
	Online Courses/ MOOC		6
		Total	**6**
		Grand Total: 174(91+83) +6OC/MOOC+4NG	

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY

Faculty of Agricultural Engineering &Technology

B. Tech. (Agricultural Engineering)

YEAR-WISE & SEMESTER WISE DISTRIBUTION OF COURSES

S. No	Course No	Course Title	Credit hours	Total credit hours
		I YEAR I SEMESTER		
1	COCA 101	Deeksharambh(Inductioncum-Foundation Course of 2 weeks)	0+2 (NG)	20 (11+9)+2NG
2	AEAS 171	Crop Production and Protection Technologies	4 (3+1)	
3	AEAS 172	Environmental Studies and Disaster Management	3 (2+1)	
4	FRSP 101	Introduction to Agricultural Engineering	4 (3+1)	
5	AEBE 161	Surveying and Levelling	3 (1+2)	
6	AEBE 162	Workshop Technology and Practice	2 (0+2)	
7	AEBE 163	Basic Electrical Gadgets and Instruments	3 (2+1)	
8	COCA 102	NSS- I/ NCC- I	1 (0+1)	
		I YEAR II SEMESTER		
1	SRDY 181	Skill Enhancement	8 (0+8)	21 (5+16)
2	AEBE 164	Engineering Drawing	2 (0+2)	
3	AEBE 165	Computer Programming and Data Structures	2 (0+2)	
4	AEBE 166	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
5	AEAS 173	Farming Based Livelihood Systems	3 (2+1)	
6	AEAS 174	Communication Skills	2 (1+1)	
7	COCA 103	NSS-II/ NCC- II	1 (0+1)	
		Post – II Semester		
1	SRDY 182	Internship (for 10 weeks, only for exit option for award of UGCertificate)	10 (0+10)	
		II YEAR I SEMESTER		
1	AEAS 271	Engineering Mathematics-I	3(2+1)	25(15+10)
2	AEAS 272	Engineering Physics	3(2+1)	
3	AEAS 273	Engineering Chemistry	3(2+1)	
4	AEBE 261	Engineering Mechanics	3(2+1)	
5	AEBE 262	Soil Mechanics	2(1+1)	
6	FMPE 211	Farm Machinery and Equipment-I	3(2+1)	
7	PFEN 221	Engineering Properties of Agricultural Produce and Food Science	3(2+1)	
8	SWCE 241	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	
9	COCA 201	Physical Education, First Aid, Yoga Practice and Meditation	2(0+2)	

S. No	Course No	Course Title	Credit hours	Total credit hours
		II YEAR II SEMESTER		
1	AEAS 274	Engineering Mathematics-II	3(2+1)	25(17+8)
2	AEBE 263	Theory of Structures	2(1+1)	
3	AEBE 264	Building Construction and Cost Estimation	2(2+0)	
4	FMPE 212	Farm Machinery and Equipment-II	3(2+1)	
5	PFEN 222	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3(2+1)	
6	SWCE 242	Watershed Hydrology	3(2+1)	
7	SWCE 243	Soil and Water Conservation Engineering	3(2+1)	
8	REEN 251	Renewable Energy Sources	3(2+1)	
9	AEAS 275	Entrepreneurship Development and Business Management	3(2+1)	
		Post – II Semester		
1	SRDY 281	Internship (for 10 weeks, only for exit option for award of UG-Diploma)	10(0+10)	
		III YEAR I SEMESTER		
1	AEBE 361	Strength of Materials	2(1+1)	20(13+7)+ 2(NG)
2	AEBE 362	Theory of Machines	2(2+0)	
3	AEBE 363	Heat and Mass Transfer	3(2+1)	
4	FMPE 311	Tractor and Automotive Engines	3(2+1)	
5	PFEN 321	Food and Dairy Engineering	4(3+1)	
6	IDEN 331	Ground water, Wells and Pumps	3(2+1)	
7	AEAS 371	Personality Development	2(1+1)	
8	SRDY 381	Seminar	1(0+1)	
9	SRDY 382	Study tour	2(0+2) NG	
		III YEAR II SEMESTER		
1	FMPE 312	Tractor Systems & Controls	3(2+1)	22 (14+8)
2	PFEN 322	Post-harvest Engineering of Horticultural Crops	2(1+1)	
3	IDEN 332	Irrigation and Drainage Engineering	4(3+1)	
4	REEN 351	Bio-energy Systems: Design and Applications	3(2+1)	
5	AEBE 364	Sensors, AI and Robotics in Agriculture	3(2+1)	
6	AEBE 365	Agricultural Structures and Environment Control	3(2+1)	
7	AEBE 366	Thermodynamics, Refrigeration and Air conditioning	3(2+1)	
8	SRDY 383	Case Study	1(0+1)	

S. No	Course No	Course Title	Credit hours	Total credit hours
		IV YEAR I SEMESTER		
1	PFEN 421	Food Quality and Safety	3(2+1)	20 (10+10)
2	IDEN 431	Sprinkler & Micro Irrigation Systems	2(1+1)	
3	SWCE 441	Watershed Planning and Management	3(2+1)	
4	AEBE 461	Engineering Graphics and Design	2(0+2)	
5	AEBE 462	Machine Design	2(2+0)	
6	AEBE 463	Electrical Machines	3(2+1)	
7	AEAS 471	Agricultural Statistics and Data Analysis	2(1+1)	
8	SRDY 481	Project-I	3(0+3)	
		IV YEAR II SEMESTER		
1	SRDY 482	Project-II	4(0+4)	21(6+15)
2	SRDY 483	Research / Internship	8(0+8)	
3		Elective-I	3(2+1)	
4		Elective-II	3(2+1)	
5		Elective-III	3(2+1)	
		TOTAL	174 (91+83) +4NG	
		Online courses/MOOCs	6	
		GRAND TOTAL	**180** +4NG	

ELECTIVE COURSES

S. No	Course No	Course Title	Credits
1	FMPE 411	Mechanics of Tillage and Traction	3(2+1)
2	FMPE 412	Farm machinery Design and Production	3(2+1)
3	FMPE 413	Tractor Design and Testing	3(2+1)
4	FMPE 414	Hydraulic Drives and Controls	3(2+1)
5	FMPE 415	Human Engineering and Safety	3(2+1)
6	FMPE 416	Precision Agriculture and System Management	3(2+1)
7	REEN 451	Photovoltaic Technology and Systems	3(2+1)
8	REEN 452	Wind Power Technology and Systems	3(2+1)
9	REEN 453	Waste and by-Product Utilization	3(2+1)
10	SWCE 442	Floods and Control Measures	3(2+1)
11	SWCE 443	Remote Sensing and GIS Applications	3(2+1)
12	SWCE 444	Information Technology for Land and Water Management	3(2+1)
13	SWCE 445	Wasteland Development	3(2+1)
14	IDEN 432	Minor Irrigation and Command area Development	3(2+1)
15	IDEN 433	Management of Canal Irrigation System	3(2+1)
16	IDEN 434	Water Quality and Management Measures	3(2+1)
17	IDEN 435	Landscape Irrigation Design and Management	3(2+1)
18	IDEN 436	Application of Plastics in Agriculture	3(2+1)
19	PFEN422	Precision Farming Technologies for	

S. No	Course No	Course Title	Credits
		Protected Cultivation	3(2+1)
20	SWCE 446	Environmental Engineering	3(2+1)
21	PFEN 423	Development of Processed Food Products	3(2+1)
22	PFEN 424	Food Packaging Technology	3(2+1)
23	PFEN 425	Food Plant and Equipment Design	3(2+1)
24	PFEN426	Emerging Technologies in Food Processing	3(2+1)
25	PFEN 427	Processing of Livestock, Fish and Marine Products	3(2+1)
26	PFEN 428	Food Business Management and Entrepreneurship Development	3(3+0)
27	AEBE 464	MATLAB Programming	3(1+2)
28	AEBE 465	Python Programming	3(1+2)
29	AEBE 466	Artificial Intelligence	3(2+1)
30	AEBE 467	Advances in Automation and Robotics in Agriculture	3(2+1)
31	AEBE 468	Machine Learning	3(2+1)
32	AEBE 469	Operations Research	3(3+0)
33	AEBE 470	Mechatronics	3(2+1)
34	PFEN 429	Natural Fibres: Extraction and Properties	3(2+1)
35	PFEN 430	Natural Fibre Applications in Agriculture	3(2+1)
36	PFEN 431	Processing of Natural Fibres	3(2+1)
37	AEAS 472	Agricultural Marketing and Trade	3(2+1)
38	PFEN 432	Seed Drying, Processing and Storage	3(2+1)

Online courses

The students will take a minimum of 6 credits of online courses (any one or more courses totaling at least 24 weeks or 80 hours' duration) during the third and fourth year as a partial requirement for the B. Tech. (Agricultural Engineering) programme. These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

The students will have to take a minimum of 6 credits of online courses, (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Agricultural Engineering) program.

The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. **These can be taken any time during the 3rd and 4th years of the UG programme**. However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

UG programme in Agricultural Engineering with Entry and Exit option

The entry and exit options for the UG programs in Agricultural Engineering are shown in the Figure 1

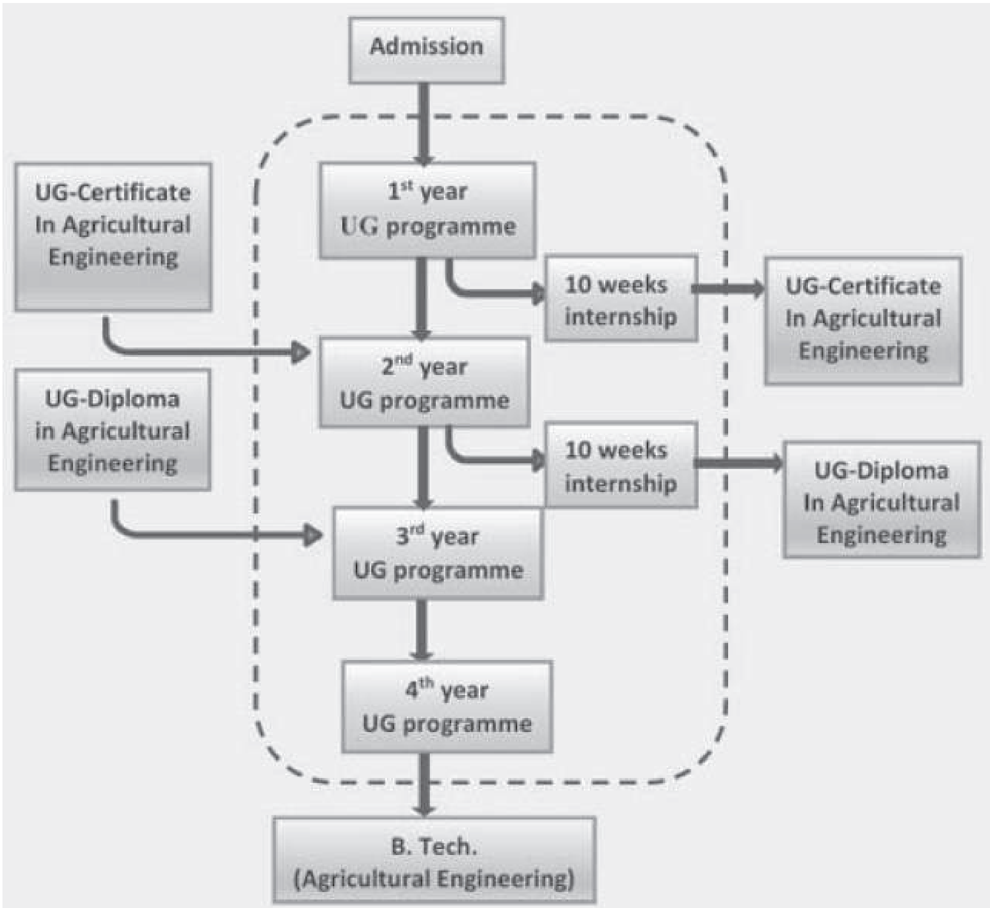

Fig.1 UG programme in Agricultural Engineering with Entry and Exit option

Eligibility for Entry into 1st year UG programme

+2 Science with Mathematics as one subject or as per the criteria decided by the ICAR/ SAU.

Exit options

1. UG - Certificate in Agricultural Engineering (exit after first year and completion of 10 weeks' internship).
2. UG - Diploma in Agricultural Engineering (exit after second year and completion of 10 weeks' internship).
3. B. Tech. (Agricultural Engineering) (on successful completion of four-year degree requirements)

Skill Enhancement courses

The Skill Enhancement courses will be offered in three stages. In the first year, the course entitled Skill Enhancement (8 credits) will aim at skill enhancement for employment and entrepreneurship. The students will have flexibility and choice in selection of skill areas from a bouquet of skill enhancement modules to be offered/ listed by the parent institute. After two to three days' common orientation on different skill enhancement modules, students will take up either two or more modules (maximum four modules recommended) as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

1. Operation and maintenance of farm machinery
2. Repair and maintenance of tractors and power tillers
3. Management of agricultural machinery custom hiring and maintenance facilities
4. Fabrication, operation and maintenance of renewable energy devices
5. Operation and maintenance of drones used for agricultural applications
6. Machine vision, sensors and sensors architecture
7. Design of solar PV system using softwares
8. Installation and maintenance of on-grid and off-grid solar systems
9. Design and maintenance of agri-voltaic systems
10. Valorization of agri-biomass and organic waste
11. Energy audit, energy conservation and energy efficiency
12. Repair and maintenance of pumps and irrigation systems
13. Installation and maintenance of micro-irrigation systems
14. Application of remote sensing and GIS for agricultural water management
15. Operation and maintenance of hydro-meteorological instruments
16. Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well
17. Installation and maintenance of roof top rain water harvesting systems
18. Operation and maintenance of soil conservation structures
19. Construction, management and maintenance of protected cultivation structures
20. Agro processing methods, equipment operation and maintenance
21. Operation and management of multi-commodity agro-processing centre
22. Primary processing and value addition and cold chain logistics
23. Food grain godown and warehouse management Post-harvest value chain management including logistics

DEPARTMENT OF FARM MACHIRARY AND POWER ENGINEERING

FMPE 211 **Farm Machinery and Equipment-I** **3(2+1)**

Course outlines

Objective

To make the students acquainted with the basic construction and operational features of different farm machinery used in operations such as seed-bed preparation, sowing, planting & transplanting etc. and their economics of operation.

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; Seedbed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls; Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines; Sowing, planting & transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation; Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components; Testing and Evaluation of tillage and sowing machinery and their test codes.

Practical

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeders; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction to farm mechanization - Classification of farm machines - Various farm machinery operations in crop production
2	Identification and selection of machines for various operations on the farm - Seed-bed preparation and its classification
3	Land reclamation and earth moving equipment - Terminology, different earth volumes swell-shrinkage and its calculations
4	Earth moving machines - Shovels, Trenchers, Bulldozers - Types of blades - different operations
Unit II	
5	Primary tillage - Objectives, implements used for primary tillage - Secondary tillage, rotary tillage, deep tillage and minimum tillage
6	Mould board plough - Components, types, accessories and adjustments
7	Disc plough - Components, types, accessories and adjustments
8	Chisel plough, sub-soiler and its components
Unit III	
9	Different types of harrows and its classification
10	Puddler, Bund former, ridger, green manure trampler
11	Types of Cultivators - Components, different types of shovels and sweeps
12	Hitching systems and controls
Unit IV	
13	Calculation of field capacities and field efficiencies of tillage implements
14	Definition of draft, unit draft and terminology
15	Effect of speed on draft of implement, parameters influencing the draft
16	Measurement of draft for trailed and mounted implements

Unit V

17 Calculations for draft of tillage tools and calculations for power requirement for the tillage implements

18 Calculation for economics of machinery usage - Cost of operation, fixed cost and operating cost, comparison of ownership with hiring of machines

19 Introduction to sowing or seeding - Different seeding methods

20 Seed drills, Planters - Functions and components

Unit VI

21 Types of Rice transplanter, components and its working

22 Introduction to No-till drills, strip-till drills and advantages

23 Seed cum fertilizer drills, components and functions

24 Introduction to different types of planters, bed-planters, planting equipment for sugarcane

Unit VII

25 Groundnut planters – Potato planters – its components

26 Different types of furrow openers in planters or seed drills

27 Different types of metering mechanisms for seed drills and planters

28 Calibration of seed-drills/ planters - Adjustments during operation

Unit VIII

29 Materials used in construction of farm machines - Properties of materials used for critical and functional components of agricultural machines

30 Different types of steels and alloys for agricultural applications - Heat treatment processes specially for the agricultural machinery components

31 Introduction to testing and evaluation of farm machinery - Importance and types of tests

32 Regulations governing in testing - Test codes of tillage and sowing machinery

Practical

No.	**Practical outline**
1	Familiarization with different farm implements and tools
2	Study of hitching systems - Implements attachment to tractor
3	Study on draft measurement for trailed and mounted implements
4	Study of different problems on machinery management
5	Study of primary tillage implements - Types, construction, operation and adjustments
6	Study of secondary tillage Implements - Types, construction, operation and adjustments
7	Calculations of power and draft requirements of primary and secondary implements

8 Study of different types of puddlers and determination of puddling index in the field
9 Study of sowing and planting equipment - Construction and types
10 Calculation for calibration of seed drill and planters
11 Study of different types of metering mechanisms used in seed drills and planters
12 Study of paddy transplanters and various pre-germinated paddy seeders and vegetable transplanters
13 Identification of materials of construction in agricultural machinery and study of material properties
14 Visit to a site to observe field operations of paddy transplanter
15 Visit to an implement manufacturing unit
16 Visit to an implement manufacturing unit

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2. Jagdishwar Sahay. 2022. Elements of Agricultural Engineering. Standard Publishers New Delhi.
3. Kepner R A, Bainer R and Barger E L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
4. Lal Radhey and Datta A.C. 1978. Agricultural Engineering through worked out examples. Saroj Prakashan, Allahabad.
5. Nakra, C.P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
6. Smith, H.P and Wilkes L.H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
7. Srivastav, A.K., Goering C.E and Rohrbach R.P. 2005. Engineering principles of Agricultural Machines. ASAE. St. Joseph, Mich.

FMPE 212 Farm Machinery and Equipment-II 3(2+1)

Course Outlines

Objective

To make the students acquainted with the basic construction and operational features and economics of operation of different farm machineries used in operations such as weeding, spraying, harvesting and threshing including operations done by combines

Theory

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to intercultural equipment; Weeders - different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment Harvesting of crops - harvesting methods, harvesting terminology; Mowers – types, constructional details, working and adjustments; Shear type harvesting devices - cutter bar, inertia forces, counter balancing, terminology and cutting pattern; Reapers, binders and windrowers - principle of operation and constructional details; Hay conditioning - importance, methods of hay conditioning and calculation of moisture content of hay Threshing - manual and mechanical systems; Types of threshing drums and their applications; Types of threshers - tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines - combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine troubles and troubleshooting; Chaff cutters- working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting - cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

Practical

Familiarization with plant protection and intercultural equipment; Study of sprayers - types, functional components, calibration; 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; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of 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; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations of various machines; Visit to implements manufacturing unit.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Different types of sprayers and dusters - Different ways of expressing spray droplet size, spray drift and factors affecting spray drift

2 Classification of sprayers and their constructional details

3 Types of sprayer nozzles and pumps - Calculations for calibration of sprayers and chemical application rates

4 Introduction to UAVs / Drones for spraying, constructional features and operation principles

Unit II

5 Introduction to intercultural equipment - Different types of manual and powered weeders

6 Functional requirements of weeders and main components

7 Different types of fertilizer application methods and equipment

8 Harvesting of crops - Harvesting methods, harvesting terminology

Unit III

9 Mowers – types, constructional details, working and adjustments

10 Shear type harvesting devices – cutter bar, inertia forces, counter balancing, terminology and cutting pattern

11 Reapers, binders and windrowers - Principle of operation and constructional details

12 Calculation of field capacity of reaper, binders and windrowers

Unit IV

13 Hay conditioning - importance, methods of hay conditioning, and calculation of moisture content of hay

14 Threshing - manual and mechanical systems, types of threshing drums and their applications

15 Types of threshers- tangential and axial, constructional details and cleaning systems

16 Factors affecting thresher performance

Unit V

17 Grain combines - combine terminology and features

18 Classification of grain combines and study of material flow in combines

19 Computation of combine losses

20 Combine troubles and troubleshooting

Unit VI

21 Chaff cutters - working principle and constructional features

22 Capacity calculations of chaff cutters

23 Straw combines- working principle and constructional details

24 Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle and calculation of material handled

Unit-VII

25 Potato and groundnut diggers

26 Cotton harvesting - cotton harvesting mechanisms

27 Cotton pickers and strippers

28 Maize harvesting combines

Unit VIII

29 Vegetables and fruit harvesting equipment and tools

30 Testing and evaluation of intercultural equipment and their test codes

31 Testing and evaluation of plant protection equipment and their test codes

32 Testing and evaluation of harvesting and threshing machinery and their test codes

Practical

No.	Practical outline
1	Familiarization with plant protection and intercultural equipment - Study of sprayers - Types, functional components, calibration
2	Study of dusters - Types and functional components, calculations for chemical application rates
3	Study of nozzle types and spread pattern using patternator
4	Familiarization with operation of Drone for spraying operation
5	Familiarization with manual and powered weeding equipment and identification of functional components
6	Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters
7	Study of various types of mowers, reaper, reaper binder and study of functional components of mowers and reapers
8	Study of threshing systems, cleaning systems in threshers and calculations of losses in threshers
9	Study of functional units of grain combines and their types and calculations for grain losses in a combine
10	Study of root crop diggers and familiarization with the functional units and attachments
11	Study of the working of cotton and maize harvesters
12	Study of different vegetable and fruit harvesters
13	Testing and evaluation of intercultural, plant protection and harvesting machinery
14	Visit to field showing operations of various machines
15	Visit to implements manufacturing unit
16	Visit to implements manufacturing unit

References

1. Surendra, S. 2020. Farm Machinery: Principles and Applications. Directorate of Information and Publications on Agriculture, ICAR, New Delhi.
2. Jain, S.C. and Phillips, G. 2003. Farm Machinery - An Approach Standard Publishers and Distributors.
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9. Suresh, R. and Kumar, S. 2018. Farm Power and Machinery Engineering. Standard Publishers and Distributors.

FMPE 311 Tractor and Automotive Engines 3(2+1)

Course outlines

Objective

To make the students acquainted with the working principles of different systems of internal combustion engines and tractor

Theory

Sources of farm power: conventional and non-conventional energy sources; Classification of tractors and IC engines Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet; Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies Study of engine components and their construction, operating principles and functions; Engine strokes and comparison of 2 stroke and 4-stroke engine cycles of CI and SI engines; Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners; Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines; Carburetion system, carburetors and their main functional components; Fuel injection system – Injection pump, their types, working principles;

Fuel injector nozzles - Types and working principles Engine governing - Need of governors, governor types and governor characteristics; Lubrication system - Need, types, functional components; Lubricants - Physical properties, additives and their application Engine cooling system - Need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency Ignition system of SI engines; Electrical system including battery, starting motor, battery charging and cut-out; Comparison of dynamo and alternator; Basics of engine testing

Practical

Study of different systems of IC engines; Study of engine parts and functions, working principles, etc., Study of valve systems construction and adjustments; Determination of physical properties of oil and fuel; Study of air cleaning system; Fuel supply system of SI engine; Study of diesel injection system and timing; Study of cooling system and fan performance, thermostat and radiator performance evaluation; Study of part load efficiencies and governing; Study of lubricating system and adjustments; Study of starting and electrical systems; Study of ignition system; Study of tractor engine heat balance and engine performance curves; Study of dynamo; Visit to a nozzle calibration unit; Visit to engine manufacturer/ assembler/ spare parts agency

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Sources of farm power: Conventional and non-conventional energy sources
2	Classification of tractors and IC engines
3	Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle
4	Derivation of thermal efficiency of Otto cycle and Diesel cycle
Unit II	
5	Derivation of thermal efficiency of Dual cycle
6	Study of engine components their construction, operating principles and functions
7	Calculation of mechanical, thermal and volumetric efficiencies
8	Calculation of mechanical, thermal and volumetric efficiencies - General energy equation and heat balance sheet
Unit III	
9	Engine strokes and comparison of 2-stroke and 4-stroke engine cycles of CI engines
10	Engine strokes and comparison of 2-stroke and 4-stroke engine cycles of SI engines
11	Engine valve systems, valve mechanism and valve timing diagram
12	Valve clearance adjustment; Cam profile, valve lift and valve opening area

Unit IV

13 Inlet and exhaust systems; Importance of air cleaning system

14 Types of air cleaners and performance characteristics of various air cleaners

15 Fuel supply system in CI and SI engines

16 Types of fuels, properties of fuels and calculation of air-fuel ratio

Unit V

17 Different tests on fuel for SI and CI engines

18 Detonation and knocking in IC engines

19 Carburetion system, carburetors and their main functional components

20 Fuel injection system – injection pump, their types, working principles

Unit VI

21 Fuel injector nozzles - Types and working principles

22 Engine governing - Need of governors, governor types and governor characteristics

23 Lubrication system - Need, types and functional components

24 Lubricants - Physical properties, additives and their application

Unit VII

25 Engine cooling system - Need, cooling methods and main functional components

26 Need and types of thermostat valves

27 Additives in the coolant; Radiator efficiency calculation

28 Ignition system of SI and CI engines

Unit VIII

29 Electrical system including battery, starting motor, battery charging, cut-out, etc

30 Comparison of dynamo and alternator

31 Introduction to turbo and super chargers

32 Basics of engine testing

Practical

No. Practical outline

1 Study of different systems of IC engines

2 Study of engine parts, functions and working principles

3 Study of valve systems construction and adjustments

4 Determination of physical properties of oil and fuel

5 Study of air cleaning system

6 Study of fuel supply system of SI and CI engine

7 Study of diesel injection system and timing

8 Study of cooling system-fan performance, thermostat and radiator performance

9 Study of governing system
10 Study of lubricating system and adjustments
11 Study of electrical and ignition system
12 Study of dynamo and alternator
13 Study of tractor engine heat balance
14 Study of engine performance curves
15 Visit to engine manufacturer/ assembler/ spare parts agency
16 Visit to engine manufacturer/ assembler/ spare parts agency

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FMPE 312 Tractor Systems & Controls 3(2+1)

Course outline

Objective

To make the students acquainted with different systems in a tractor, such as the transmission, brake, steering and hydraulic systems, and also to understand the ergonomical and safety considerations in tractor

Theory

Transmission system - need of the system in a tractor, types, major functional systems; Clutch - need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box - principle of operation, gear box types, functional requirements, and calculation for speed ratio; Differential system - need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system - requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors; Hydraulic system - principle of operation, types, main functional components, functional requirements Hydraulic system adjustments and ADDC; Tractor power outlets - PTO standards, types and functional requirements. Traction - traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres - solid and pneumatic tyres, tyre construction and tyre specifications; Traction aids; Tractor mechanics - forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring - mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practical

Study of basic 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, final drive and planetary gears; Study of brake systems and some design problems; Study of geometry and adjustments of tractor steering; Study of hydraulic systems in a tractor, hydraulic trainer and design problems; Study of various controls in different makes of tractors in relation to anthropometric measurements; Determination of CG and moment of inertia of a tractor; Study of traction performance of a traction wheel; Study of power transmission system of tractor; Study of hitching system of tractor with various matching implements; Study on safety requirements of tractor during operation; Study of tractor testing; Visit to tractor dealers' outlet/ tractor manufacturers

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction to transmission system - Need of the system in a tractor, functions of drive train
2	Clutch - Need, types, functional requirements, construction and principle of operation
3	Familiarization with mechanical clutches - Single plate, multi-plate, centrifugal and dual clutch systems
4	Gear box - principle of operation, gear box types, functional requirements and calculation for speed ratio
Unit II	
5	Differential system - Need, functional components, construction, calculation for speed reduction
6	Final drive - Need, functional components, construction and working
7	Brake system - Types, principle of operation, construction, calculation of braking torque
8	Brake system - Working of mechanical brakes - Internal expanding brake, external contracting brake and disc brakes

Unit III

9 Brake system - construction and working of hydraulic brakes, qualities of good brakes

10 Steering system - Types, requirements, steering geometry characteristics, functional components, working of mechanical and power steering

11 Steering system - Conditions and qualities for good steering, familiarization with Ackerman steering types, Steering systems in track type tractors

12 Steering system - Types of steering gear boxes, construction and working

Unit IV

13 Hydraulic system - Principle of operation, types, main functional components, functional requirements

14 Hydraulic system - Types and necessity of Hydraulic controls, working of draft control and position control system, familiarization with Hydraulic system adjustments and ADDC (Auto Draft and Depth control)

15 Hydraulic system - Hitching of implement, types of hitches, construction and working of three-point linkage mechanism and operations, free link and restrain link operation

16 Tractor power outlets - PTO, drawbar, hydraulic system, PTO standards, types and functional requirements

Unit V

17 Introduction to Traction - Traction terminology

18 Traction - Traction aids

19 Traction - Theoretical calculation of thrust force and rolling resistance of traction device using various traction models

20 Traction - Theoretical calculation of other field performance parameters using various traction models

Unit VI

21 Wheels and tyres - Types, solid tyres and pneumatic tyres and their construction

22 Wheels and tyres - Tyre specifications and tyre terminology, ply rating

23 Tractor mechanics - Forces acting on the tractor and tractor-implement combination

24 Tractor mechanics - Determination of CG of a tractor using various methods

Unit VII

25 Tractor mechanics - Importance and determination of moment of inertia of a tractor

26 Tractor stability - Longitudinal stability, lateral stability, mechanics of tractor under static and dynamic condition

27 Tractor stability - Mechanics of tractor implement combination under static and dynamic condition

28 Tractor stability - Weight transfer and importance, maximum drawbar pull and its determination

Unit VIII

29 Familiarization with Tractor as a spring - mass system

30 Ergonomic considerations and operational safety of tractor, safety measures in tractor - ROPS

31 Introduction to tractor testing and performance - Preparation of tests, test procedure, power test, ergonomical tests and miscellaneous tests

32 Types of tractor tests - Deciphering the engine test codes and test codes for various tests

Practical

No.	Practical outline
1	Study of basic transmission systems and components
2	Study of clutch functioning, parts and design problem on clutch system
3	Study of different types of gear boxes
4	Calculation of speed ratios, design problems on gear box
5	Study on differential, final drive and planetary gears
6	Study of brake systems and some design problems
7	Study of geometry and adjustments of tractor steering
8	Study of hydraulic systems of tractor
9	Study of three-point linkage geometry of tractor
10	Study of hitching system of tractor with various matching implements
11	Study of hitching system of tractor with various matching implements
12	Study of traction performance of a traction wheel
13	Determination of CG and moment of inertia of a tractor
14	Study of operational safety and ROPS construction
15	Visit to tractor dealers' outlet / tractor manufacturers
16	Visit to tractor dealers' outlet / tractor manufacturers

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DEPARTMENT OF PROCESSING AND FOOD ENGINEERING

PFEN 221 Engineering Properties of Agricultural Produce and Food Science 3(2+1)

Course outlines

Objective

To make the students acquainted with the different engineering properties of agricultural produce, fundamentals of food science, and to help them to understand the importance of these properties and food science aspects in handling, processing and storage of biological materials.

Theory

Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage; Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model.

Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity. Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, transpiration, co-efficient of thermal expansion; Electrical and dielectric properties such as resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant.

Rheological characteristics of food, elastic, plastic and viscous behavior, viscoelasticity; rheological models to explain food characteristics; Fluid behavior as Newtonian, non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods.

Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging, and acoustic techniques.

Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology, and food fermentation.

Practical

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness);

Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Different engineering properties of foods and their importance Classification of engineering properties

2 Application of engineering properties in handling, processing and storage of biological materials

3 Physical properties, viz. Size and its measurement for fruits, vegetables and flours

4 Shape, roundness, sphericity of biological materials

Unit II

5 Volume, density, porosity, specific gravity of biological materials

6 Surface area of various biological materials

7 Colour properties and its importance in machine vision systems design

8 Colour models and its instrumental measurement

Unit III

9 Frictional properties, viz. static friction, kinetic friction, rolling resistance and their importance in design of various bulk storage and machines

10 Angle of internal friction, angle of repose, flow of bulk granular materials. Failures of bulk storage structures

11 Aero-dynamic characteristics such as drag coefficient, terminal velocity and their importance in separation and conveyance

12 Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity

Unit IV

13 Heat of respiration, co-efficient of thermal expansion and their importance

14 Electrical properties as conductivity, resistance, capacitance and their measurement
15 Dielectric properties as dielectric loss factor, loss tangent, and dielectric constant and their importance in microwave and radiofrequency processing
16 Rheological characteristics of food, elastic, plastic and viscous behavior of biological materials

Unit V

17 Visco-elasticity and importance of bio yield point and rupture point
18 Rheological models to explain food characteristics
19 Fluid behavior as Newtonian, Non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic
20 Textural characteristics of foods

Unit VI

21 Non-destructive methods of food quality determination of foods
22 Principles of machine vision systems
23 Spectroscopy and their application
24 Hyperspectral imaging and their application

Unit VII

25 Acoustic techniques in food processing
26 Introduction to Food science and food technology
27 Biochemical reactions involved in food processing and during storage
28 Food spoilage agents and spoilage prevention

Unit VIII

29 General methods for food preservation (physical, chemical and biological methods)
30 Food microbiology - Classification of microorganisms associated with foods, multiplication of bacteria
31 Different beneficial and harmful microorganisms in relation to food preservation and spoilage
32 Industrial bacteriology and food fermentation

Practical

No. Practical outline

1 Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system, determination of the shape (sphericity and roundness)
2 Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains
3 Determination of the volume, density and specific gravity of large individual objects (F and V)

4 Determination of the surface area of the F and V
5 Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction
6 To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel
7 Determination of specific heat and thermal conductivity of some food grains
8 Determination of electrical properties of food materials
9 Determination of hardness of food materials
10 Determination of viscosity of food materials
11 Study and comparison of color of food materials
12 Determination of carbohydrates
13 Determination of total nitrogen
14 Determination of oil content and Determination of ash content
15 Study of different types of microorganisms and microbiological examination of food products
16 Field visit

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PFEN 222 Post-Harvest Engineering of Cereals, Pulses and Oilseeds 3(2+1)

Course outlines

Objective

To make the students acquainted with the different operations in processing of major cereals, pulses and oilseeds, and to make them study the respective processing equipment related to the cereals, pulses and oilseeds

Theory

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds. Cleaning and grading: Principles of cleaning, scalping, sorting and grading; screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators such as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator. Drying: Moisture content and water activity, free moisture, bound moisture 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 periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill Milling of rice: Parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, viz traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice Milling of wheat: Unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran Material handling: Basic parts of different types of conveyors and elevators, viz belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage godown

Practical

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; 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 psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operations and machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	General unit operations in agricultural process engineering and importance of these unit operations in grain processing
2	Structure and composition of cereals, pulses and oil seeds
3	Cleaning and grading- Principles of cleaning, scalping, sorting and grading
4	Screens, different types of screen separators, fixed and variable aperture screens
Unit II	
5	Capacity and effectiveness of screens, sieve analysis
6	Various types of separators such as specific gravity, magnetic, disc, spiral, pneumatic
7	Inclined belt draper, velvet roll separator, colour sorter, cyclone separator
8	Drying- Moisture content and water activity, free moisture, bound moisture
Unit III	
9	Equilibrium moisture content, isotherm, hysteresis effect, EMC determination
10	Psychrometric chart and its use in drying
11	Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods
12	Maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation
Unit IV	
13	Drying methods (conduction, convection, radiation, batch, continuous)
14	Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC
15	Fluidized, rotary and tray, tempering during drying; dryer performance
16	Size reduction- Principle; Bond's law, Kick's law, Rittinger's law, sieve analysis
Unit V	
17	Different classifications of size reduction machines; description of jaw crusher
18	Hammer mill, attrition mill and ball mill
19	Milling of rice- parboiling- merits and demerits, changes during parboiling of rice
20	Parboiling methods, viz traditional methods, CFTRI method, Jadavpur method, pressure parboiling
Unit VI	
21	Different unit operations and equipment involved in traditional and modern rice milling methods
22	Preparation of rice products as rice flakes and puffed rice

23 Milling of wheat- unit operations and equipment

24 Milling of corn: unit operations and equipment in dry and wet milling methods

Unit VII

25 Milling of pulses- pre-conditioning, dry milling and wet milling methods

26 CFTRI and Pantnagar methods of pulse milling, pulse milling machines

27 Milling of oilseeds- preconditioning of oilseeds, mechanical expression, screw press

28 Hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran

Unit VIII

29 Material handling- Basic parts of different types of conveyors and elevators, viz belt, roller

30 Chain, screw, and bucket elevator, cranes & hoists, pneumatic conveying, power requirement for conveying and elevating

31 Principles of grain storage; different types of grain storage structures; deep bin and shallow bin

32 Design of a silo, structural and functional requirements of a grain storage godown

Practical

No.	Practical outline
1	Study of different types of screens and study of screen effectiveness
2	Study of construction and operation of different types of cleaners and separators
3	Measurement of moisture content- dry basis and wet basis and Study on drying characteristics of grains and determination of drying constant
4	Determination of EMC (static and dynamic method)
5	Study of psychrometric chart
6	Study of various types of dryers
7	Study of different size reduction machines
8	Sieve analysis, determination of fineness modulus and uniformity index
9	Study of different unit operations and machineries in rice mills
10	Study of different unit operations and machineries in pulse mills
11	Study of different unit operations and machineries in oil mills
12	Study of different unit operations and machineries in wheat/ flour mills
13	Study of different unit operations and machineries in corn processing units
14	Study of extrusion process
15	Study of different types of conveying and elevating equipment
16	Visit to milling industry

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PFEN 321 Food and Dairy Engineering 4(3+1)

Course outlines

Objective

To make the students acquainted with the different unit operations in processing and value addition of different dairy and food products and to make them understand the different types of equipment and their working principles.

Theory

Introduction to different unit operations in food processing-Process flow charts for preparation of various food products- Mass and energy balance Dehydration of foods-dryers for solid foods- construction and operation of direct and indirect type solar dryers- tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc Dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer Evaporation of food products- principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression Thermal processing- Thermo-bacteriology, D value, Z value, reaction quotient, process time- different types of retorts and continuous sterilizers-canning process, aseptic processing Principles and applications of different nonthermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing Principles and applications of novel heating methods, viz ohmic, infrared and dielectric heating Mixing: theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator Extrusion cooking- principle, factors affecting extrusion cooking, single and twin-screw extruders Separation processes- principle and equipment for sedimentation of solids in liquid and solids in air- Principle and operation of tubular bowl centrifuge and disc bowl centrifuge Filtration-principle, construction and working principles of different types of filters such as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter Membrane separation- principle, characteristics and applications of reverse osmosis, nano-filtration, ultra-filtration and microfiltration; membrane modules Unit operations in milk processing- engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation Preparation of butter, cheese, paneer and ice cream; Filling and packaging-selection of different types of packaging materials for different types of food products- equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles Nanotechnology and its applications in food industry Basics of food plant design and layout; Plant utilities

Practical

Preparation of flow charts for different food processing industries; Study of different parts of retort and canning process; Study of different types of evaporators and multiple effect evaporation system; Study of drum dryer and spray dryer and comparison of product qualities; Study of different types of mixers for solids and liquids; determination of mixing effectiveness and mixing index; Study of settling and sedimentation process in a tank; Study of different types of filters; Study of membrane modules and different types of membranes; Study of measurement of different properties of milk and milk products; Study of milk pasteurizer, sterilizer and homogenizer; Study on preparation of cream and butter; Study of preparation of cheese, paneer and ice cream; Study of different types of packaging materials; Study of different types of filling machines for liquids and powder/ granules; Study of layout of a food processing plant; Visit to food processing industries and dairy plants to study the plant layout and unit operations

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction to different unit operations in food processing-process flow charts for preparation of various food products

2 Dehydration of foods- dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer

3 Introduction to freezing and freeze dryer

4 Dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer

5 Evaporation of food products- principle, different types of evaporators

6 Thermal analysis of Evaporator- Steam economy, Factors affecting steam economy, Boiling point elevation

Unit II

7 Multiple effect evaporators – methods to improve evaporator efficiency – Vapour recompression using mechanical and thermal methods

8 Thermal processing-Thermo-bacteriology, D value, Z value, reaction quotient, process time

9 Different types of retorts and continuous sterilizers, canning process, aseptic processing

10 Principles and applications of different non-thermal processing methods- vacuum processing

11 Principles and applications of high-pressure processing, PEF Processing

12 Principles and applications of Ultrasonication, radiation processing

Unit III

13 Principles and applications of novel heating methods, viz ohmic heating, Infrared heating

14 Principles and applications of dielectric heating

15 Mixing theory, measurement of mixing and mixing index

16 Mixing of liquid foods- Agitators, Turbines, Propeller, Paddle, Gate impeller- Power requirement for liquid mixing; Correlation between density and viscosity of mixtures

17 Mixing of solid foods, powders, viscous materials and pastes - Screw mixtures, Ribbon mixers, Tumbling mixers, Pneumatic agitation, Double cone blenders, Kneader mixer for pastes

18 Mixing times of miscible liquids

Unit IV

19 Principles of extrusion cooking- expression of mass flow rate and mean velocity of Newtonian and Non-Newtonian extrudates

20 Numerical on extrusion

21 Extrusion systems–Cold extrusion, Single screw extruder, Twin screw extruder

22 Design of extruders- Numerical

23 Introduction and classification of mechanical-physical separation processes – settling and sedimentation in particle-fluid separation- Theory of particle movement through fluid, Hindered settling

24 Equipment for settling and sedimentation- Gravity settling tank for liquid-liquid and dust settling, Spliztkastern classifier, sedimentation thickener, continuous thickener

Unit V

25 Centrifugal separation Process- equations for centrifugal force, rates of settling in centrifuge, separation of liquids in centrifuge

26 Centrifuge equipment for sedimentation – Tubular, Disc bowl centrifuge

27 Centrifugal filtration – Gas-solid cyclone separator –Theory of cyclone separator

28 Theory of filtration- Constant volume and constant pressure filtration and equations for pressure drop and rate of filtration of liquid through filter cakes

29 Types of filtration equipment-Bed filters, leaf filters, Plate and frame filter press, Leaf filters, continuous rotary filters, Centrifugal filter; Filter media and filter aids

30 Equations for washing of filter cakes and total cycle time and tutorial problems

Unit VI

31 Introduction to membrane separation-Principles–Microfiltration, Ultrafiltration, Nano filtration and Reverse Osmosis-Applications - Types of equipments – Batch mode, continuous mode and cross flow

32 Flux equations for Microfiltration and ultrafiltration Generalized correlation between operating parameters and flux, indicating the areas of pressure control and mass transfer control Mechanism of flux decline -The concept of fouling and concentration polarization Classical filtration models–Cake filtration, partial pore blocking, completer pore blocking and standard pore blocking

33 Flux equations for reverse osmosis, Osmotic pressure of solutions; Diffusion model for transport of solute across membrane

34 Membrane modules- Plate and frame, Tubular, spiral wound and hollow fibre modules

35 Milk and its constituents- physical, thermal and chemical properties of milk – Special milks- standard milk, toned milk, double toned milk, rehydrated milk, reconstituted milk, condensed milk

36 Receipt of milk, unit operations in production of market milk – Principle of Cream separation and equipment – Principle of standardization –Pearson’s square method and algebraic method

Unit VII

37 Principles of homogenization – single and double stage – Theory of homogenization

38 Principles of pasteurization, sterilization, ultrahigh temperature processes and equipment’s

39 Production technology of paneer and butter

40 Production technology of cheese

41 Production technology of ice cream and their constituents

42 Selection of different types of packaging materials for different types of food products

Unit VIII

43 Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles

44 Plant Location- Factors affecting plant location, factors affecting the plant size (technical and economical) Product and Process Design-design of product, product

specifications, least cost mix of raw materials, process design, process selection considering technical, economic and social aspects Process planning and scheduling, flow sheeting, flow diagrams and process flow charts

45 Plant Layout Types of layouts, considerations involved in planning an efficient layout, preparation and development of layout, evaluation of alternate layouts, use of computers in development and evaluation of layouts, equipment symbols, flow sheet symbols, electric symbols, graphic symbols for piping systems, standards for space requirement and dimensions, distances between critical plant areas and for different plant facilities

46 Food process industry utilities and equipment Boilers -Fire tube and water tube boilers; compressed air-types of air compressors, water, electricity, effluent treatment plant, fire protection equipment's

47 Food plant utilities -refrigeration systems, cold rooms, chilling rooms, effluent treatment plant

48 Nanotechnology and its applications in food industry

Practical

No.	Practical outline
1	Study of process flow charts and tutorial on mass balance
2	Tutorial on energy balance
3	Study of freeze dryer and production of powder from fruit juices
4	Study of Spray dryer and production of powder from fruit juices
5	Tutorial on Single effect evaporator, boiling point elevation
6	Tutorial on Multiple effect evaporator
7	Tutorial on D Value, Z Value, F Value, Reaction quotient
8	Study of Ohmic heater and practical on Ohmic heat processing
9	Tutorial on mixing and mixing index, liquid mixing and power consumption
10	Study of ribbon mixer, kneaders
11	Study of extruder and production of extruded products
12	Tutorials of constant pressure and constant rate of filtration
13	Determination of permeate flux in bench top dead-end filter
14	Platform test for milk
15	Visit to dairy plant
16	Field visit

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PFEN 322 Post-harvest Engineering of Horticultural Crops 2(1+1)

Course outlines

Objective

To make the students acquainted with unit operations in processing of major horticultural crops and working principles of different machineries for these.

Theory

Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing; General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.

Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling).

Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction; Blanching: importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment.

Drying: Dryers for fruits and vegetables, Osmo-dehydration, foam mat drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables; Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans; Chilling and freezing: Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical & cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores.

Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers; Packaging and storage: packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging; Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.

Practical

Preparation of different processed horticultural products; Study of fruit graders; Study of different types of peelers and slicers; Study of juicer and pulper; Study of minimal processing of vegetables; Study of blanching equipment, testing the adequacy of blanching; Study of different dryers for fruits and vegetables; Study of foam mat drying and osmotic dehydration processes; Study of different activities in pack house; Cold storage heat load calculations and design; Study of different types of packaging materials; Study of CAS and MAP of vegetables; Study of shrink packaging of foods; Study of hammer mill, pulveriser for grinding of spices to powder; Visit to fruit and vegetable processing/ spice processing plant.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Importance of processing of fruits and vegetables, spices, condiments; Characteristics and properties of horticultural crops.
2. General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.

Unit II

3. Sorting and grading methods specific to fruits and vegetables - shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling - Methods and devices (manual, mechanical, chemical and thermal peeling).
4. Minimal processing and pack house activities; Size reduction and juice extraction - Equipment for slicing, shredding, crushing, chopping, juice extraction

Unit III

5. Blanching – Importance, objectives, methods and equipment, effects on food (nutrition, colour, pigment, texture)
6. Dryers for fruits and vegetables – tray dryers, tunnel dryers, conveyor dryers or belt dryers, fluidized bed dryers, roller or drum dryer, spray dryer, freeze dryer

Unit IV

7. Osmo-dehydration, foam mat drying; advanced drying techniques – microwave drying, vacuum drying; quality deterioration during drying of fruits and vegetables.

8. Canning of fruits and vegetables - Methods and equipment, types of cans, failures of cans

Unit V

9. Chilling and freezing - Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing
10. Equipment for chilling and freezing (mechanical & cryogenic)

Unit VI

11. Cold chain logistics and reefer containers; Design of cold storage, heat load calculations and selection of matching equipment.
12. Post-harvest management and equipment for spices and flowers.

Unit VII

13. Packaging and storage - Packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products – wooden containers, metal, glass containers.
14. Plastics in packaging; bulk and retail packages.

Unit VIII

15. Modified atmosphere packaging, smart packaging; Packaging machines- shrink packaging, vacuum packaging
16. Storage methods - Low temperature storage, evaporative cooled storage and controlled atmospheric storage.

Practical

No. Practical outline

1. Preparation of different processed horticultural products
2. Study of fruit graders
3. Study of different types of peelers and slicers
4. Study of juicer and pulper
5. Study of minimal processing of vegetables; Study of blanching equipment, testing the adequacy of blanching
6. Study of different dryers for fruits and vegetables
7. Study of foam mat drying and osmotic dehydration processes
8. Study of different activities in pack house
9. Cold storage heat load calculations and design
10. Study of different types of packaging materials
11. Study of CAS and MAP of vegetables
12. Study of shrink packaging of foods

13. Study of hammer mill, pulveriser for grinding of spices to powder
14. Visit to fruit and vegetable processing industry
15. Visit to spice processing plant
16. Field visit

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PFEN 421 Food Quality and Safety 3(2+1)

Course outlines

Objective

To enable the student to know about the concept and aim of food quality and safety, food quality characteristics – physical, chemical and biological properties, different hazards and their prevention, different methods for measuring food quality as well as the food safety management system.

Theory

Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and safety indices; Quality control, quality control tools, statistical quality control; Sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials; Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition; Non-destructive methods for evaluation of food quality. NIR, FTIR and chemometrics theory and application in food quality prediction. Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy; Sensory evaluation methods, panel selection methods, Interpretation of sensory results; Food hazards and food safety, Food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, GAP, GHP, GMP, TQM, TQC; Hazards and HACCP, Sanitation in food industry (SSOP); Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food standards (ISO-22000, CAC); Food Recall, Traceability; Bio safety and Bioterrorism; Sanitation in food industry

Practical

Study of statistical process control in food processing industry; Study of sampling techniques, tools and protocols used in different types of food handling, processing and marketing establishments; Study of registration process and licensing procedure under FSSAI; Examination of cereals, oilseeds and pulses from go-downs and market shops in relation to specifications provided by standardization techniques; Detection of adulteration and examination of ghee for various standards of Agmark/FSSAI; Detection of adulteration and examination of spices for Agmark/ FSSAI standards; Detection of adulteration and examination of milk and milk products for FSSAI standards; Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification; Visit to a professional quality control laboratory; Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Basics of food quality, safety and food analysis
2	Concept, objectives and need of food quality
3	Definition, objective measurement of quality and quality and safety indices
4	Quality control, quality control tools, statistical quality control
Unit II	
5	Sampling (Chemical and Microbiological)
6	Purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials
7	Instrumental method for testing food quality, measurement of colour, flavor
8	Consistency, viscosity, texture and their relationship with food quality and composition
Unit III	
9	Non-destructive methods for evaluation of food quality

10 NIR, FTIR and chemometrics theory and application in food quality prediction

11 Theory and application of X-ray, CT, MRI

12 Ultrasound for internal quality inspection of fruits and vegetables

Unit IV

13 Sorting grading using external image analysis

14 internal biochemical analysis using spectroscopy

15 Sensory evaluation methods, panel selection methods

16 Interpretation of sensory results

Unit V

17 Food hazards and food safety

18 Food borne infections

19 Contaminants (physical, chemical, biological)

20 Adulteration, food safety strategies

Unit VI

21 Food Safety Management Systems

22 GAP, GHP, GMP

23 TQM, TQC

24 Hazards and HACCP, Sanitation in food industry (SSOP)

Unit VII

25 Food Laws and Regulations

26 BIS, AGMARK, FSSAI

27 International Food standards (ISO-22000, CAC)

28 Food Recall

Unit VIII

29 Traceability

30 Bio safety

31 Bioterrorism

32 Sanitation in food industry

Practical

No. Practical outline

1 Study of statistical process control in food processing industry

2 Study of sampling techniques, tools and protocols used in different types of food handling, processing and marketing establishments

3 Study of registration process under FSSAI

4 Study of licensing procedure under FSSAI

5 Examination of cereals from go-downs and market shops in relation to specifications provided by standardization techniques

6 Examination of oilseeds from go-downs and market shops in relation to specifications provided by standardization techniques

7 Examination of pulses from go-downs and market shops in relation to specifications provided by standardization techniques

8 Detection of adulteration and examination of ghee for various standards of Agmark/ FSSAI

9 Detection of adulteration and examination of spices for Agmark/ FSSAI standards

10 Detection of adulteration and examination of milk and milk products for FSSAI standards

11 Detection of adulteration in fruit products such as jam as per FSSAI specification

12 Detection of adulteration in fruit products such as jelly as per FSSAI specification

13 Detection of adulteration in fruit products such as marmalades as per FSSAI specification

14 Visit to a professional quality control laboratory

15 Visit to food processing laboratory in an industry

16 Visit and Study of records and reports maintained

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    https://www.fssai.gov.in/cms/food-recall.php

    https://www.fao.org/fao-who-codexalimentarius/en/

DEPARTMENT OF IRRIGATION AND DRAINAGE ENGINEERING

IDEN 331 Groundwater, Wells and Pumps 3(2+1)

Course outlines

Objective

To make the students acquainted with the quality of ground water, equipment's and methods for construction of wells, and different types of water lifting devices.

Theory

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of ground water, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells; Darcy's law, determination of hydraulic conductivity by laboratory and field method; Groundwater hydraulics- Dupuit's assumptions and Dupuit's method, Thiem's method; Well interference; determination of aquifer parameters by different methods such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells; Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise ground water development, safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of groundwater; Quality of ground water, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upconing of saline water, Ghyben-Herzberg relationship between fresh and saline water; Pumping systems: water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump.

Practical

Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods; Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field; Study of different drilling equipment; Sieve analysis for gravel and well screens design; testing of well screen; Estimation of specific yield and specific retention; Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis Recovery method; Design of well; Study of well losses and well efficiency; Determination of safe yield by Hill's method; Determination of various parameters on groundwater quality; Study on various types of wells; Estimation of ground - water balance; Study of various artificial ground water recharge structures; Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump; Visit to a drilling site; Visit to a groundwater project and a river lift project.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction-role of groundwater in water resources-global water scenario-water resources status in India-Water budget in India-classification of ground - water and its vertical distribution-occurrence and movement of ground water
2	Aquifer-aquitard, aquifuge, aquiclude-unconfined aquifer, confined aquifer, leaky aquifer-perched aquifer-diagrammatic representation
3	Darcy's law and its application, Hydraulic conductivity and its determination by laboratory and field methods-groundwater flow direction, flow in relation to groundwater contours
4	Classification of wells based on type of aquifer, depth of the well and method of construction of the well-types of flows in wells-fully penetrating tube wells and open wells, familiarization of various types of bore wells
Unit II	
5	Design of open wells-site for an open well and it's types-design procedure for open wells
6	Methods of ground water recharge -Artificial groundwater recharge techniques. Ground water replenishment-direct method-indirect method and combination methods
7	Groundwater exploration techniques-Test drilling, geophysical methods, electrical resistivity methods, gamma ray logging, electrical resistivity surveying, seismic refraction surveying
8	Groundwater well hydraulics- static water level-piezometric water level, pumping water level, drawdown, area of influence and well yield- aquifer characteristics influencing yield of wells-hydraulic conductivity, transmissibility, storage coefficient, specific yield, leakage factor and hydraulic resistance
Unit III	
9	Determination of aquifer parameters -steady state flow through unconfined and confined aquifers-Dupuit Theim equations
10	Determination of aquifer parameters in confined aquifer under unsteady state conditions-Theis method
11	Chow's method for finding out aquifer parameters in confined aquifer under unsteady state conditions
12	Jacob method-Theis recovery test for unsteady state aquifer

Unit IV

13 Method of drilling wells-percussion, rotary, reverse rotary-DTH methods

14 Common drilling difficulties, Bore hole instability, lost circulation-bailing up crooked holes etc.,

15 Design of tube well-well diameter and yield, size of the casing pipe and well screen, well depth, length of well screen

16 Design of gravel packing-installation of well screen and its' types, losses and maintenance of well screens- well development

Unit V

17 Well interference-multiple well point system Basin wise ground - water development

18 Safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of ground water

19 Quality of ground water suitable for irrigation-groundwater pollution

20 Sea water intrusion, coastal aquifers, sources of saline water intrusion, upconing of saline water, Ghyben-Herzberg relationship between fresh and saline water

Unit VI

21 Pumping systems and water lifting devices, Classification of Pumps-Indigenous water lifting devices such as Swing basket, Don, Archimedean screw, Water wheel, Persian wheel, Chain pump, Rope and bucket lift

22 Wind powered water lifts, solar powered and biogas operated water lifts

23 Reciprocating Pumps-single and double acting pumps and their working principles

24 Hydraulic ram and its working principle

Unit VII

25 Components of centrifugal pumps-volute and diffuser types and their principles, diagrammatic representation-classification of centrifugal pumps based on different criteria- necessity of priming

26 Terminology and problems on horse power-water horse power, shaft horse power, brake horse power, kilowatt input to motor with drive efficiency and motor efficiency

27 Selection of pump-installation, trouble shooting of pumps

28 Performance curve, effect of speed on capacity head, power and efficiency curves Effect of change of impeller dimensions on performance of characteristics and related problems

Unit VIII

29 Propeller pumps and mixed flow pumps and their performance characteristics

30 Jet pumps and air lift pumps-diagrammatic representation-their working principle

31 Deep well turbine pump-submersible pump diagrammatic representation – working principles

32 Cost economics of motor and pump sets-fixed costs, variable costs, operational cost

Practical

No.	Practical outline
1	Verification of Darcy’s law
2	Study of piezometer, observation well and measurement of water table
3	Study of groundwater flow direction, preparation of iso-bath maps and its application in the field
4	Sieve analysis for gravel packing and well screens design; testing of well screen
5	Study of different drilling equipment
6	Estimation of specific yield and specific retention
7	Estimation of aquifer parameters by Theis method and Coopers-Jacob method
8	Chow’s method and Theis Recovery method
9	Design of well; Study of well losses and well efficiency
10	Determination of safe yield by Hill’s method
11	Determination of various parameters on groundwater quality
12	Study on various types of wells
13	Estimation of ground water balance
14	Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump
15	Visit to a drilling site/ Visit to a groundwater project / a river lift project
16	Field visit

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IDEN 332 Irrigation and Drainage Engineering 4(3+1)

Course outlines

Objective

To make the students acquainted with the different methods of irrigation depending on the crop water requirement and the different drainage solutions depending on specific situations

Theory

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weirs flumes and orifices and other methods. 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; 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; Water logging-causes and impact Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient; Surface drainage, types and design; Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc, types and use of subsurface drainage system, interceptor and relief drains 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, tile drains, mole drains Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters.

Practical

Measurement of soil moisture by different instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; Estimation of evapotranspiration and water requirement of crops; Study on scheduling of irrigation of field crops; Study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; Study on evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method; Study on in-situ measurement of hydraulic conductivity by auger hole method; Study on drainage coefficients determination; Study of piezometer, observation well and measurement of water table; Preparation of iso-bath maps; Design of surface drainage systems; Design and installation of subsurface drainage systems; Determination of various chemical properties of soil and water; Study of tile drainage; cost analysis of surface and subsurface drainage system; Visit to a waterlogged area and study of a drainage project.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction – Irrigation development and classification of irrigation project major, medium and minor irrigation schemes of India
2	Environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country
3	Irrigation terminology-GCA, CCA, base period, crop period, delta, duty, relationship between duty and delta
4	Irrigation Engineering – purpose of irrigation and advantages of irrigation
5	Measurement of irrigation water – units of measurements, methods of measurement, direct measurement of velocity by using the current meter and indirect methods viz area-velocity method, ordinate method for measuring discharges from the pipes, Dethridge meter and tracer methods
6	Direct measurement of discharges through the different devices such as weirs, flumes and orifices and other methods
Unit II	
7	Open channel water conveyance system – methods of conveyance of irrigation water
8	Design capacity of open channel – velocity and discharge of flow in open channel, lining and unlining of irrigation filed channels
9	Design capacity of open channel using Lacey's and Kennedy's theories and related problems
10	On farm structures for water conveyance, structures to control erosion in irrigation channel – drop structure, pipe drop structure and chute spillways
11	Water control – check gates, portable check gate, diversions and others
12	Lining canals, lining materials – Cement concrete lining, bricks with sandwiched mortar lining, LDPE film
Unit III	
13	Underground pipeline water distribution system – types of pipes used for underground pipelines, reinforced and non-reinforced concrete pipes Testing of the pipe line and estimation of discharge capacity of pipelines

14 Design and installation of underground pipelines systems and common troubles of pipelines

15 Land grading – criteria for land levelling, soil profile condition, land slope, rainfall characteristics, cropping pattern, irrigation methods, and other conditions

16 Land levelling design methods – plane method and profile method

17 Land levelling design methods – plane inspection method and others

18 Estimation of earth work – end area method

Unit IV

19 Introduction to soil – water – plant relationship – soil physical properties such as soil texture, soil structure, capillary conductivity, soil consistency and volume- mass relationships of constituents. Soil properties influencing the irrigation management, kinds of soil water, soil water movement – infiltration, accumulated infiltration rate, factors affecting the infiltration rate, measurement of infiltration in the field and by using the curve fitting method

20 Soil water potential – gravitational potential, pressure potential, matric potential and osmotic potential. Soil moisture characteristics curve, soil moisture constants such as saturation capacity, field capacity, moisture equivalent and permanent wilting point and rooting characteristics and moisture use of crops.

21 Terminology related with the movement of water within soils- water intake, percolation, interflow, seepage, permeability, hydraulic conductivity and hydraulic gradient, measurement of soil moisture – gravimetric method, tensiometers, pressure membrane and pressure plate apparatus and others

22 Moisture movement under saturated conditions and unsaturated conditions of the soil Moisture stress and plant response

23 Evaporation, transpiration and concept of Evapotranspiration (ET) and estimation of ET- Blaney-criddle, Thornthwaite, Penman and modified Penman and Penman – Monteith equations and potential ET (PET)

24 Water and irrigation requirement of crops – importance of water in plant growth, procedures for working out the net irrigation requirement (depth of irrigation), gross irrigation requirement, irrigation frequency

UNIT V

25 Irrigation efficiency – conveyance, application, storage, distribution and water use efficiency and related problems

26 Surface methods of water application – classification, border, check basin and furrow irrigation methods and their advantages and disadvantages

27 Border irrigation – components of border irrigation –width, length and slope for different soils and adaptability, hydraulics of border irrigation

28 Design of border irrigation and derivation of Israelson' equation for the width of the border

29 Check basin irrigation – advantages and disadvantages, determination of infiltration under check basin conditions, adaptability and design consideration

30 Furrow irrigation system – advantages and disadvantages, estimation of infiltration depth in furrow by inflow and outflow method

Unit VI

31 Drainage- definition, objectives and types of drainage, familiarization with the drainage problems of the state

32 Surface drainage, effects of poor drainage, areas requiring drainage, factors affecting drainage requirement, drainage coefficient, determination of drainage coefficient based on different criteria

33 Types of Surface drainage- Random field drain system, bedding system, parallel field drain, parallel lateral open ditch, cross slope drain system, interception system

34 Design of open drainage channels using manning's equation and alignment of open ditches

35 Investigations on design parameters, hydraulic conductivity, drainable porosity, fluctuations of depth to water table in the areas

36 Methods of determining hydraulic conductivity by single auger hole method and derivation of Hooghout's equation for 'K' with assumption and inverse auger hole

Unit VII

37 Sub-surface drainage: purpose and benefits, types and use of subsurface drainage system, interceptor and relief drains

38 Components of subsurface drainage system-layout and types- Random type, Herringbone type Grid iron, Cutoff or interceptor drains

39 Depth and spacing of drains, size of pipe drains using mannings equation, drain materials, slope /grade for the drains

40 Investigation of sub-surface drainage design parameters -hydraulic conductivity, drainable porosity, water table etc.,

41 Derivation of Hooghoudt's drain spacing equation

42 Derivation of Ernst's drain spacing equation

Unit VIII

43 Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope

44 Construction and installation of drains

45 Drainage structures, loads on conduits, ditch conduit conditions and projecting conduit conditions

46 Vertical drainage, bio-drainage, tile drains and mole drains

47 Salt balance, classification and reclamation of saline and alkaline soils, soil amendments, leaching requirements- leaching ratio, changes in soil salinity levels with evaporation of groundwater

48 Conjunctive use of fresh and saline water

Practical

No.	Practical outline
1	Measurement of soil moisture by different instruments and Measurement of irrigation water using weirs, notches, orifices *etc.,*
2	Measurement of infiltration characteristics, Determination of bulk density, field capacity and wilting point
3	Estimation of evapotranspiration and water requirement of crops and study on scheduling of irrigation of field crops
4	Study of advance, recession and computation of infiltration opportunity time and infiltration by inflow-outflow method
5	Study on in-situ measurement of hydraulic conductivity by auger hole method
6	Study on determination of drainage coefficient
7	Study of piezometer, observation well and measurement of water table and preparation of iso-bath maps
8	Study on evaluation of border irrigation method
9	Study on evaluation of furrow irrigation method
10	Study on evaluation of check basin irrigation method
11	Design of surface drainage systems
12	Design and installation of subsurface drainage systems
13	Determination of various chemical properties of soil and water
14	Study of tile drainage system
15	Cost analysis of surface and subsurface drainage system
16	Visit to a waterlogged area and study of a drainage project

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IDEN 431 Sprinkler & Micro Irrigation Systems 2(1+1)

Course outlines

Objective

To make the students acquainted with the importance of micro irrigation systems, their design and layout for efficient water, fertilizer and pesticides applications.

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: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency. Micro Irrigation systems: types- drip, spray, and bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, 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, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

Study of different components of sprinkler irrigation system; Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler; Study of discharge and uniformity coefficient; Design and installation of sprinkler irrigation system; Study of cost economics of sprinkler irrigation system; Study on maintenance of sprinkler irrigation system; Field visit to a sprinkler irrigation project; Study of different components of drip irrigation; Design and installation of drip irrigation system; Determination of pressure discharge relationship and emission uniformity for a given emitter; Study of different types of filters and determination of filtration efficiency; Study of fertigation, types of liquid fertilizers, determination of rate of injection and calibration for chemigation / fertigation; Design of irrigation and fertigation schedule for crops; Study on removal of clogging of emitters; Study on maintenance of drip irrigation system; Study of cost economics of drip irrigation system; Field visit to micro irrigation system and evaluation of drip system; Field visit to study foggers.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Sprinkler irrigation: Historical development, adaptability, problems and prospects

2 Types of sprinkler irrigation systems - Based on sprinkling mechanism, volume of application, portability etc.

Unit II

3 Components of the sprinkler system - Pump set, main line, lateral lines, sprinkler heads, debris screens, de-silting basins, booster pumps, take-off valves, flow control valves, fertigation equipment

4 Design of sprinkler system and layout - Inventory of resources and conditions; layout of laterals and mains, sprinkler selection and spacing, capacity of sprinkler systems

Unit III

5 Hydraulic design of sprinkler irrigation system - Main line, submain lines and laterals, selection of pump and power unit

6 Factors affecting performance of sprinkler irrigation-Performance evaluation of sprinkler irrigation system, water distribution pattern and overlapping of sprinklers and laterals

Unit IV

7 Uniformity coefficient and pattern efficiency; Operation and maintenance of the system

8 Micro Irrigation systems: types - drip, spray and bubbler systems, merits and demerits, different components

Unit V

9 Drip Irrigation - Historical development, adaptability, advantages and limitations, Components of drip irrigation - Head control system, water carrier system and water distribution system

10 Design of drip irrigation system - General considerations, wetting patterns, irrigation requirement

Unit VI

11 Hydraulics of drip irrigation system; Manufacturing coefficient of variation and emission uniformity

12 Types of emitters and emitter selection, Emitter discharge relations

Unit VII

13 Types of filters and other important components, Filter cleaning, flushing and chemical treatment

14 Necessary steps for proper installation and operation of a drip irrigation system. Maintenance of micro irrigation system: clogging problems

Unit VIII

15 Fertigation - Advantages and limitations of fertigation, Fertilizer solubility, proportional and non-proportional concept

16 Fertigation frequency, duration and injection rate, methods of fertigation

Practical

No.	Practical outline
1	Study of different components of sprinkler irrigation system
2	Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler and uniformity coefficient
3	Tutorial class on design of sprinkler irrigation
4	Design and installation of sprinkler irrigation system
5	Study of cost economics of sprinkler irrigation system
6	Study on maintenance of sprinkler irrigation system
7	Study of different components of drip irrigation
8	Tutorial class on design of drip irrigation system
9	Design and installation of drip irrigation system
10	Determination of pressure discharge relationship and emission uniformity for a given emitter and study of foggers
11	Study of different types of filters and determination of filtration efficiency
12	Study of fertigation, types of liquid fertilizers, determination of rate of injection and calibration for chemigation/ fertigation
13	Design of irrigation and fertigation schedule for crops
14	Study on maintenance of drip irrigation system
15	Field visit to micro irrigation system and evaluation of drip system
16	Visit to Micro irrigation industry

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DEPARTMENT OF SOIL AND WATER CONSERVATION ENGINEERING

SWCE 241 Fluid Mechanics and Open Channel Hydraulics 3(2+1)

Course outlines

Objective

To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering.

Theory

Properties of fluids: Ideal and real fluid, units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, metacenter and metacentric 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, venturi meter, orifice meter and pitot tube, siphon.

Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe.

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, Chezy's formula for loss of head in pipes, flow through simple and compound pipes, transmission of power through pipes.

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter.

Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'pi' theorem, types of similarities, dimensionless numbers; Introduction to fluid machinery.

Practical

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow; Determination of meta-centric height; 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; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter; Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froude's number and Reynold's number; Study of various types of pumps and its components.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Fluids - Definitions, classification, properties, units and dimensions
2	Fluid pressure - Introduction, Pascal's law, measurement of fluid pressure piezometer tube, manometer and types of manometers
3	Mechanical gauges - Bourdon's tube pressure gauge, diaphragm pressure gauge, dead weight pressure gauge
4	Fluid static force on submerged surfaces - Total force on horizontal, vertical and inclined surfaces
Unit II	
5	Centre of pressure of an inclined immersed surface - Centre of pressure of a composite section
6	Pressure on a curved surface and its applications in engineering structures
7	Buoyancy, meta centre and meta centric height, Archimede's principle, condition of floatation and stability of submerged and floating bodies
8	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 vorticity and vortex motion
Unit III	
9	Dynamics of fluid flow - Various forms of energy in flow, frictional loss, general equation
10	Bernoulli's theorem, Euler's equation of motion and derivations
11	Practical applications of Bernoulli's theorem, venturi-meter and orifice meter Pitot tube, nozzle and siphon

12 Laminar flow - Stress strain relationships, flow between infinite parallel plates, both plates fixed, one plate moving, discharge and average velocity

Unit IV

13 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

14 Flow through orifices (Measurement of discharge) - Types of orifices, jet of water, vena contracta, hydraulic coefficients, experimental method for hydraulic coefficients, discharge through a rectangular orifice

15 Flow through orifices (Measurement of time) - Time of emptying a square, rectangular or circular tank through an orifice at its bottom, time of emptying a hemispherical tank through an orifice at its bottom

16 Time of emptying a circular horizontal tank through an orifice at its bottom. Time of emptying a tank of variable cross - Section through an orifice

Unit V

17 Flow through mouthpieces-Types of mouthpieces, loss of head of a liquid flowing in a pipe, discharge through a mouthpiece

18 Flow over notches-Types of notches, discharge over a rectangular notch, triangular notch, stepped notch. Time of emptying a tank over a rectangular notch and triangular notch

19 Flow over weirs - Types of weirs, discharge over a weir, Francis's formula for discharge over a rectangular weir (Effect of end contractions), Bazin's formula for discharge over a rectangular weir, velocity of approach, determination of velocity of approach

20 Flow through simple pipes - Loss of head in pipes, Darcy's formula for loss of head in pipes, Chezy's formula for loss of head in pipes

Unit VI

21 Time of emptying a tank through a long pipe, time of flow from one tank into another through a long pipe

22 Flow through compound pipes - Discharge through a compound pipe (Pipes in series), discharge through pipes in parallel, equivalent size of a pipe, discharge through branched pipes from one reservoir to another

23 Open channel hydraulics - Classification of open channel and definitions

24 Chezy's formula for discharge through an open channel

Unit VII

25 Bazin's formula and Kutter's formula for discharge, problems on design

26 Manning's formula for discharge through an open channel

27 Specific energy concept - Specific energy of a flowing fluid, specific energy diagram, critical depth, types of flows

28 Critical velocity, velocity and pressure profiles in open channels

Unit VIII

29 Hydraulic jump, types of hydraulic jumps, depth of hydraulic jump, loss of head due to hydraulic jump

30 Dimensional analysis and similitude - Rayleigh's method

31 Buckingham's pi theorem

32 Types of similarities, dimensionless numbers, study of fluid machinery

Practical

No.	Practical outline
1	Study of manometers and pressure gauges
2	Study of transmissibility of liquid pressure
3	Determination of meta-centric height
4	Verification of Bernoulli's theorem
5	Determination of coefficient of discharge of venturi-meter
6	Determination of coefficient of discharge of orifice meter
7	Determination of coefficient of friction in pipeline of different sizes/materials
8	Determination of coefficient of discharge for rectangular notch
9	Determination of coefficient of discharge for triangular notch
10	Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice
11	Determination of coefficient of discharge for mouth piece
12	Study of hydraulic ram
13	Measurement of velocity by current meter
14	Study of open channel flow: Velocity distribution in open channels and determination of Manning's coefficient of rugosity and Chezy's roughness coefficient
15	Study on non-dimensional constants such as Froude's number and Reynold's number
16	Study of various types of pumps and it's components

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SWCE 242 **Watershed Hydrology** **3(2+1)**

Course outlines

Objective

To make the students acquainted with the different hydrological processes, their methods of analysis so as to enable them to apply these for watershed development, water harvesting, minor irrigation, drought and flood control

Theory

Hydrologic cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges 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 Flood routing - channel and reservoir routing; Hydrology of dry land areas, Troll's climatic classification; Drought- classification, causes and impacts, drought management strategy

Practical

Visit to meteorological observatory and study of different instruments; Study of optimal rain gauge network; Study of intensity - frequency - duration curves; Study of depth - area - duration curve; Analysis of rainfall data and estimation of mean rainfall by different methods; Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records; 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; Study and determination of geomorphic parameters of watersheds; Study of runoff hydrograph and separation of base flow and surface flow ; Study of unit hydrograph; Study of synthetic hydrograph; Study of flood routing; Study of various discharge measuring devices

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Hydrology - Definition, hydrologic cycle and its components

2 Forms of Precipitation, Characteristics of rainfall in India

3 Measurement of Rainfall – Non-Recording Rain gauges

4 Measurement of Rainfall – Recording Rain gauges

Unit II

5 Estimation of mean rainfall over an area – Arithmetic Mean, Thiessen Polygon, Isohyetal methods

6 Estimation of missing rainfall and optimum number of rain gauges

7 Frequency analysis of point rainfall – Weibull and California

8 Presentation of Rainfall data – Mass Curve and hyetograph

Unit III

9 Depth-Area-Duration (DAD) relationships and curves

10 Intensity-Duration-Frequency relationships

11 Definition of interception, infiltration and factors influencing and determination of net effective rainfall - Infiltration indices - Phi index and W- index

12 Evaporation and its process, method of estimating lake evaporation -Types of evaporimeters, measures to reduce lake evaporation, Soil evaporation

Unit IV

13 Runoff - Definition - Components of runoff - direct runoff and base flow, overland flow and interflows, runoff characteristics of streams, factors affecting runoff - climatic factors and physiographic factors

14 Stream flow measurement, Stage discharge rating curve, Current meter

15 Runoff estimation using Rational method and Cook's method

16 Runoff estimation using SCS curve number method

Unit V

17 Geomorphology of watersheds- Linear aspects of watersheds

18 Geomorphology of watersheds- Aerial and relief aspects of watersheds

19 Hydrographs-Definitions and components, factors affecting flood hydrographs

20 Methods of base flow separation

Unit VI

21 Hydrograph separation for simple and complex storms

22 Unit Hydrographs-Concept and the three implications of the definition and the two basic assumptions (linear response and time invariance)

23 Derivation of unit hydrographs from total hydrograph, average unit hydrographs from several storms of the same duration

24 Derivation of unit hydrograph for complex storms, the conversion of unit hydrograph duration

Unit VII

25 Methods for unit hydrographs of different durations -Method of superposition and S - Curve method

26 Synthetic unit hydrograph, Concept, Snyder' synthetic unit hydrograph, formulas relating hydrograph features (basin lag, Peak flow and time base of the unit hydrograph)

27 Flood Routing – Introduction and basic equations

28 Hydrologic Storage Routing -Modified Pul's method

Unit VIII

29 Hydrologic Storage Routing - Goodrich's method

30 Hydrologic Channel Routing - Muskingum method

31 Troll's climatic classification, Hydrology of dry land areas

32 Drought - classification, causes and impacts, drought management strategy

Practical

No.	Practical outline
1	Visit to meteorological observatory and study of different instruments
2	Study of optimal rain gauge network
3	Study of intensity - frequency - duration curves and depth - area – duration curves
4	Analysis of rainfall data and estimation of mean rainfall by different methods
5	Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records
6	Computation of infiltration indices
7	Computation of peak runoff and runoff volume by Cook's method and Rational formula
8	Computation of runoff volume by SCS curve number method
9	Study of stream gauging instruments- current meter and stage level recorder
10	Study and determination of geomorphic parameters of watersheds
11	Study of runoff hydrograph and separation of base flow and surface flow
12	Study of unit hydrograph
13	Study of synthetic hydrograph
14	Study of flood routing by Modified Pul's method
15	Study of various discharge measuring devices
16	Visit to a nearby watershed

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SWCE 243 Soil and Water Conservation Engineering 3(2+1)

Course outlines

Objective

To make the students acquainted with the different causes of soil erosion and water loss and the different measures for soil and water conservation

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 EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples 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 stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains Grassed waterways and design. Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump 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.

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, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short term and long-term techniques; 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.

Practical

Estimation of soil loss by USLE, 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; Estimation/measuring techniques of soil loss; 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 drying method Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs; Design and layout of contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond design, capacity and estimation; Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway; Hydraulic and structural design of chute spillway, design of SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Study on prioritization of watershed; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Soil erosion - Introduction, causes and ill effects of soil erosion, factors affecting on soil erosion and types of soil erosion according to origin and according to erosion agents

2 Water erosion, classification of water erosion - Splash, rill, sheet, gully, ravines and stream bank erosion, mechanics of water erosion; Gullies and their classification, Stages of gully development

3 Soil loss estimation – Universal soil loss equation (USLE); Rainfall erosivity estimation by KE >25 and EI_{30} methods

4 Soil erodibility - Topography, crop management and conservation practice factors, Modified USLE, numerical problems on USLE

Unit II

5 Measurement of soil erosion - Runoff plots, rainfall simulator, soil samplers - multislot devisor, Coshocton wheel sampler

6 Water erosion control measures - Agronomical measures - contour farming, strip cropping, conservation tillage and mulching

7 Engineering measures or mechanical measures – Bunds and terraces; Bunds – Types of bunds, Classification of bunding system, Contour bunds - design of contour bunds horizontal interval-vertical interval-cross section of the contour bunds - seepage line consideration

8 Design of contour bunds - Size of the bund - bund height, length of contour bund, loss of area due to bunding and earth work of contour bund, Construction of contour bunds in field

Unit III

9 Graded bunds - Design of graded bunds, construction and alignment of bunds Design of surplus arrangements

10 Terraces- Classification of terraces –level and graded terraces, narrow based and broad-based terraces

11 Bench terraces- Types of bench terraces, design of bench terraces – terrace spacing, terrace gradient and terrace cross section

12 Derivation of vertical interval, terrace width, area lost in bench terracing and earth work per hectare in case of vertical terrace cut, terrace cut is 1:1 slope and terrace cut is ½:1 batter slope

Unit IV

13 Design of graded terrace- Terrace spacing, depth of cut, terrace slope, terrace length and terrace cross section; numerical problems on graded terraces

14 Contour stone wall and contour trenching- Types of contour trenches, design, layout and construction of contour trenches

15 Gully and ravine reclamation-Principles of gully control - stabilization of gully head, vegetative measures

16 Temporary gully control structures –Brush wood dams, wire mesh dams and diversion drain

Unit V

17 Vegetated waterways - Types of water ways based on shapes, expressions for wetted perimeters, areas, hydraulic radius, types of vegetation, roughness of different grasses and design of vegetated waterways

18 Energy and momentum principles in open channels; Specific energy concept-Specific energy of a flowing fluid, specific energy diagram, critical depth, types of flows, critical velocity and Specific force

19 Hydraulic jump and its applications, types of hydraulic jumps, depth of hydraulic Jump, loss of head due to hydraulic jump

20 Soil erosion permanent gully control structures - Introduction, classification and functional requirements

Unit VI

21 Permanent structures for soil conservation and gully control- Check dams, drop, chute and drop inlet spillways

22 Design of drop spillways for gully control - Hydrologic, hydraulic and structural design and related problems

23 Drop inlet spillways – Uses, requirements and planning for design of the spillways and related problems

24 Design of chute spillways for gully control - Hydrologic, hydraulic and structural design, planning for design of the spillways

Unit VII

25 Wind erosion- Factors affecting wind erosion, mechanics of wind erosion, soil loss estimation in wind erosion

26 Wind erosion- Control measures - Vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes

27 Land use capability classification based on different criteria with a special reference to slope, sub classification; dryland farming

28 Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs

Unit VIII

29 Water harvesting – Principles, advantages and disadvantages of water harvesting; Water harvesting techniques - classification based on source, storage and use, Runoff harvesting – short-term and long-term techniques; Short-term harvesting techniques - Terracing, bunding, semi-circular hoop, rock and ground catchments

30 Long-term harvesting techniques - Farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes, type of embankments

31 Farm pond- Components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction

32 Percolation pond - Site selection, design and construction details Design considerations of nala bunds

Practical

No.	Practical outline
1	Estimation of soil loss by USLE
2	Computation of rainfall erosivity index and soil erodibility index in soil loss estimation
3	Determination of length of slope (LS) and cropping practice (CP) factors in USLE
4	Study of rainfall simulator for erosion assessment and estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor
5	Determination of sediment concentration through oven dry method
6	Study on sedimentation of reservoirs and calculation of rate of sedimentation and storage loss in tanks
7	Design and layout of contour bunds and graded bunds
8	Design and layout of broad base terraces and bench terraces
9	Design of vegetative waterways
10	Design of shelter belts and wind breaks for wind erosion control
11	Farm pond design, capacity and estimation and design of water harvesting structures
12	Hydrologic, Hydraulic and structural design of drop spillway
13	Hydraulic and structural design of chute spillway and design of SAF energy dissipater
14	Design of drop inlet spillway and study on components of earth embankments and its design
15	Study on prioritization of watershed
16	Visit to watershed and soil erosion sites for studying erosion control and water conservation measures

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SWCE 441 Watershed Planning and Management 3(2+1)

Course outlines

Objective

To acquaint the students with different aspects of watershed planning and management including participatory approaches and also on the integrated watershed management practices.

Theory

Watershed- introduction and characteristics; 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 Community mobilization and participatory institution building: participatory watershed management, role of watershed associations, user groups and self-help groups; Participatory Rural Appraisal, understanding gender in relation to agriculture 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, nonarable lands- forestry, fishery and animal husbandry; Effect of cropping systems, land management and cultural practices on watershed hydrology; Use of remote sensing thematic maps and GIS in watershed planning Watershed programme- execution, follow-up practices, maintenance, monitoring and evaluation; Planning and formulation of project proposal for watershed management programme including cost- benefit analysis; Financial management and accounting procedure.

Practical

Delineation of watersheds using toposheets; Surveying and preparation of watershed map; Quantitative analysis of watershed characteristics and parameters; Investigations on watershed for planning and development including PRA; Analysis of hydrologic data for planning watershed management; Measurement of discharge and sediment in a watershed; Water budgeting of watersheds; Study of thematic maps using remote sensing; Study of watershed action plan using GIS; Prioritization of watersheds based on sediment yield index; Study of functional requirement of watershed development structures; Study on components of earth embankments and its design; Study of watershed management technologies; Study of role of various functionaries in watershed development programmes; Study of accounting and financial management systems in watershed entities; Visit to watershed development project areas .

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Watershed: Introduction and Characteristics
2. Watershed Management-Concept and Objectives
3. Factors Affecting Watershed Planning based on Land Capability Classes
4. Hydrologic data required for Watershed Planning

Unit II

5. Watershed codification
6. Watershed delineation from toposheets
7. Prioritization of Watersheds: Sediment Yield Index
8. Community Mobilization and participatory institution building

Unit III

9. Participatory Watershed Management and role of Watershed Associations
10. User Groups and Self-Help Groups
11. Participatory Rural Appraisal
12. Understanding Gender in Relation to Agriculture

Unit IV

13. Water Budgeting in a Watershed- Management Measures
14. Rainwater Conservation Technologies: in-situ Storage
15. Rainwater Conservation Technologies ex-situ Storage
16. Water Harvesting and Recycling

Unit V

17. Dry Land Farming Techniques
18. Inter-terrace and Inter-bund Management
19. Integrated Watershed Management-Concept and Components
20. Arable Lands- Agriculture and Horticulture

Unit VI

21. Non-Arable Lands-Forestry
22. Fishery, and Animal Husbandry
23. Effect of Cropping Systems
24. Land Management and Cultural Practices on Watershed Hydrology

Unit VII

25. Use of Remote Sensing Thematic maps
26. GIS in watershed planning
27. Watershed Programme Execution
28. Follow-up Practices, Maintenance, Monitoring and Evaluation

Unit VIII

29. Planning of Project Proposal for Watershed Management programme.
30. Formulation of Project Proposal for Watershed Management programme.
31. Cost benefit analysis in Watershed Management
32. Financial Management and Accounting Procedure

Practical

No. Practical outline

1. Delineation of watersheds using toposheets
2. Surveying and preparation of watershed map
3. Quantitative analysis of watershed characteristics and parameters
4. Investigations on watershed for planning including PRA
5. Analysis of hydrologic data for watershed Management
6. Measurement of discharge and sediment in a Watershed
7. Water budgeting of watersheds
8. Study of thematic maps using Remote Sensing
9. Study of watershed action plan using GIS
10. Prioritization of watersheds based on sediment yield index
11. Study of Functional Requirements of Watershed Development Structures
12. Design of earth embankments

13. Study of watershed management technologies
14. Study of role of various functionaries in watershed development programmes
15. Study of accounting and financial management systems in watershed entities
16. Visit to a watershed development project area

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DEPARTMENT OF RENEWABLE ENERGY ENGINEERING

REEN 251 **Renewable Energy Sources** **3(2+1)**

Course outlines

Objective

To make the students acquainted with the different renewable energy sources and to enable them to analyze and select the appropriate technology to meet the energy demand in different types of agricultural operations.

Theory

Different sources of renewable energy: Concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; 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 solar drying system; Solar photo voltaic- basics and applications, 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 availability, general formula, lift and drag; Basics 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; Wind farms, aero-generators, wind power generation system Biogas: Basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Generation of power from biogas; Design and use of different commercial biogas plants Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification and Dendrothermal); Mini and micro hydel plants; Fuel cells and its associated parameters.

Practical

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

Lecture outlines

Theory

No. Lecture Outline

Unit I

1 Classification of energy sources- conventional and non-conventional energy sources, importance of non-conventional sources Advantages of renewable energy, obstacles to implementation of renewable energy systems, prospects of renewable energy sources

2 Criteria for assessing the potential of renewable energy sources

3 Concepts and limitations of different renewable energy sources (RES) as solar, wind, biomass, Ocean thermal, Geothermal, tidal *etc.,*

4 Solar energy- Introduction, energy available from sun, solar radiation data

Unit II

5 Solar geometry, types of solar radiations, Instruments to measure solar radiation

6 Solar Energy collectors - flat-plate collectors, concentrated type collectors, Principles of conversion of energy, collector energy balance equation

7 Solar thermal devices- box type cooker, dish type cooker, solar water heating system; natural circulation type and forced circulation type

8 Solar thermal devices- solar space heating system, passive and active types, solar still, space heating/ cooling, solar pond

Unit III

9 Solar grain dryers- solar cabinet dryer, principle of natural and forced convection solar drying system

10 Solar greenhouses, basics of plant growth, modes of heat transfer, types of solar greenhouses

11 Solar photo voltaic- Fundamentals of photovoltaic conversion, SWOT analysis of solar photovoltaic system, semiconductor materials, P-type and N-type semiconductors, p-n junctions

12 Solar cell, solar module, solar array, components of solar water pumping system

Unit IV

13 Solar street lights, solar refrigeration system, grid type and non-grid type solar PV systems

14 Design of solar photo voltaic system for domestic/industrial applications

15 Wind energy; basic principles of wind energy conversion, energy available in wind, forces on the blades and thrust on the turbine

16 Site selection for installation of wind turbine, Basic components of wind energy conversion system

Unit V

17 Classification of WEC systems, wind energy collectors, Horizontal axis type and vertical axis type, advantages and disadvantages of WEC system

18 Biogas plants -Introduction, anaerobic digestion, phases of anaerobic digestion, advantages of anaerobic digestion, factors affecting bio- digestion

19 Biogas plants, classification of biogas plants, Continuous and batch type plants, dome and drum type, different variations in dome types

20 Advantages and disadvantages of floating drum and fixed dome type plants, KVIC biogas plants, Janata type biogas plants, comparison between Janata type and KVIC type plants, application of biogas

Unit VI

21 Digester design considerations, retention time, volume of digester for biogas production using cow dung, numerical on biogas plant design

22 Methods of maintenance of biogas, Problems related to biogas plants, starting of biogas plant

23 Utilization of biogas plant, modifications required in CI and SI engines for operating on biogas

24 Gasifiers- Definition, advantages, classification of gasifiers, construction and working principle of different type of gasifiers (fixed bed, down draft, cross draft, fluidized bed gasifiers)

Unit VII

25 OTEC- Methods of Ocean Thermal Electrical Power Generation, Open, Closed and Hybrid systems, Heat Exchangers, Site selection

26 Tidal Energy- Principles of tidal power, types of tidal power plants, components of tidal power plants

27 Estimation of energy and power in single basin and double basin tidal system, numerical related to tidal power generation

28 Wave energy, Energy and power from the waves, wave energy conversion devices

Unit VIII

29 Micro, mini and small hydel power plants, classification of small hydro power stations, Components of small hydro power station

30 Civil work design considerations for micro and mini power stations, different types of turbines, advantages and limitations

31 Fuel cells and its associated parameters- Introduction, design and principle of operation of fuel cell, hydrogen fuel cells, classifications of fuel cells

32 Types of fuel cells, polarization in fuel cell, conversion efficiency, advantages and disadvantages

Practical

No.	Practical outline
1	Demonstration of Solar data collection instruments
2	Demonstration of box type solar cooker
3	Demonstration of parabola type solar cooker
4	Demonstration of Solar water heating system
5	Demonstration of solar cabinet dryer and forced convective dryer
6	Demonstration of various functional components of SPV system
7	Demonstration of grid type and non-grid type solar photovoltaic systems
8	Design of solar photovoltaic system for domestic/industrial applications
9	Demonstration of solar green house
10	Demonstration/ study of functional components of WECS
11	Demonstration of different wind turbines (Horizontal and Vertical)
12	Demonstration of Janata type biogas plant
13	Demonstration of KVIC type biogas plant
14	Demonstration/visit to hydro power plant
15	Visit to solar park/wind energy turbine unit
16	Demonstration of working of fuel cell

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2. Rai, G.D. 2020. Solar Energy Utilization, Khanna Publishers, New Delhi
3. Rathore, N.S., Mathur, A.N. and Kothari, S. 2007. Alternate Sources of Energy. ICAR publications, New Delhi

REEN 351 Bio-energy Systems: Design and Applications 3(2+1)

Course outlines

Objective

To make the students acquainted with the different biomass sources, and the different thermo-chemical and bio-chemical processes for bio-energy and fuel production.

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems. 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).Bio-energy-properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas- type, operating principle; gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Biohydrogen production routes. Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio-energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles; Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas and producer gas; Testing of diesel engine operation using dual fuels and gas alone; Performance evaluation of biomass gasifier engine system (throat less and downdraft); Study on producer gas- types, application, shaft power generation, thermal application and economics; Study of cost economics of biofuel.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Biomass- Classification, different sources of biomass
2	Biomass characteristics- Proximate analysis, ultimate analysis, ash deformation and fusion temperature
3	Calorific value of biomass, bulk density, rate of devolatilization
4	Fermentation processes and its general requirements
Unit II	
5	An overview of aerobic and anaerobic fermentation processes
6	Industrial applications of fermentation process
7	Heat transfer process in anaerobic digestion system
8	Biomass production- Survey, site selection, selection of species, methods of field preparation and transplanting

Unit III

9 Preparation of soil mixture, method of sowing, transportation of seedlings to the site, maintenance of plantation

10 Harvesting of biomass- Factors to be considered for biomass harvesting, harvesting methods; coppicing, pollarding, pruning, thinning

11 Biomass preparation techniques for harnessing – Size reduction

12 Biomass preparation techniques for harnessing – drying

Unit IV

13 Biomass preparation techniques for harnessing – Densification, types of densifications, biomass briquetting machines

14 Thermo-chemical conversion of biomass, pyrolysis of biomass to produce solid, liquid and gases fuel

15 Thermo-chemical conversion of biomass, combustion of biomass to produce energy

16 Parameters affecting combustion process of biomass, conditions for efficient combustion of biomass

Unit V

17 Furnaces for biomass combustion, horizontal grate furnace, inclined step grate furnace, horizontal and vertical cyclone furnace

18 History of small gas producer engine system; gasification process, Producer gas, properties of producer gas

19 Types of gasifiers- Up-draft, down-draft, cross-draft and fluidized bed, chemistry of gasification

20 Preparation of producer gas for various applications

Unit VI

21 Conditioning of producer gas, applications of producer gas

22 Shaft power generation from producer gas

23 Thermal applications and economics of producer gas

24 Bio-fuel, advantages of bio-diesel, comparison between bio-fuels and normal fuels, potential use of bio-fuels in India

Unit VII

25 Bio-diesel production-Trans-esterification, batch process, super critical process

26 Bio-diesel production through ultrasonic method, microwave method

27 Production of bio-diesel from jatropha / pongame seed

28 Applications of bio-fuels, cost economics of bio-fuels

Unit VIII

29 Bio-hydrogen production routes, thermo-chemical process, stream-methane reforming, coal gasification, biomass gasification

30 Bio-hydrogen production; biomass derived liquid reforming, photo-biological method, microbial biomass conversion

31 Environmental aspect of bio-energy

32 Assessment of greenhouse gas mitigation potential

Practical

No.	Practical outline
1	Study of anaerobic fermentation system
2	Study of gasification for industrial process heat
3	Study of biomass plantation procedures
4	Study of biomass harvesting methods
5	Determination of moisture content of biomass sample
6	Determination of Ash deformation and fusion temperature of biomass sample
7	Determination of calorific value of biomass sample
8	Study of working of different gasifiers
9	Study/visit of different types of furnaces
10	Study/visit of briquetting machines/industry
11	Study of drying process of biomass material
12	Study of size reduction process of biomass sample
13	Study of biodiesel production from jatropha seed
14	Testing of diesel engine with biodiesel/blended bio-fuel
15	Study of cost economics of bio-fuel
16	Visit to local industry which is utilizing producer gas for generating heat

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4. Basu, P. 2018. Biomass Gasification, Pyrolysis and Torre faction. Academic Press.
5. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. The Bio-diesel Handbook. AOCS Press.

DEPARTMENT OF BASIC ENGINEERING

AEBE 161 **Surveying and Levelling** **3(1+2)**

Course outlines

Objective

To enable the students to conduct the survey work for any area and also to prepare layout of engineering structures.

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, methods, advantages and disadvantages. 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

Linear measurements using different instruments; Reconnaissance survey in the field; Use of field book; Study on various types of chain used in chain survey and its components; Study of errors in chain surveying; Use of ranging rods and ranging in the field; Obstacles during chaining; Offsets in chain survey; Cross Staff; Survey of an area; Preparation of map; Study on various types of compass; Compass survey of an area; Plotting of compass survey; Plane table surveying and different methods; Study on various types of levels and its components; Setting up of dumpy level in the field; Computation of various methods for RL; Study on Levelling, L section and X sections and its plotting; Measurement of slope in the field; Study on contour and its characteristics; 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; Use of minor instruments; Use of total station, EDM in the field; Use of modern computers for surveying.

Lecture outlines

Theory

No Lecture outline

Unit I

1 Introduction of Surveying, definition, units of measurement – basic units of length, area and volume, objectives of surveying, classification of surveying

2 Uses of surveying and Principles of surveying – Difference between a plan and map, precision in surveying – work of the surveyor. Measurement of distance – Linear Measurements, direct measurement, chains and their constructional details, chain types

Unit II

3 Measuring tapes – Instruments for chain survey. Instruments for marking stations, instruments used for ranging, direct ranging, indirect ranging, reciprocal ranging, folding and unfolding of chain

4 Method of chaining – Errors in measurements – Chain and tape corrections – problems on correction of distance and areas

Unit III

5 Chain surveying – Triangulation – basic definitions – Base line, check line and tie line – field work in chain surveying – Method of booking field notes – offsets – layout of offsets

6 Cross Staff survey – types of cross staffs – French cross staff, Optical square etc. – computation of areas by plain meter

Unit IV

7 Compass Survey – Introduction – types of traversing – Meridians – True meridian, Magnetic Meridian, Arbitrary Meridian. Description of prismatic and Surveyor's compass – method of declination – concept of local attraction

8 Bearing – type – designation of bearing – fore and back bearings, Examples on bearings – Included angles – Examples on computation of included angles. Determination of true bearing from magnetic bearings

Unit V

9 Plane table survey – basic definitions –setting of plane table – orientation methods of plane tabling

10 Levelling – introduction – basic definitions – Methods of levelling. Classification of leveling profile leveling – cross sectioning – curvature and refraction leveling – Instruments used in leveling – Levelling difficulties and errors in leveling

Unit VI

11 Temporary adjustments of dumpy level, Bench Marks – Booking the staff readings – Methods of calculating reduced level – Height of collimation and Rise and Fall methods

12 Contouring – characteristics of contour lines – contour drawing – Computation of area and volume

Unit VII

13 Theodolite traversing – components of the theodolite – types – temporary adjustments in Theodolite

14 Introduction to setting of curves – horizontal curves – vertical curves – need for providing curves – classification of curves – degree of circular curve – stationing – layout of a curves by the incremental chord method – layout of a curve by the total chord method

Unit VIII

15 Total station – Operations of Total Station – use of total station – advantages, Electronic Theodolite difference between total station and Theodolite

16 Introduction to GPS survey – The Fundamental Components of GPS – errors in GPS

Practical

No.	Practical outline
1	Measurement of distances by pacing method
2	Acquaintance with the survey instruments
3	Folding, unfolding of the chain and ranging a chain line
4	Chain triangulation survey
5	Plotting of chain triangulation
6	Cross staff survey
7	Plotting of cross staff survey
8	Study of prismatic compass and surveyor compass and accessories
9	Compass survey by intersection method and plotting
10	Plotting of compass survey by intersection method
11	Compass survey by traverse method and plotting
12	A tutorial class on problems on bearings
13	Plane table survey by radiation and plotting
14	Acquaintance with leveling equipment
15	Temporary adjustments for a leveling instrument
16	Tutorial class on reduction of levels
17	Simple leveling
18	Differential leveling
19	Profile leveling
20	Contour survey by grid method
21	Plotting of contour map
22	Computation of areas and volumes
23	Introduction of software in drawing contour
24	Study of Theodolite and temporary adjustments
25	Measurement of horizontal angles by repetition method
26	Measurement of horizontal angles by reiteration method
27	Measurement of vertical angles / Height of object and deflection angles
28	Traversing by included angles
29	Setting out curves by Theodolite

30 Detailed study of components total station

31 Total station survey of an area

32 Total station survey of an area

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2. Arora K R. 1990. Surveying (Vol.I), Standard Book House, Delhi.
3. Kanetkar T P. 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.
4. Punmia B C. 1987. Surveying (Vol.I). Laxmi Publications, New Delhi.

AEBE 162 Workshop Technology and Practice 2(0+2)

Course outlines

Objective

To expose the students to basic manufacturing processes involved for production of different machine elements and to facilitate hands–on experience of using these machines.

Practical

Practical Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop; Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T – half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding; Preparation of Lap and butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper; changing a round MS rod into square section with a shaper; Exercise on a milling machine such as making a slot, gear tooth forming and indexing.

Practical

No.	Practical outline
1	Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop
2	Study of different measuring, marking, cutting and holding tools used for fitting operations
3	Exercise on fitting: sawing, filing and square fitting of MS flat
4	Exercise on fitting: sawing, filing and square fitting of MS flat
5	Exercise on fitting: sawing, filing and circular fitting of MS flat
6	Exercises on operations of drilling, reaming, and threading with taps and dies
7	Preparation of paper weights
8	Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools
9	Preparation of simple wooden joints – Cross half lap joint
10	Preparation of simple wooden joints – T halving joint
11	Preparation of simple wooden joints – Mortise and Tenon joint
12	Preparation of simple wooden joints – Dovetail joint
13	Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding.
14	Study of working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding
15	Preparation of Butt joint and lap joint with ARC welding.
16	Preparation of Butt joint and lap joint using gas welding.
17	Overview of lathe machine and study of different tools used in lathe machine.
18	Exercise of facing and plane turning on lathe machine
19	Exercise of facing and plane turning on lathe machine
20	Exercise of step turning on lathe machine
21	Exercise of step turning on lathe machine
22	Exercise of taper turning on lathe machine
23	Preparation of drilling, knurling and threading on lathe machine
24	Exercise on sheet metal marking, cutting and bending
25	Exercise on punching, riveting, drawing operations – preparation of square tray using GI sheet
26	Preparation of Pen stand using GI sheet and pipe bending on hydraulic bending machine
27	Working of shaper machine and its operations
28	Preparation of v – block on shaper machine
29	Preparation of square block from MS rod on shaper machine

30 Working of milling machine and its operations

31 Exercise on a milling machine – making a slot, gear tooth forming and indexing

32 Exercise on a milling machine – making a slot, gear tooth forming and indexing

References

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3. Khurmi R S and Gupta J K. 2018. A Text Book of Workshop Technology. S. Chand & Company Ltd., New Delhi.
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AEBE 163 Basic Electrical Gadgets and Instruments 3(2+1)

Course outlines

Objective

To impart knowledge to students on basic electrical circuits, distribution of three phase power, transistors, rectifiers, filters, op – AMP, Digital electronics to operate in Agricultural Engineering gadgets and instrumentation for various engineering measurements

Theory

Introduction to different electrical appliances used in agricultural buildings, structures and farm operations; Difference between AC and DC supply system; Introduction to AC fundamentals; AC through series RL, RC, and RLC circuits, parallel AC circuit, series and parallel resonance; Q – factor and bandwidth Three –phase AC circuit: Concept of balanced three – phase AC circuits, line and phase quantity in star and delta network, power in three – phase circuit, various methods of three phase power measurement like (one wattmeter and two – wattmeter method). Diode and its applications: Rectifier, Clipper, Clamper, voltage multiplier and capacitive filter zener diode as voltage regulator. Transistor and its applications: Bipolar junction transistor, operating point. Various biasing methods, fixed, self –biasing and potential divider biasing method; OP – AMP, Ideal OP – AMP characteristics, Linear and non - linear applications of OP – AMP (adder, subtractor, integrator, active rectifier, comparator). Introduction to digital electronics and logic gates: Basic theorem of boolean algebra, combinational logic circuits (basic gates, SOP rule and K – map), binary adder. Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multi – meter, etc.

Practical

To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring); To prepare an electrical switch board to control two light points using two – way switch (staircase wiring); To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer – grinder, etc.; To find faults and repair UPS; To measure the power requirement and power factor in a AC single phase series RLC circuit; To measure energy of a single phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter; To measure the power consumption in a three – phase circuit using two – wattmeter method.

Instrumentation

To prepare a DC power supply unit using diode and filter circuit; To study the Zener diode as voltage regulator circuit; To study transistor characteristics in CE configurations; To verify different logic gates; To measure unknown resistance using Wheatstone bridge; To measure the displacement and to determine the characteristics of LVDT; To measure the displacement using LVDT and potentiometer; To measure the pressure using strain gauge and Bourden tube; To measure the temperature using RTD, thermistors and thermocouple and study their characteristics; To measure the speed, wind velocity, solar radiation etc, using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.; To acquaint with different other types of instruments used in agriculture and food processing applications

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction to the use of different electrical appliances in agricultural buildings, structures and farm operations

2 Difference between AC and DC supply system, AC fundamentals – cycle amplitude, phase, frequency

3 AC through resistive, inductive, capacitive circuit, LR circuit

4 RC and LCR circuit, parallel AC circuit

Unit II

5 Series resonancecircuit, Q – factor, graphical representation, sharpness, bandwidth

6 Parallel resonance circuit, Q – factor, graphical representation, sharpness, bandwidth

7 Distribution of three phase power, concept of balanced three phase ac circuit

8 Star connection – relation between line voltage, phase voltage, line current and phase current using phasor diagram, power in star connection.

Unit III

9 Delta connection – relation between line voltage, phase voltage, line current and phase current using phasor diagram, power in Delta connection

10 Measurement of three phase power using single watt meter, two watt meter, three watt meter methods

11 PN diode its action half wave rectifier, efficiency, ripple factor, voltage regulation.

12 Full wave rectifier, bridge rectifier, efficiency, ripple factor, voltage regulation

Unit IV

13 Clipping circuit – Negative, Positive clipper, biased clipper, combination clipper, positive and negative clamping circuits

14 Voltage multipliers – half wave and full wave voltage multiplier filter circuit – shunt capacitor filter its ripple factor and regulation.

15 Series induction filter, ripple factor, regulation, regulator DC power supply zener diode voltage regulator

16 Bipolar junction transistor – PNP, NPN transistor, transistor connections – CB, CE, CC, operating point, DC, AC load lines

Unit V

17 Transistor Biasing – Stability factor, various biasing methods, fixed bias

18 Collect to base bias (self) potential divider bias methods

19 OP – AMP – Introduction, characteristics of ideal OP – AMP, differential amplifier

20 Linear and non – linear applications of OP – AMP as comparator, subtractor and adder

Unit VI

21 OP – AMP as integrator, differentiator active rectifier, instrumentation amplifier

22 Introduction to digital electronics – logic gates basic theorems of Boolean algebra

23 Combination logic circuits – AND, OR, NOT, NOR, NAND, gates, SOP rule, K – MAP, binary adder

24 Principle of general instruments, measurement of displacement – inductive transducer, potentiometric transducer, photo electric transducer

Unit VII

25 Measurement of displacement, capacitative transducer, and LVDT

26 Measurement of temperature – thermistors, thermocouple, RTD, pyrometer

27 Measurement of velocity – variable reluctance pick up, tachometer, stroboscopic method

28 Measurement of force – using load cells, using strain gauge

Unit VIII

29 Pressure measurement – bourdon tube, oscillation transducer, photo tube as a transducer

30 Speed measurement – tacho meter – eddy current type – tacho meter, electric generator tachometer, stroboscopic tacho meter

31 Wind speed measurement – anemometer – Hot wire anemometer, constant current type – constant temperature type

32 Solar radiation measuring instrument – pyrometer, pyroheliometer – Multimeter uses

Practical

No. Practical outline

Basic Electrical and Electronics Gadgets

1 To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring)

2 To prepare an electrical switch board to control two light points using two way switch (staircase wiring); To connect and test a fluorescent lamp;

3 To find faults and repair home appliances such as heater, electric iron, fans and mixer – grinder and repair UPS

4 To measure the power requirement and power factor in an AC single phase series RLC circuit

5 To measure energy of a single-phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter

6 To measure the power consumption in a three – phase circuit using two wattmeter method

Instrumentation

7 To prepare a DC power supply unit using diode and filter circuit and study of Zener diode as voltage regulator.

8 To study transistor characteristics in CE configurations

9 To verify different logic gates

10 To measure unknown resistance using Wheatstone bridge

11 To measure the displacement and to determine the characteristics of LVDT

12 To measure the displacement using LVDT and potentiometer

13 To measure the pressure using strain gauge and Bourdon tube

14 To measure the temperature using RTD, thermistors and thermocouple and study their characteristics

15 To measure the speed, wind velocity, solar radiation etc., using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.

16 To acquaint with different other types of instruments used in agriculture and food processing applications

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AEBE 164 Engineering Drawing 2(0+2)

Course outlines

Objective

To enable the students to draw engineering drawings for some simple machines / equipment

Practical

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, references planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, whit worth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints.

Practical

No.	Practical outline
1	Introduction to engineering drawing, practice of different layout drawings – Drawing instrument and their use.
2	Introduction to lines, letterings, single stroke letters.
3	Dimensioning – continuous and progressive dimensioning, dimension line, extension line, arrow heads.
4	Scales – Plain Scale and diagonal Scale with representative fraction (R.F.) – Problems
5	Scales – Plain Scale and diagonal Scale with representative fraction (R.F.) – Problems
6	Introduction to orthographic projection – first angle projection and third angle projection
7	Projection of Points – I quadrant, II quadrant, III quadrant, IV quadrant – Problems
8	Projection of lines – parallel, perpendicular an inclined to one or both planes – Problems
9	Projection of lines – parallel, perpendicular an inclined to one or both planes – Problems
10	Projection of planes – Parallel, perpendicular and inclined to H.P and V.P – Problems
11	Projection of planes – Parallel, perpendicular and inclined to H.P and V.P – Problems
12	Projection of Solids – Projection of regular solids inclined to one or both planes – Problems
13	Projection of Solids – Projection of regular solids inclined to one or both planes – Problems
14	Section of solids – section planes and sectional view of right regular solids – Prism, cylinder, pyramid and cone. True Shapes of sections
15	Section of solids – section planes and sectional view of right regular solids – Prism, cylinder, pyramid and cone. True shapes of sections
16	Section of solids – section planes and sectional view of right regular solids – Prism, cylinder, pyramid and cone. True Shapes of sections
17	Principle of isometric projections – isometric scales – isometric views – conventions – isometric view of lines, plane figures simple and compound solids
18	Principle of isometric projections – isometric scales – isometric views – conventions – isometric view of lines, plane figures simple and compound solids
19	Principle of isometric projections – isometric scales – isometric views – conventions – isometric view of lines, plane figures simple and compound solids
20	Need for drawing conventions
21	Conventional representation of thread – Nomenclature, thread profile

22 Conventional representation of thread – Nomenclature, thread profile – Practice session

23 Conventional representation of screw – Forms of screw threads like metric thread whit worth thread – Square thread, acme thread, knuckle thread, buttress thread and trapezoidal thread

24 Conventional representation of screw – Forms of screw threads like metric thread whit worth thread – Square thread, acme thread, knuckle thread, buttress thread and trapezoidal thread – practice session

25 Conventional representation of nut and bolt – Square bolt, eye bolt – hexagonal and square bolt and nut – foundation bolts

26 Conventional representation of nut and bolt – Square bolt, eye bolt – hexagonal and square bolt and nut

27 Conventional representation of Screw – machine screws, cap screws and wood screws – Drawing of stud screws, set screws, butt, hexagonal and square

28 Conventional representation of Riveted joints – rivet heads and riveted joints

29 Conventional representation of keys – taper, rank taper, hollow saddle etc.

30 Conventional representation of keys – taper, rank taper, hollow saddle etc.

31 Conventional representation of Weld Joints – symbols and types of weld joints

32 Conventional representation of Weld Joints – symbols and types of weld joints

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1. Bhatt, N. D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
2. Bhatt, N. D. and Panchal, V. M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
3. Narayana, K. L. and Kannaiah, P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.

AEBE 165 Computer Programming and Data Structures 2(0+2)

Course outlines

Objective

To make the students conversant on computer programming languages, specifically "C" language as well as to make them familiar with programming for simple agricultural engineering applications

Practical

Introduction to high level languages; structure programming, C programming, a simple 'C' programming, execution of a 'C' program, program and instruction; Familiarizing with Turbo C IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; 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; Creating user defined functions; Developing structures and union; Using local, global & external variables; Using pointers; Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion / Deletion in queues.

Practical

No.	Practical outline
1	Programming languages – Types and Introduction to high level languages
2	Programming structure and 'C' programming (Basic Structure of 'C' program)
3	A simple C programming and execution of a 'C' program, Complier
4	Program and Instruction – Debugger (Step by step execution of 'C' program)
5	Familiarizing with Turbo 'C' IDE (Integrated development Environment)
6	Building an executable version of C programs
7	Study of Operators: Arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators
8	Developing and executing 'C' programs – on Arithmetic operations
9	Developing and executing 'C' programs – on to perform mathematical & logical operations
10	Control and Loop statements: Developing and executing 'C' programs – By using conditional operator
11	Developing and executing 'C' programs – By using Decision Making/ Control statements: If
12	Developing and executing 'C' programs – By using Decision Making/ Control statements: go to
13	Developing and executing 'C' programs – By using Decision Making/ Control statements: switch
14	Developing and executing 'C' programs – By using Loop Statements/ Iteration statements: while
15	Developing and executing 'C' programs – By using Loop Statements/ Iteration statements: do while
16	Developing and executing 'C' programs – By using Loop Statements/ Iteration statements: for
17	Developing and executing 'C' programs – By Using nested control structures
18	Data Structures: Familiarizing with one- and two-dimensional arrays

19 Developing and executing 'C' programs – By using Arrays: one, two dimensional Arrays
20 Study of Functions and Implementing the functions
21 Developing and executing 'C' programs – By using Input / Output Library Functions: unformatted input library functions
22 Developing and executing 'C' programs – By using Input/output Library Functions: unformatted output library functions
23 Developing and executing 'C' programs – By using User Defined Functions: Function without arguments and without return statement
24 Developing and executing 'C' programs – By using User Defined Functions: Function with arguments and without return statement
25 Developing and executing 'C' programs – By using Parameter Passing Mechanisms: Call – by – Value, Call – by – Reference
26 Developing and executing 'C' programs – By using Local, Global, and External Variables
27 Study of Structures, Union and Pointers and their Implementation.
28 Developing and executing 'C' programs – By using Pointers, Structures, Unions
29 Study of Linked List, Stack and Queue and their Implementation Developing and executing 'C' programs – Implementing a Liked Lists
30 Developing and executing 'C' programs – Implementing a Stack push / pop functions
31 Developing and executing 'C' programs – Implementing a Queue – Insertion / Deletion
32 Practical examination

References

1. Ashok N. Kamthane. 2011. Programming in 'C', 2nd Edition. Pearson Education, New Delhi
2. Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/ Asaf Ali Road, New Delhi
3. Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education, New Delhi
4. Let Us 'C', 2003. Yashwanth Kanethkar, BPB Publications, New Delhi

AEBE 166 Agricultural Informatics and Artificial Intelligence 3(2+1)

Course outlines

Objective

To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision– making processes, etc. and to make students familiar with Agricultural–Informatics, its components and applications in agriculture.

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS–Office for creating, Editing 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 and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e–Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: 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 applications 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, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses 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 and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

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, Handling macros. MS – ACCESS: creating Database, preparing queries and reports, Demonstration of Agri – information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT / Crop–Info/Crop Syst / 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, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction to Computers – Definition, Evolution of computers, Advantages and limitations
2	Anatomy of Computers (with block diagram) – Components of computer and it's functions
3	Overview of Input and output devices of Computer
4	Computer memory concepts – Units of Memory – Primary memory and Secondary memory – RAM – ROM – PROM – EPROM –EAPROM – Cache memory
Unit II	
5	Processors and Speed, Classifications of Computers, Hardware and Software
6	Computer Languages – Machine, Assembly and High – level languages – Algorithm and flow charts
7	Types of Software – Operating system – Translators – interpreters – utility program Application program, General Purpose program – Viruses and Vaccines
8	Operating System (OS) – Functions of OS – Types of OS – DOS and Windows – Booting process
Unit III	
9	WINDOWS: Features of Windows OS, Desktop and its elements, Anatomy of a WINDOW – Title Bar, Minimize, Maximize, Restore and Close Buttons, Scroll Bars, Menus and Tool – Starting and shutting down of WINDOWS. WINDOWS Explorer, working with organization of files and folders, Copy, Move and Print files – setting time and date
10	Introduction to MS – Office and Applications. MS – Word: Features of good word processor. Creating, Editing and Formatting a document
11	MS – Word: Toolbar options, Equation editor, Drop cap, Format Painter, Auto text, Auto correct etc.
12	MS – word: Inserting Table, Mail merging, Macros etc.
Unit IV	
13	MS – Excel: Features, Data presentation, Tabulation, Sorting, Filtering, Merging of cells, etc., Creation of Diagrams and Graphs– pivot Table
14	MS – Excel: Solving of formula expressions through formula toolbar, In–built functions (Sum, Average, Standard deviation, Correlation. etc.)
15	Applications of Data Analysis tools – Introduction to Statistical analysis – Descriptive Statistics, Correlation and Regression
16	MS – Excel: Data Analysis tools – t – test, z– test and ANOVA

Unit V

17 Introduction of Database Management System. Applications of DBMS in Agriculture and other fields

18 Introduction of MS – Access, Objects of MS – Access and types of fields

19 MS – Access: Concepts and creating data base

20 MS – PowerPoint: Creating slides, Layout, Action buttons, Transitions, Animations etc.

Unit VI

21 Networking – Types of networks (LAN,WAN, MAN, EAN etc.,) – networking equipment's and Internet – World Wide Web (WWW) – Concepts

22 Introduction on e – Agriculture – concepts of smart agriculture

23 Application of innovative ways to use information and communication technologies (IT) in Agriculture

24 Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, advantages and limitations

Unit VII

25 Smartphone mobile apps in agriculture for farm advice: Market price, post – harvest management etc.

26 Geospatial technology: Concepts, techniques, components and uses for generating valuable agri – information

27 Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions

28 Preparation of contingent crop planning and crop calendars using IT tools

29 Digital India and schemes to promote digitalization of agriculture in India

Unit VIII

30 Introduction to Artificial Intelligence (AI) – Definition, background and its applications and limitations

31 Use of AI in agriculture for autonomous crop management – Livestock health monitoring – Food and nutrition sciences etc.

32 Introduction and applications of the Internet of Things (IoT) in agriculture and other sectors with examples – Role of Big Data analytics in Agriculture sector

Practical

No. Practical outline

1 Study of computer components, accessories – Booting of computer and its shut down – Practicing Windows operating system – Title bar – Minimum, maximum and close buttons – Scroll bars Menus and tool bars

2 DOS Commands – DATE, TIME, DIR, COPY, PATH, LABEL, VOL, MD, CD, DEL and TREE etc.

3 Windows explorer–creating files and folders, File Management, Control Panel – Taskbar and desktop management – Paint, notepad, wordpad, calculator etc.

4 MS – Word: Menu bar, creating a document, saving and editing etc.

5 MS – Word: Creation of tables, Equation editor, Drop cap, Format Painter, pivot Table, mail merge

6 MS – PowerPoint: Creating slides, editing (Layout, action buttons...etc.) and power point presentation

7 MS – Excel: Creating a spread sheet and data entry– Basic Functions (Mathematical and Statistical) through formula bar and use of in – built functions. Sorting – Filtering and Text to column

8 MS – Excel – RBD Analysis using cell reference

9 MS – Excel: Pivot table, Creating diagrams and graphs, What if analysis etc.

10. MS – Excel: Analysis of scientific data– Data Analysis tools – Descriptive Statistics (Mean, Median, Mode. Etc.), Histogram, Correlation and Regression

11 MS – Excel: Data Analysis tools – Testing of hypothesis (t – test, z – test, F – test), ANOVA one way and ANOVA two – way classification

12 MS – Access: Creating Database by structuring with different types of fields and Creating relationships

13 MS – Access: Preparing queries and report

14 Introduction to World Wide Web (WWW) – Internet concepts – Creating Email – use of Search Engines

15 Use of smart phones and other devices in Agro–advisory and dissemination of market information

16 GIS Applications in Agriculture

References

1. Fundamentals of Computers by V. Rajaraman
2. Introduction to Information Technology by Pearson
3. An Introduction to Database Systems by C. J. Date
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan Satpathy, Wiley India
5. Introductory Agri Informatics by Subrat K. Mahapatra et al., Jain Brothers Publication
6. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, Pearson (2013)
7. Principles of Artificial Intelligence by Nils J. Nilsson, Narosa Publishing House (2001)

AEBE 261 ENGINEERING MECHANICS 3(2+1)

Course outlines

Objective

To make the students acquainted with the principles of engineering mechanics and the calculation of different stresses to be helpful for design of engineering structures.

Theory

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units; Composition and resolution of forces, analytical method, graphical method; Laws of forces, moments and their application, levers, parallel forces and couples; Equilibrium of forces, free body diagrams; Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections; Moment of inertia: methods of finding out M.I., methods of integration, M.I. of different sections, theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction, wedge friction, screw friction, screw jack; Analysis of simple framed structures, methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads; Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, strain related problems, fundamentals of shear force and bending moment, SFD and BMD of cantilever, simply supported and overhanging beams, point of contra-flexture; Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft; Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

Practical

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams and torsion of the shafts; Analysis of plane and complex stresses.

Lecture outlines

Theory

No.	Lecture outline
UNIT I	
1	Basic concepts of Engineering mechanics - Statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units
2	Effects and characteristics of forces - Principles of forces, system of forces
3	Composition and resolution of forces - Analytical method, parallelogram law of forces, method of resolution for resultant force
4	Composition and resolution of forces - Graphical method, laws of forces
UNIT II	
5	Moments - Types of moments, law of moments, applications of moments
6	Introduction to Levers - Types
7	Classification of Parallel forces - Methods for resultant of parallel forces, analytical method
8	Methods for resultant of parallel forces - Graphical method
UNIT III	
9	Couple - Moment of a couple, Classification and characteristics of couples
10	Equilibrium of forces - Principles of equilibrium, Lami's theorem
11	Construction of free body diagrams - Conditions and types of equilibrium
12	Centre of Gravity - C.G by geometrical considerations, C.G by moments
UNIT IV	
13	Axis of reference - Centre of gravity of simple geometrical figures, centre of gravity of plane figures, centre of gravity of symmetrical sections
14	Centre of gravity of unsymmetrical sections
15	Centre of gravity of solid bodies
16	Centre of gravity of sections with cut out holes
UNIT V	
17	Moment of inertia - Methods for finding out moment of inertia, moment of inertia by integration
18	Moment of inertia of different sections - Theorem of perpendicular axes, parallel axes
19	Moment of inertia of a composite section
20	Moment of inertia of a cut out sections
UNIT VI	
21	Frictional forces - Static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction
22	Laws of friction - Equilibrium of a body on a horizontal and inclined plane

23 Applications of friction - Ladder friction, wedge friction.

24 Screw Friction - Screw jack, relation between effort and weight lifted by screw jack, efficiency of a screw jack

UNIT VII

25 Analysis of simple framed structures - Types of frames, analytical methods for the forces, method of sections and joints, force table

26 Types of loads – Analytical method for the reactions of a beam, types of end support of beams, simply supported, hinged and roller support beams

27 Simple stresses and strains - Hooke's law, poisson's ratio, modulus of elasticity, stress-strain relations

28 Fundamentals of shear force and bending moment - Drawing of SFD and BMD of cantilever, simply supported and overhanging beams, point of contra flexture.

UNIT VIII

29 Torsion of circular shaft - Torsional effect, hoop stress, power transmitted by a shaft

30 Principal stresses and strain - Analysis of plane and complex stress

31 Principal planes and principal stresses, Mohr's circle

32 Finding out principal stresses and different analysis

Practical

No.	Practical outline
1	Problems on composition and resolution of forces, moments of a force
2	Problems related to resultant of a concurrent-coplanar force system
3	Problems related to non-concurrent coplanar force system
4	Problems related to centroids or C.G of composite areas
5	Problems on moment of inertia, radius of gyration of composite areas
6	Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system
7	Problems involved with frictions
8	Analysis of simple trusses by methods of joints
9	Analysis of simple trusses by methods of sections
10	Analysis of simple trusses by graphical method
11	Problems on simple stress and strains
12	Problems on shear moment diagrams
13	Problems on bending moment diagrams
14	Problems on stresses on beams
15	Problems on torsion of the shafts
16	Analysis of plane and complex stresses

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2. Khurmi, R.S. 2018. A Text Book of Engineering Mechanics. S. Chand Publishing.
3. Khurmi, R.S. 2006. Strength of Materials. S. Chand Publishing.
4. Prasad, I.B. 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
5. Prasad, I B. 2004. Applied Mechanics. Khanna Publishers, New Delhi.
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AEBE 262 SOIL MECHANICS 2(1+1)

Course outlines

Objective

To make the students acquainted with the principles of soil mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures.

Theory

Introduction to soil mechanics, field and scope of soil mechanics; Phase diagram, physical and index properties of soil, particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit; Classification of soils, effective and neutral stress, Boussinesq and Wester-guard's analysis, New-mark's influence chart, stress distribution and diagrams; Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; 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 of soils, standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control; Consolidation of soils, Terzaghi's theory of one dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method 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 moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of grain size by hydrometer method; Determination of liquid limit by Cassagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by triaxial shear test.

Lecture Outlines

Theory

No. Lecture outline

Unit I

1 Introduction of soil mechanics - Field and scope of soil mechanics

2 Soil on three phase systems - Physical and index properties of soil

Unit II

3 Particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit

4 Classification of soils

Unit III

5 Stress condition in soils - Effective and neutral stress

6 Concept on Bousinesq's analysis - Assumptions, concentrated force, pressure distributiondiagrams, isobars, vertical pressure distribution on a horizontal plane

Unit IV

7 Concept on Bousinesq's analysis - Vertical pressure distribution on vertical line, verticalpressure under a uniformly loaded circular area, equivalent point load method

8 Westerguard's analysis - Comparison between Bousinesq's and Westergaurd's solutions, preparation of Newmark's influence chart

Unit V

9 Shear strength - Mohr's stress circle, theoretical considerations, MohrCoulomb failure theory

10 Shear strength - Effective stress principle, determination of shear parameters by direct shear test, triangle test and vane shear test

Unit VI

11 Compaction, standard and modified protector test, abbot compaction and Jodhpur mini compaction test and field compaction method and control

12 Consolidation of soil - One dimensional analysis spring analogy, Terzaghi's theory

Unit VII

13 Laboratory consolidation test, calculation of void ratio and coefficient of volume change, determination of coefficient of consolidation, Taylor's and Casagrande's method

14 Stability of slopes - Introduction to stability analysis of infinite and finite slopes, friction circle method, Taylor's stability number

Unit VIII

15 Earth pressure - Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure

16 Active and passive earth pressure for cohesive soils

Practical

No.	Practical outline
1	Determination of water content and specific gravity of soil
2	Determination of field density of soil by core cutter methodand sand replacement method
3	Numerical exercises on physical and index properties of soil
4	Grain size analysis by sieving and hydrometer method
5	Determination of liquid limit by Casagrande's method and cone penetrometer, plastic limit and shrinkage limit
6	Numerical exercises on Bousinesqs analysis and Newmark's influence chart
7	Determination of shear parameters by direct shear test
8	Determination of shear parameters by triaxial test
9	Determination of shear parameters by vane shear test
10	Numerical exercises on determination of shear strength, Mohr's stress circle
11	Determination of optimum moisture content of saturated soil by Abbot's compaction test
12	Determination of compaction properties by Standard Proctor test
13	Determination of consolidation properties of soils
14	Numerical exercises on consolidation and compaction
15	Numerical exercises on earth pressure
16	Numerical exercises on stability of slopes

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3. Singh, A. 1994. Soil Engineering. Vol. I. CBS Publishers and Distributions, New Delhi.

AEBE 263 THEORY OF STRUCTURES 2(1+1)

Course outlines

Objective

To make the students acquainted with the principles of structural design and to enable them to design small and medium RCC and steel structures.

Theory

Types of Loads and use of BIS code. Design of steel structures: Specifications, use of IS code (IS 800-2007) and steel table, design of steel sections under tension, compression and bending, use of any one design software such as Staad Pro, ETABS, etc. for design of roof truss. Design of RCC structures: Specifications, use of IS code (IS 456-2000), analysis and design of singly and doubly reinforced sections, design of beams, design of one way and two-way slabs, columns and foundations, design considerations for retaining walls and silos, use of design software for simple RCC structures.

Practical

Design and drawing of steel roof truss including tension member, compression member and member under bending; use of design softwares; Design and drawing of RCC building, including single reinforced beam, double reinforced beam, one-way slab, two-way slabs, columns and foundations; use of design softwares for simple RCC structures.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Types of loads and BIS codes - Loading of a bar, principle of superposition, classification of loaded bar, gradual, sudden, impact and shock loading, tension and compression, axially loaded bar

2 Design of steel structures - Specifications, use of IS code (IS 800-2007) and steel table, Design of Thin cylindrical shells, Failure of thin cylindrical shells, stresses in a thin cylindrical shell, circumferential and longitudinal stress. Design of thick cylindrical shells - Lame's theorem, stress, stress in compound thick cylindrical shells, difference of radii of shrinkage, problems on thick cylindrical shells

Unit II

3 Design of spherical shells, thick spherical shells, problems on thick spherical shells, combined bending and axial thrust, design of steel roof trusses

4 Design of steel sections under tension, compression and bending and use of any one design software such as Staad Pro, ETABS, etc. for design of roof truss

Unit III

5 Analysis and designing of single reinforced sections - Properties of reinforced concrete, advantages, assumptions, modular ratio, equivalent area of R.C.C., stress and strain diagram, neutral axis, moment of resistance, design of rectangular section

6 Analysis of balanced over reinforced and under reinforced sections and related problems

Unit IV

7 Analysis and designing of double reinforced sections - Modular ratio for compression shell equivalent area of steel in compression, neutral axis, moment of resistance, steel beam theory, problems

8 Shear stresses in beams - Shear stress induced in homogeneous and R.C. beams, nominal shear stress, varying depth, effect of shear in R.C. beams, failures and shear resistance of concrete without shear reinforcement

Unit V

9 Design of shear reinforcement, problems - Vertical stirrups and inclined bars - Design of inclined - Vertical stirrups and inclined bars - Design of inclined bars - Critical section for shear, problems

10 Bond and development of length and Curtailment of bars

Unit VI

11 Design of one-way slabs - Loading on slabs, arrangement of reinforcement, problems, design of reinforced brick slabs, problems

12 Design of two-way slabs - Rankine - Grashoff theory, shear force on the edges, design problems, Merco's Method-Torsion reinforcement, load and bending moment problems- slabs with edges fixed

Unit VII

13 Axially loaded columns - Types of columns, effective length of columns, long and short columns, composite columns, basic rules for design of columns, arrangement of transverse reinforcement, problems

14 Foundations - Types of foundations, design criteria-problems

Unit VIII

15 Retaining walls - Earth pressure on a retaining wall, active earth pressure, passive earth pressure-Stability of walls-conditions for stability of retaining walls, problems

16 Silos, circular or cylindrical tanks and design criteria - Permissible stresses in concrete, permissible stresses in steel, base, minimum reinforcement, design, problems - Circular tanks with rigid joints-H. Carpenter's method, problems

Practical

No.	Practical outline
1	Design and drawing of steel roof truss including tension member, compression member and member under bending
2	Use of design software's for design and drawing of steel roof truss
3	Design and drawing of RCC building for single reinforced beam
4	Design and drawing of RCC building for double reinforced beam
5	Design and drawing of RCC building for one-way slab
6	Design and drawing of RCC building for two-way slabsusing Rankine - Grashoff theory
7	Design and drawing of RCC building for two-way slabs using Merco's method
8	Design and drawing of R.C.C. Columns
9	Design and drawing of shear reinforcement
10	Design and drawing of footing
11	Design and drawing of grillage foundation
12	Design and drawing of retaining wall
13	Design and drawing of circular silo
14	Design and drawing of cylindrical silo
15	Use of design software's for simple RCC structures
16	Staad Pro

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AEBE 264 Building Construction and Cost Estimation 2(2+0)

Course outlines

Objective

To make the students acquainted with the methods of construction of agricultural buildings and to enable them to prepare various types of estimates of buildings.

Theory

Building materials: Description of important building materials, rocks, different stones; Formation of stones, types of stones, quarrying process, stone products and uses; Bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades, concrete grades, preparation, mixing and laying of concrete, use of sand; Use of ferrous material, iron and steel products; Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials; Building construction: building components, foundations, brick work, lintels, columns, roofs and stair cases, different types of floors, plastering and pointing, damp proofing and water proofing, white washing, distempering and painting, steps for building construction, needs of different agricultural buildings, types and uses, types of roofs, slope and flat roof buildings; Estimating and costing: types of estimates, rough cost, detailed and supplementary estimate, preparation of cost estimate, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development; Cost economics: measurement and pricing, economic methods for evaluation of buildings, benefit cost calculation, rate of return period (payback period).

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Building materials - Introduction, description of important building materials

2 Rocks, different stones, formation of stones, types of stones, quarrying process, stone products and uses

3 Bricks - Types and their properties, preparation and burning of bricks, properties and uses, Tiles, types and classification

4 Lime - Properties of lime and uses

Unit II

5 Different grades of cement, concrete and its uses, preparation of concrete, mixing and laying of concrete, uses of sand

6 Ferrous material - Iron and steel products, uses

7 Use of non-ferrous metals, glass, rubber, plastics, aluminium, copper, nickel Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials

8 Building components - Types, foundation, brick works, flooring, walls and roof

Unit III

9 Lintels - Components, types of lintels, terminology connected, design criteria

10 Columns and their types

11 Types of floors

12 Stair cases - Types, principles in keeping the stair case and construction procedure

Unit IV

13 Damp proofing and water proofing for floors and slabs, latest additions in DPC, their usage and importance in the building aesthetics and hygiene

14 Plastering and pointing, places of pointing examples, brick pointing, granite masonry pointing, art involved in pointing work and specifications

15 White washing, painting, types of paints, tools and equipment used for white washing and paintings

16 Distempering, distempers used for buildings

Unit V

17 Steps for building construction

18 Agricultural buildings - Types of agricultural buildings

19 Need of agricultural buildings and uses

20 Types of roofs, slope and flat roof buildings

Unit VI

21 Estimating and costing - Types of estimates, rough cost

22 Preliminary estimates - Types, procedure of arriving at final estimate cost

23 Detailed Estimates - Calculation of quantities and abstract estimate

24 Supplementary estimates, preparation of cost estimate

Unit VII

25 Cost analysis, use of cost analysis for controlling design

26 Schedule of rates, analysis of rates

27 Factors affecting building costs

28 Building codes and estate development

Unit VIII

29 Measurement and pricing of buildings

30 Economic methods for evaluation of buildings

31 Benefit cost calculation

32 Calculation of rate of return period (payback period)

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2. Duggal, S.K. 2012. Building material. New Age International Publishers.
3. Sane, Y.S. 1964. Planning and Designing of Buildings. Engineering Book Publishing Co. Pune.
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AEBE 361 Strength of Materials 2(1+1)

Course Outlines

Objectives

To make the students acquainted with the importance of strength parameters of different materials and the techniques to calculate unknown forces in 2D structures

Theory

Introduction to strength of materials Slope and deflection of beams: Slope and deflection of beam using integration techniques, moment area theorems, conjugate beam method, problems of slope and deflection Theory of columns and struts, problems of column and struts Steel connections: Analysis of rivet connections, analysis of welded connections Stability analysis of masonry dam; problems on masonry dam Statically indeterminate structures-analysis of propped beams, analysis of fixed beams, analysis of continuous beams using superimposition and three moment equation Analysis of beam using moment distribution method and solving problems

Practical

To determine the quality of check of two different aggregates through impact test; To perform the tensile test of steel specimen - 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 prepare mortar specimen of different cement, demoulding of the specimen next day for compression and tension test after 2nd and 4th week; To prepare concrete specimen to perform the compression, bending test and to measure elasticity -

concrete cylinders, cubes and beams to test after 2nd and 4th week; To perform compression and tension test on mortar specimen prepared 2 weeks before; To perform compression and bending test of the concrete specimen prepared 2 weeks before; To perform compression and tension test on mortar specimen prepared 4 weeks before; To perform compression and bending test of the concrete specimen prepared 4 weeks before; To determine young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre and quarter points; To perform Brinell's hardness tests on a given specimen; To study the behaviour of materials 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 write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction - Stresses, Tensile, Compressive and Shear- Strains, Units- Elastic Curve, Elastic Limit - Poisson's Ratio Elastic Constants- Young's Modulus (E), Bulk Modulus (K) and Shear Modulus (G) - Relation between them

2 Slope and Deflection equations of a simply supported beam with a central point load

Unit II

3 Slope and Deflection equations of a simply supported beam with an eccentric point

4 Slope and Deflection equations of a Simply supported beam with a uniformly distributed load

Unit III

5 Deflection by moment area method for simply supported beam with a central point load

6 Deflection by conjugate beam method for simply supported beam with a central point load

Unit IV

7 Columns and struts, Euler's column theory ant its assumptions Expression for buckling load of a column with both ends hinged- with both ends fixed Types of end conditions of columns; both ends hinged, both ends fixed, one end fixed and other is hinged & one end fixed and other end is free

8 Types of end conditions of columns; both ends hinged, both ends fixed, one end fixed and other is hinged & one end fixed and another end is free Limitations of Euler's formula- Rankine's formula for columns

Unit V

9 Riveted joints, types of joints- Design of riveted joints, eccentric riveted connections, strength of a rivet and riveted joint-efficiency of a riveted joint

10 Welded joints, types of welded joints- Strength of welded joints, technical terms

Unit VI

11 Design of welded joints, eccentric welded joints

12 Stability of dams, Design of base width of dams

Unit VII

13 Statically indeterminate structures- analysis of propped beams

14 Statically indeterminate structures- analysis of fixed beams

Unit VIII

15 Analysis of continuous beams using superposition and three moment equation

16 Analysis of beam using moment distribution method

Practical

No.	Practical outline
1	To determine the quality of check of two different aggregates through impact test
2	To perform the tensile test of steel specimen - 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
3	To prepare mortar specimen of different cement, demoulding of the specimen next day for compression and tension test after 2nd and 4th week
4	To prepare concrete specimen to perform the compression, bending test and to measure elasticity - concrete cylinders, cubes and beams to test after 2nd and 4th week
5	To perform compression and tension test on mortar specimen prepared 2 weeks before
6	To perform compression and bending test of the concrete specimen prepared 2 weeks before
7	To perform compression and tension test on mortar specimen prepared 4 weeks before
8	To perform compression and bending test of the concrete specimen prepared 4 weeks before
9	To study load deflection and other properties of closely coiled helical spring in tension and compression
10	To determine Young's modules 'E' of beams with the help of deflection produced at centre due to loads placed at centre
11	To determine Young's modules 'E' of beams with the help of deflection produced at centre due to loads placed at quarter point
12	To perform Brinell's hardness tests on a given specimen

13 To study the behaviour of materials under torsion and to evaluate various elastic constants
14 To study load deflection and other physical properties of closely coiled helical spring in tension and compression
15 To write detail report emphasizing engineering importance of performing tension, compression, bending
16 Torsion, impact and hardness tests on the materials

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AEBE 362 Theory of Machines 2(2+0)

Course outlines

Objective

To make the students acquainted with the importance of strength parameters of different materials and the techniques to calculate unknown forces in 2D structures

Theory

Simple mechanism: 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; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth, spur gear, nomenclature; 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, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission, chain drives, classification of chain drive, terms used in chain drive; Types of friction, laws of dry friction; friction of pivots and collars, single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves Sensitiveness, stability, hunting, isochronism, power and effort of a governor; Static and dynamic balancing, balancing of rotating masses in one and different planes.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction to theory of machines – Mechanism, machine, constrained motion and its types, simple mechanism
2	Elements, links, pairs, kinematic chain and mechanisms, classification of pairs and mechanisms, lower and higher pairs
3	Degrees of freedom for planar mechanism – Kutzbach and gruebler's equation and problems
4	Inversions of mechanism - Four bar chain and slider crank chain mechanisms
5	Problems on DOF for mechanisms and inversion of mechanisms
Unit II	
6	Introduction to velocity in mechanism – Method for determining the velocity in mechanism, instantaneous centre method, location of instantaneous centre
7	Determination of velocity using graphical method - Four bar chain mechanism and slider crank mechanism
8	Determination of acceleration using graphical method - Four bar chain mechanism and slider crank mechanism
9	Practice problems on determination of velocity and acceleration using graphical method
Unit III	
10	Introduction to belt drives: Types of drives, belt materials, types of flat belt drives, belt size for flat and V belts
11	Velocity ratio, length of belt drive, slip of the belt, creep of the belt, formula for length of open belt and cross belt drive, power transmitted by a belt and effect of centrifugal tension
12	Problems on flat belt and cross belt drives
13	Chain drives, classification of chain drive, terms used in chain drive
Unit IV	
14	Introduction to gears, types of gears and Nomenclature
15	Law of gearing, velocity of sliding between two teeth in mesh, involute and cycloidal profile for gear teeth
16	Introduction to spur, helical, spiral, bevel and worm gear

17 Gear train - Simple, compound, reverted

18 Epicyclic gear trains - Determining velocity ratio by tabular method and problems

Unit V

19 Introduction to turning moment diagrams - Single cylinder double acting steam engine, turning moment diagram for 4-S internal combustion engine and multi cylinder engine

20 Fluctuation of energy - Determination of maximum fluctuation of energy, coefficient of fluctuation of speed and energy

21 Problems on fluctuation of energy

22 Energy stored in flywheel and its applications

Unit VI

23 Introduction to friction, types of friction, laws of dry friction, friction of pivots and collars

24 Friction on clutches – Cone, single disc and multiple disc clutches, rolling friction

25 Problems on friction on clutches

Unit VII

26 Governors - Types, terms used in governors, centrifugal governors and constructional details

27 Analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves, sensitiveness, stability, hunting, iso-chronism, power and effort of a governor

28 Problems on Watt, Porter and Proell governors

Unit VIII

29 Balancing of rotating masses - single and multiple masses in different planes

30 Analytical and graphical methods for primary, secondary and higher balancing of rotating masses

31 Problems on balancing of rotating masses single using analytical method

32 Problems on balancing of rotating masses multiple using graphical method

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2. Bansal, R.K. 2009. A Text Book of Theory of Machines Laxmi Publications (P) Ltd, New Delhi.
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AEBE 363 Heat and Mass Transfer 3(2+1)

Course outlines

Objective

To make the students acquainted with principles of heat and mass transfer and to make them understand the mathematical and practical aspects of various applications of heat and mass transfer .

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 without heat generation, electrical analogy Critical insulation thickness-insulation materials One dimensional steady state conduction through plane wall, tubes and spheres with internal heat generation; Fins-types of fins, general equation for temperature distribution and rate of heat transfer from fins, effectiveness and efficiency of fins; Unsteady state conduction heat transfer- Newton's law of cooling, Lumped capacitance method, instantaneous and total heat transfer, time constant of thermocouple; Introduction to transient conduction heat transfer using graphical solutions (Gurney-Lurie charts and Heisler charts); Free and forced convection - heat transfer coefficient in convection, non-dimensional numbers, equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, dimensional analysis; Types of heat exchangers- fouling, log mean temperature difference, heat exchanger performance, transfer units, heat exchanger analysis restricted to parallel and counter flow heat exchangers; Thermal radiation, black body radiation, Stefan-Boltzmann law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity; Heat transfer analysis involving conduction, convection and radiation; Radiation heat transfer between parallel plates, shape factor; Introduction to mass transfer-analogy between heat and mass transfer, Fick's law of diffusion, convective mass transfer coefficient, Reynold's, Colburn analogies for heat and mass transfer

Practical

Tutorial on steady state conduction heat transfer on flat plate, composite wall, cylinder and sphere; Determination of thermal conductivity of a metal bar and an insulating powder; Determination of rate of heat transfer in composite slab; Tutorial on critical insulation thickness on cylinder, wire and sphere; Tutorial on temperature distribution and heat transfer from fins, effectiveness and efficiency of fins; Tutorial on unsteady state heat transfer– lumped capacitance methods, time constant of thermocouple; Tutorial on determination of convective heat transfer coefficient in forced and free convection; Tutorial on heat exchanger analysis using LMTD and NTU method; Tutorial on radiation heat transfer; Tutorial on diffusion and convective mass transfer

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Basics of transport processes - Heat, mass and momentum transfer; Concept and modes of heat transfer, basic laws governing heat transfer
2	Heat transfer by conduction, Fourier's law of conduction, thermal conductivity of materials, thermal resistance General one-dimensional steady state conduction heat transfer in cartesian coordinate system
3	One dimensional steady state conduction through plane and composite walls, without internal heat generation and electrical analogy
4	One dimensional steady state conduction through hollow cylinder and sphere without heat generation; Measurement methods of thermal conductivity
Unit II	
5	Concept of Critical insulation thickness - critical insulation for cylinder and sphere; Overall heat transfer coefficient
6	One dimensional steady state conduction through plane wall with internal heat generation with same temperature on both walls and one side insulated
7	One dimensional steady state conduction through plane wall with internal heat generation with different temperatures on both walls
8	One dimensional steady state conduction through solid cylinder with internal heat generation
9	One dimensional steady state conduction through solid sphere with internal heat generation
Unit III	
10	Fins-types of fins, analysis of heat flow through rectangular fins
11	Heat dissipation from an infinitely long fin and from the fin insulated at tip
12	Heat dissipation from a fin losing heat at the tip
13	Concept of fin effectiveness and fin efficiency
Unit IV	
14	Unsteady state conduction heat transfer- applications, unsteady state heat transfer with negligible internal resistance, significance of Biot number and Fourier number
15	Instantaneous and total heat transfer during unsteady state conduction
16	Introduction to the graphical method of solving transient conduction heat transfer using Heisler charts and Gurney-Lurie charts
Unit V	
17	Free and forced convection-heat transfer coefficient in convection, the concept of boundary layer, hydrodynamic and thermal boundary layer, non-dimensional numbers, Reynold's number, Prandtl number, Nusselt number and their significance

18 Empirical correlations for convective heat transfer coefficient for laminar and turbulent flow over flat plates and inside tube

19 Empirical correlations for convective heat transfer coefficient for laminar and turbulent flow over cylinder and sphere

20 Free convection - Grashoff number, empirical correlations for convective heat transfer coefficient over vertical plates and cylinders, horizontal plates and cylinders

21 Dimensional analysis - Rayleigh's method

22 Dimensional analysis - Buckingham's pi-method

Unit VI

23 Heat exchanger definition, applications-types of heat exchangers

24 Thermal analysis of Heat exchanger- Log Mean Temperature difference for a parallel and counter flow heat exchanger, fouling

25 Effectiveness of Heat exchanger- NTU method for parallel flow

26 Effectiveness of Heat exchanger- NTU method for counter flow

Unit VII

27 Radiation heat transfer - Thermal radiations, surface emission properties absorptivity, reflectivity and transmissivity; Concept of black body - Stefen-Boltzmann law, Plank's law, Kirchoff's law, Wein's displacement law, Intensity of radiation and Lambert's cosine law

28 Concept of shape factor and its salient features

29 Heat exchange between non-black bodies, infinite parallel planes

Unit VIII

30 Introduction to mass transfer - Modes of mass transfer, Fick's law of diffusion, steady state equi-molar counter diffusion

31 Steady state diffusion in common geometries, liquids; Mass transfer coefficient and convective mass transfer coefficient

32 Reynold's and Colburn analogies for mass transfer - Combined heat and mass transfer

Practical

No. Practical outline

1 Tutorials on steady state conduction heat transfer on flat plate, composite wall, cylinder and sphere

2 Determination of thermal conductivity of metal bar

3 Determination of thermal conductivity of insulating powder

4 Determination of rate of heat transfer in composite slab

5 Tutorials on critical insulation thickness on cylinder, wire and sphere

6 Tutorials on temperature distribution and heat transfer from fins and effectiveness and efficiency of fins

7 Tutorials on unsteady state heat transfer lumped capacitance methods, time constant of thermocouple

8 Determination of rate of heat transfer in unsteady state

9 Tutorial on determination of convective heat transfer coefficient in forced convection

10 Tutorials on determination of convective heat transfer coefficient in free convection

11 Determination of convective heat transfer coefficient in forced and free convection

12 Tutorials on Heat exchanger analysis using LMTD and NTU method

13 Determination of rate of heat transfer in parallel flow heat exchanger

14 Determination of rate of heat transfer in counter flow heat exchanger

15 Tutorials on radiation heat transfer

16 Tutorials on diffusion and convective mass transfer

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AEBE 364 Sensors, AI and Robotics in Agriculture 3(2+1)

Course outlines

Objective

To enable the student to know the basics and selection of sensors for different agricultural applications, application of artificial intelligence and AI programming techniques, Problem-solving through search and knowledge representation and reasoning with AI and Use of open-source hardware (arduino and raspberry pi); robot programming, controlling algorithm and basics on neural network.

Theory

Sensors Fundamentals: Introduction to sensors and transducers; Need for sensors in the agriculture; Sensor Classification; Units of measurements; Sensor characteristics, Active and passive sensors– static characteristics, dynamic characteristics- first and second order sensors; Photoelectric effect – Photo dielectric effect – Hall effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect – Pyroelectric effect- Magneto mechanical effect (magnetostriction) –Magneto resistive effect Basics of detector materials/ sensor type (Silicon diode, InGaAS- etc) and their characteristics Fundamentals of visual, NIR, IR and FTIR spectroscopy, Remote sensing, data acquisition and their analysis; Training and validation of sensor and its results Sensors in different applications: Occupancy and motion detectors; Position, displacement and level; Velocity and acceleration; Force, strain, and tactile Sensors; Pressure sensors, Temperature, sensors, Optical sensors and electromagnetic wave detector Capacitance sensors; Weather sensors, imaging sensors and their application in agriculture Principle and working of sensors for soil moisture, soil temperature, chlorophyll meter, colour sensor, spectral sensor, temperature sensor, humidity sensor, wind speed, motion sensors, position sensor etc Biosensors, general components of biosensor, biomolecules in biosensors such as enzyme, DNA, antibody, Nanomaterials in biosensors- Quantum dots. Selection of sensors: Introduction to Artificial Intelligence: Overview- foundations, scope, problems, history and approaches of AI Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, AI programming techniques Classical AI, concept of expert system, conflict resolution, multiple rules, forward chaining, backward chaining; Advantages and limitations of AI systems Problem-solving through Search: Forward and backward, state-space, blind, heuristic, problem reduction, alpha-beta pruning, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, bidirectional search, heuristic search, problems and examples Knowledge Representation and Reasoning: Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications Planning: planning as search, partial order planning, construction and use of planning graphs. Robotics: Introduction to Robotics-classification with respect to geometrical configuration (anatomy), selection based on the agriculture application; Hardware for robot, sensors and actuator in robot, control of robot, system interface and integration in robot; Communication- internal and external communications; Fundamentals of microprocessor architecture; Introduction to use of open source hardware (arduino and raspberry pi); robot programming, controlling algorithm basic on neural network; Feedback system, safety sensors; Controlled system and chain type: Serial manipulator and parallel manipulator Components of Industrial robotics-precession of movement resolution, accuracy and repeatability; Dynamic characteristics - speed of motion, load carrying capacity and speed of response Application in Agriculture: Introduction to precision farming tools for implementation of precision agriculture; Application of site-specific management - nutrient management, agrochemicals and fertilizer management, weeds management; Application of drone- pesticides/nutrient spraying, environmental monitoring; Yield monitoring and mapping, soil sampling and analysis; Protected cultivation - smart irrigation system; precision livestock farming, application in food processing; image processing- shape analysis, feature detection and object location; gas and chemical sensor for electronic nose and electronic tongue.

Practical

Identify various sensors viz Proximity sensors, ultrasonic sensors, optical sensors, electro chemical sensors and mechanical sensors; Measurement of displacement, force and pressure using different sensors; Use of load sensor on tractors to predict pulling requirements for ground engaging equipment; Introduction to open source programming languages, advantages and drawbacks of open source programming; Programming in Embedded- C, Concepts of C language; Identify various components in open source hardware (arduino and raspberry pi); Using of open source hardware and program for LED blink; Using of open source hardware and program for buzzer; Measurement of distance using ultrasonic sensor and IR sensor using open source hardware and programs; Experiment using moisture, temperature and relative humidity sensors for automatic irrigation and protected cultivation; Detection based spraying system using ultrasound for spraying operation using opens source hardware by programming with sensor and testing; Detection based spraying system using ultrasound for spraying operation – installation on sprayer unit with actuator/sensor and testing; Learning on open source image processing software for shape analysis and object detection; Learning about the different applications of robots in agriculture; Fabrication and integration of sensors; Visit to robot fabrication facilities/workshop

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction to sensors and transducers - Definitions, differences, working principles and signal conversion methods Overview, need and use cases of sensors in agriculture

2 Sensor classification and units of measurement

3 Sensor characteristics - Static & dynamic characteristics, selection parameters, evaluation of sensor suitability for agricultural tasks

4 Active and passive sensors - Differences with examples and analysis of first and second-order sensor behaviours

Unit II

5 Physical principles of sensors - Principles of photoelectric, photo dielectric, thermoelectric, piezoresistive, piezoelectric, pyroelectric, magnetomechanical, magneto-resistive and Hall effects of sensors

6 Sensor Materials and types - Silicon diodes and InGaAs and their characteristics, material selection criteria

7 Spectroscopy and remote sensing - Principles of visual, NIR, IR, and FTIR spectroscopy, basics of remote sensing with satellites, drones and its use of data acquisition systems

8 Calibration and validation of sensors - Techniques for sensor calibration, model training and validation

Unit III

9 Overview of sensors - Principles and working of motion detection, position, displacement, level, velocity & acceleration, force, strain and tactile sensors and their applications in agriculture

10 Environmental sensors - Temperature, pressure, optical, capacitance, weather& imaging sensors and electromagnetic wave detector and their applications in agriculture

11 Soil moisture sensors - soil moisture, temperature and chlorophyll levels, colour, spectral, humidity and wind speed sensors and its application in agriculture

12 Biosensors - Components including biomolecules like enzymes, DNA, and antibodies, use of nanomaterials such as quantum dots in biosensors and its applications

Unit IV

13 Introduction to Artificial Intelligence (AI)-Basic principles of AI, history, foundations, problems, scope and approaches of AI Overview of AI's role in agriculture

14 AI intelligent agents - Reactive, deliberative, goal driven, utility driven and learning agents and AI programming techniques

15 Classical AI - Concept of expert system, conflict resolution, multiple rules, forward & backward chaining, advantages and limitations of AI systems

16 Overview of search techniques - Forward/backward search, state-space search, blind and heuristic search and problem reduction

17 Techniques like alpha-beta pruning, minimax, bidirectional search, neural and stochastic methods, evolutionary search algorithms

Unit V

18 Knowledge representation in AI - Methods of representing knowledge in AI systems, including predicate logic, situation calculus and description logics, sample applications

19 Logical reasoning and reasoning about objects, relations, events, time, space, and actions

20 Planning as a search, partial order planning, construction and use of planning graphs

Unit VI

21 Basics of robotics and classification - Definition and scope of robotics, classification based on geometrical configuration (anatomy) & overview of robotic applications in agriculture

22 Hardware components of robots - Sensors and their types, actuators

23 Structural components of robot arms, joints and frames

24 Robot control systems - Open-loop vs closed-loop control, feedback systems and their importance, system interfaces for robotics, communication types

Unit VII

25 Fundamentals of microprocessor architecture, introduction to arduino and raspberry Pi for robotics projects

26 Basics of robot programming languages, examples of agricultural automation using open-source hardware

27 Controlling algorithms based on neural networks, safety sensors and feedback system

28 Components of industrial robotics - Precision, resolution, accuracy and repeatability, dynamic characteristics such as speed, load capacity and response time

Unit VIII

29 Precision Farming - Introduction to precision farming tools, role of robotics and AI in precision farming, including soil sampling and analysis, site specific management for nutrient, weeds, chemical and fertilizer management, yield monitoring and mapping.

30 Drones - Construction and working use of drones for agricultural applications such as pesticide/nutrient spraying, crop monitoring and soil health assessment

31 Protected cultivation - Robots used for smart irrigation systems, soil sampling, precision livestock farming

32 Application of image processing and robotics in agricultural tasks like shape analysis, feature & object detection and automated sorting in food processing

Practical

No.	Practical outline
1	Identify various sensors (proximity, ultrasonic, optical, electro-chemical, mechanical) and test their working principles
2	Identify various sensors (proximity, ultrasonic, optical, electrochemical, mechanical) and test their working principles
3	Measurement of linear displacement using a potentiometer and LVDT
4	Measurement of force and pressure using strain gauges or piezoelectric sensors
5	Predicting of pulling force requirement of ground engaging equipment by using load cells on tractor
6	Identify components and set up an Arduino/Raspberry Pi environment
7	Programming and testing LED blinking using arduino hardware
8	Buzzer control using arduino hardware
9	Distance measurement using ultrasonic sensor and arduino
10	Measurement of distance using an IR sensor
11	Measurement of soil moisture and control a water pump automatically
12	Temperature and humidity monitoring using DHT11/22 sensors for protected cultivation
13	Study of detection-based spraying system for crop spraying using ultrasonic sensors
14	Installation and testing of detection-based spraying system mounted on sprayer unit with actuators/sensors
15	Shape analysis and object detection using open-source image processing software (OpenCV)
16	Visit of Robot fabrication facilities/workshop

References

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AEBE 365 Agricultural Structures and Environment Control 3(2+1)

Lecture outlines

Objective

To make the students acquainted with the different types of agricultural structures and to enable them to prepare plan and estimate for different farm structures and environment control measures.

Theory

Farm and farmstead, farmstead planning and lay out; Environmental control- scope, importance and need, physiological reaction of livestock, environmental control, systems and design, control of temperature, humidity and air ventilation; BIS standards for dairy, piggery and other farm structures;

Farm structures- design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, farm fencing, implement shed, barn for cows, buffalo, poultry etc.; Greenhouses - types, poly houses /shade nets, cladding materials, plant environment interactions, design and construction of greenhouses, site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating systems.

Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins; Storage of seeds;

Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation; Sewage system and design, maintenance, septic tank for small family;

Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practical

Measurement of environmental parameters, Temp, RH, wind velocity, cooling load; Design and layout of a dairy farm; Design and layout of a poultry house; Design and layout of a goat/sheep house; Design and layout of a farm fencing system; Design and layout of a feed/fodder system; Design and layout of a greenhouse; Design and layout of a grain storage structure; Design and layout of a bag storage structure; Performance of domestic storage structure; Design layout of a threshing floor.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Farm and farmstead, farmstead planning and layout
2	Environmental control- scope, importance and need, physiological reaction of livestock
3	Environmental control systems and their design – Temperature, humidity and air ventilation
4	BIS standards for dairy, piggery and other farm structures
Unit II	
5	Design, construction and cost estimation of farm structures
6	Design, construction and cost estimation of animal shelters – Dairy barn for cows
7	Design, construction and cost estimation of animal shelters – Dairy barn for buffalo
8	Design, construction and cost estimation of animal shelters – Poultry houses
Unit III	
9	Design, construction and cost estimation of compost pit, fodder silo
10	Farm fencing - Types, design, construction and cost estimation
11	Design, construction, requirements and cost estimation of implement shed
12	Greenhouses – Types based on shape, utility, construction and covering materials
Unit IV	
13	Shade nets; cladding materials for greenhouses
14	Plant environment interactions – Light, air, temperature, soil, water, relative humidity and wind
15	Design and construction of greenhouses – site selection, orientation, ventilation requirement using exhaust fan system, selection of equipment

16 Greenhouse cooling systems for active summer and winter – Fan and pad cooling system, fog cooling system, convection tube cooling and horizontal air flow cooling

Unit V

17 Greenhouse heating systems – Unit heaters, central heating system, radiation heating system and Solar heating system

18 Grain storage structure – grain storage methods, moisture and temperature changes in grain bins

19 Traditional storage structures, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin)

20 Design considerations for grain storage go-downs

Unit VI

21 Design considerations for bag storage structures

22 Shallow and deep bins – calculation of pressure in bins

23 Storage of seeds – Purpose and stages of seed storage, factors affecting seed longevity in storage, general principles of seed storage

24 Rural housing and development; Farm roads – Types of roads, construction methods, repair and maintenance of rural roads

Unit VII

25 Water supply and sanitation – sources of water supply for human beings and animals, drinking water standards

26 Water treatment methods for rural community – Screening, plain sedimentation, sedimentation aided with coagulation

27 Filtration – Types of filters

28 Site selection and orientation of buildings for sanitation – Principles of sanitation and factors

Unit VIII

29 Design and maintenance of sewage system

30 Design of septic tank for small family

31 Estimate of domestic power requirement

32 Sources of power supply and electrification for rural housing

Practical

No.	Practical outline
1	Measurement of environmental parameters – Temperature
2	Measurement of environmental parameters – RH, wind velocity
3	Tutorials on cooling load calculations
4	Design and layout of a dairy farm

5 Design and layout of a poultry house
6 Design and layout of a goat house/sheep house
7 Design and layout of a farm fencing system
8 Design and layout of a feed/fodder system
9 Design and layout of a greenhouse
10 Design and layout of a grain storage structure (Bulk storage)
11 Design and layout of a bag storage structure (Go down storage)
12 Study and performance evaluation of domestic storage structure
13 Design layout of a threshing floor
14 Visit to Grain storage structures
15 Visit to Dairy farm
16 Visit to Poultry house

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AEBE 366 Thermodynamics, Refrigeration and Air Conditioning 3(2+1)

Course outlines

Objective

To make the students acquainted with the principles of refrigeration, different types of refrigerating equipment and to enable them to design the refrigeration and air conditioning systems.

Theory

Basic concepts and definitions of thermodynamics-statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems, thermodynamic equilibrium; Properties of systems- state, path, process, cycle, point function, path function; Temperature and zeroth law of thermodynamics; Pressure, specific volume, density, energy, work and heat; First law of thermodynamics- internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process; energy-a property of system, perpetual motion machine of the first kind-PMM1; Characteristic equation of state, specific heats; application of first law of thermodynamics to non-flow or closed system; free expansion and throttling process; Second law of thermodynamics-limitations of first law of thermodynamics and introduction to second law, Clausius statement, Kelvin-Planck statement; perpetual motion machine of the second kind-PMM2; Clausius inequality, Carnot

Cycle, Carnot's Theorem; Entropy- entropy changes for a closed system; Definition of pure substance, phases of a pure substance, phase change process of a pure substances; Compressed liquid and saturated liquid, saturated vapour and superheated vapour, saturated temperature and saturated pressure; T-V diagram for heating of water at constant pressure; Latent heat - latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve, property diagram for phase change process-T-V diagram, P-V diagram, P-T diagram; property tables, liquid and vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid; Principles of refrigeration-units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; Vapour compression refrigeration-mechanism, P-V, T-S,P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling; Vapour absorption refrigeration system; Common refrigerants and their properties; 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 processes; Air conditioning- principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, factors considered for designing an air conditioning system; Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants; Calculation of refrigeration load and cold storage design considerations.

Practical

Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration; Solving problems on air refrigeration cycle; Solving problems on vapour compression refrigeration cycle; Study of domestic water cooler; Study of domestic household refrigerator; Study of vapour absorption refrigeration system; Study of cooling tower and to find its efficiency; Study of heat pump test rig; Study of Ice plant test rig; Study of psychrometric chart, processes and problems; Study of window air conditioner; Study of cold storage for fruit and vegetables, freezing load and time calculations for food materials;

Study on repair and maintenance of refrigeration and air-conditioning systems; Visit to a chilling or ice making and cold storage plants.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view, thermodynamic systems and equilibrium
2	Properties of systems; state, path, process, cycle; point function, path function; temperature and zeroth law of thermodynamics; pressure, specific volume, density, energy, work and heat, specific heats, ratio of specific heats
3	First law of thermodynamics - internal energy, law of conservation of energy, property of system, perpetual motion machine of the first kind-PMM1, characteristic equation of state, application of first law of thermodynamics to non-flow or closed system and expressions for work done during isochoric, isothermal, processes
4	Expressions for work done during adiabatic, polytropic processes, free expansion & throttling process
Unit II	
5	Introduction to second law of thermodynamics - Clausius statement, KelvinPlanck statement, perpetual motion machine of the second kind-PMM2, performance of heat engines and reversed heat engines
6	Carnot cycle, Carnot theorem, Classius inequality
7	Concept of entropy and entropy changes in the closed system
8	Definition of pure substance, phases of a pure substance, phase change process of pure substances: P-T (pressure- temperature) diagram for a pure substance. P-VT (pressure-volume-temperature) surface; Phase change terminology and definitions. Property diagrams in common use-T-V, P-V and P-T diagrams
Unit III	
9	Formation of steam - Important terms relating steam formation, thermodynamic properties of steam and steam tables
10	External work done during evaporation, internal latent heat; internal energy of steam. Entropy of water, evaporation, wet steam and superheated steam; Enthalpy-entropy (h-s) chart or Mollier diagram.
11	Principles of refrigeration, units, terminology, production of low temperatures, sensible cooling using a cold medium, endothermic mixing, phase change processes, throttling expansion of a liquid with flashing, reversible adiabatic expansion of a gas, thermoelectric cooling, adiabatic demagnetization

12 Air refrigerators working on reverse carnot cycle, Bell-Coleman cycle and CoP of Bell-Coleman cycle

Unit IV

13 Types of air refrigeration systems - Simple air cooling, simple evaporative air cooling, Bootstrap air, evaporative, reduced ambient and regenerative air cooling

14 Vapour compression refrigeration (VCR) - Mechanism, functional parts, P-V, TS, P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling

15 Classification of compressors - Reciprocating, rotary, diaphragm, lobe, screw, vane, centrifugal

16 Types of expansion valves - Variable restriction type, automatic expansion, thermal expansion valve and constant restriction type-capillary type

Unit V

17 Classification of condensers

18 Types of evaporators used in VCR system

19 Vapour absorption refrigeration (VAR) system - Functional parts, simple VAR and practical VAR system, advantages of VAR system over VCR

20 Expression for maximum coefficient of performance in VAR system

Unit VI

21 Common refrigerants and their properties and nomenclature of refrigerants

22 Domestic Electrolux refrigerator

23 Thermodynamic properties of moist air, psychrometric relations, adiabatic saturation process, wet bulb temperature and its measurement

24 Psychometric chart and its uses

Unit VII

25 Elementary psychometric processes - Mixing of air streams, Sensible heating, sensible cooling, cooling and humidification, cooling and dehumidification, heating and humidification and heating and dehumidification

26 Comfort conditioning, factors affecting human comfort, physiological conditions in air conditioning, modified comfort chart, inside and outside summer design conditions

27 Air conditioning - Principles, type and functions of air conditioning, equipment used in air conditioning systems, summer, winter and all-round year air conditioning

28 Classification of ducts - Design of ducts, continuity equation, Bernoulli’s equation and pressure loss equation for ducts, equivalent diameter of a circular duct, dynamic losses in ducts, pressure loss due to enlargement in area and contraction in area, pressure loss due to obstruction

Unit VIII

29 Components of cooling load calculations, room ratio line, sensible heat factor, by-pass factor

30 Cold storage plant, design and considerations

31 Applications of refrigeration and air conditioning - Domestic refrigerator, freezer, window air conditioner, water cooler

32 Applications of refrigeration and air conditioning - Refrigerated trucks, marine air conditioning, ice manufacturing, cooling of milk, cooling and heating of foods

Practical

No.	**Practical outline**
1	Tutorials on 1st law of thermodynamics using PV charts
2	Tutorials on 2nd law of thermodynamics, carnot cycle
3	Tutorials on entropy
4	Enthalpy-entropy (h-s) chart or Mollier diagram.
5	Tutorials on Bell Coleman cycle
6	Tutorials on vapour compression refrigeration cycle
7	Study of domestic water cooler
8	Study of domestic household refrigerator
9	Tutorials on vapour absorption refrigeration cycle
10	Tutorials using psychrometric chart
11	Tutorials on psychrometric processes
12	Tutorials on air conditioning system
13	Study on window/split air conditioning system
14	Tutorials on design of cold storage
15	Tutorials on design of cold storage
16	Visit to cold storage/chilling centre/ripening chamber

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AEBE 461 Engineering Graphics and Design 2(0+2)

Course outlines

Objective

1. To acquaint the students with CAD software's for drawing of machine components
2. To integrate the computers at various levels of planning and manufacturing

Practical

Application of computers for design; CAD - Introduction, overview of CAD window; Various options on drawing screen; Practice on draw and dimension tool bar; Practice on OSNAP, line thickness and format tool bar; Practice on mirror, offset; Practice on array commands; Practice on trim, extend; Practice on trim chamfer and fillet commands; Practice on copy, move, scale and rotate commands; Drawing of 2D- 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; Drawing of foot step bearing, 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 lift, sweep and press pull, revolving, joining; Demonstration on CNC machine and practice problems.

Note: CAD Software's are Auto CAD, CATIA and Solid works

Practical

No.	Practical outline
1	Introduction to CAD and application of computers for design
2	Overview of CAD window – Explanation of various toolbars on drawing screen
3	Study of draw tool bar, dimension and dimensional editing tool bar and practice on draw and dimension tool bars
4	Study on operational tool bar – Line thickness, mirror, offset, mirror, array tool, trim, extend, chamfer and fillet commands, copy, move, scale and rotate
5	2D Drawing–I, create a 2D view of the given diagram using CAD Software
6	2D Drawing–2, create a 2D view of the given diagram using CAD Software
7	2D Drawing–3, create a 2D view of the given diagram using CAD Software
8	2D Drawing–4, create a 2D view of the given diagram using CAD Software
9	Study on drafting - Creating boundary, region, hatch and gradient commands, dimensions, allowance, setting of view ports for sketched drawings; Printing of selected view ports in various paper sizes
10	2D Drafting–1, Create a 2D view of the given diagram using tools in CAD Software
11	2D Drafting–2, Create a 2D view of the given diagram using tools in CAD Software
12	2D Drafting–3, Create a 2D view of the given diagram using tools in CAD Software
13	Sectioning of foot step bearing using drafting in CAD Software
14	Sectioning of Stuffing box using drafting in CAD Software
15	Study and practice on 3-D tools - Extrusion, lift, sweep, press pull and revolving
16	3D Modeling–1, Create a 3D view of the V Block using tools in CAD software
17	3D Modeling–2, Create a 3D view of the Open bearing using CAD software
18	3D Modeling–3, Create a 3D view of the Angular block using CAD software

19 3D Modeling–4, Create a 3D view of the Dove tail Bracket using CAD software
20 3D Modeling–5, Create a 3D view of the Tool post using CAD software
21 3D Modeling–6, Create a 3D view of the Piston using CAD software
22 Joining - assembly - Preparation of foot step bearing joint using CAD software
23 Joining - assembly - Preparation of knuckle joint using CAD software
24 Demonstration on CNC machine and Practice problems
25 CNC system components and computer hardware for CNC
26 Manual part programming & machining using auto cad for CNC turning
27 Manual part programming using auto cad for CNC milling
28 Real-time modeling-1, preparation of agricultural tool/implement using CAD software
29 Real-time modeling-2, preparation of agricultural tool/implement using CAD software
30 Real-time modeling-3, preparation of agricultural tool/implement using CAD software
31 Real-time modeling-4, preparation of agricultural tool/implement using CAD software
32 Real-time modeling-5, preparation of agricultural tool/implement using CAD software

References

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AEBE 462 Machine Design 2 (2+0)

Course outlines

Objective

To make the students acquainted with design considerations for various machine components so as to enable them to take up the work of new design.

Theory

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; Design of shafts under torsion and combined bending and torsion; Design of keys; Design of muff, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of welded subjected to static loads; Design of helical and leaf springs; Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading; Design of flat belt and V-belt drives and pulleys; Design of gears; Selection of anti-friction bearings.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Machine design - Definition, classification of machine design, design considerations, general procedure in machine design

2 Engineering materials - Classification, selection of metals, physical and mechanical properties of metals

3 Simple stress in machine parts - Introduction, load, stress, strain, tensile stress and strain, compressive stress and strain

4 Simple stress in machine parts - Young's modulus, shear stress and strain, shear modulus, bearing stress

Unit II

5 Stress-strain diagram, working stress, factor of safety and selection, stresses in composite bars, thermal stresses

6 Linear and lateral strain, Poisson's ration, volumetric strain, bulk modulus and relations, impact stress, resilience

7 Principal stresses and principal planes - Theories of failure under static load, Rankine's theory

8 Principal stresses and principal planes - Guest's theory, maximum distortion theory, stress concentration, notch sensitivity

Unit III

9 Shafts - Introduction, material used for shafts, types and sizes of shafts, stresses in shafts, maximum working stresses

10 Design of shaft subjected to twisting moment and numerical

11 Design of shaft subjected to bending moment only, numerical on design of shaft subjected to bending moment

12 Design of shaft subjected to combined twisting and bending loads, numerical on design of shaft subjected to combined twisting and bending moment

Unit IV

13 Keys and coupling - Introduction, types of keys, sunk keys, saddle keys, tangent keys, round keys, splines

14 Keys and coupling - Forces acting on sunk keys, strength of sunk key

15 Effect of key ways, shaft couplings, numerical on design of keys

16 Introduction and types of cotter joints

Unit V

17 Design procedure of cotter joint

18 Numerical on design of cotter joint

19 Introduction and applications of knuckle joint

20 Design procedure of knuckle joint

Unit VI

21 Numerical on design of knuckle joint

22 Welded joints - Advantages, welding processes, types of welded joints, strength of transverse and parallel fillet welded joints

23 Springs - Introduction, types of springs, material for helical springs, spring wire, terminology

24 Springs in series and parallel, numerical on helical springs

Unit VII

25 Leaf spring - Constructional details, design of leaf spring, materials for leaf spring

26 Numerical on design of leaf spring

27 Power screws - Types of screw threads, torque required to raise the load by square threaded screw, numerical

28 Torque required to lower the load by square threaded screw, efficiency of square threaded screw, numerical

Unit VIII

29 Introduction to V-belts and pulleys - Types, design of flat belt

30 Design of V-belt drives and design of pulleys

31 Introduction to gears - Gear terminology, design of spur gear

32 Introduction to bearings - Classification of bearings, selection of anti-frictional bearings

References

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2. Jain, R. K. 2013. *Machine Design*. Khanna Publishers, 2-B Nath Market, NaiSarak, New Delhi.
3. Bhandari, V. B. 2007. *Introduction to Machine Design*.Tata Mc. Graw Hill Publishing House. New Delhi.
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AEBE 463 Electrical Machines 3(2+1)

Course outlines

Objective

To make the students acquainted with operating principles of various electrical motors and other machines and to help them gain practical exposure of different electrical devices and their controls.

Theory

Introduction to electrical machines; Basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor, 1-phase induction motor, 3-phase induction motor, and BLDC motor; Magnetic circuit: concept of magnetic flux production, magneto 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/ load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests; D.C. machines: principles operation and performance of DC machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control

Three phase induction motor: construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition. phasor diagram, starting and speed control methods; Single phase induction motor: principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split, shaded pole motors, performance characteristics

Practical

To study different parts of DC/AC machines; To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters; To perform short circuit test on a single phase transformer and hence find copper loss, equivalent circuit parameters, voltage regulation and efficiency; To study how to start the D.C motor using 3point Starter; To start and run the D.C. motor (shunt, series & compound); To control the speed of DC shunt motor using flux control method; To control the speed of DC shunt motor using armature voltage control method; To conduct brake test on DC shunt motor and to determine its performance curves; To obtain the load characteristics of DC shunt motor and draw its characteristics; To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection; To perform no load test on 3-phase induction motor and to determine its no-load losses; To perform blocked-rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters & to draw the circle diagram; To perform no load on1-phase induction motor to determine its no-load losses; To perform blocked rotor test on 1-phase induction motor & to determine the parameters of equivalent circuit on the basis of double revolving field theory; To perform load-test on1-phase induction motor & plot torque-speed characteristic.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Introduction to electrical machines, basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor, 1-phase induction motor, 3-phase induction motor, and BLDC motor
2. Magnetic circuit - Concept of magnetic flux production, electromotive forces, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits
3. Hysteresis - Area of hysteresis loop, Steinmetz formula for hysteresis loss
4. Eddy current losses, Steinmetz formula for eddy current loss

Unit II

5. Single – phase transformer, principle of working, construction, EMF equation
6. Ideal transformer characteristics, phasor diagrams of 1-Phase transformer no load and on load
7. Leakage reactance, equivalent circuits, voltage regulation, losses in transformer
8. Power efficiency, condition for maximum power efficiency and energy efficiency

Unit III

9. Open circuit and short circuit tests in 1-Phase transformer
10. D.C. machines - DC Generator, principles, operation and construction of DC generator
11. EMF equation, armature winding, lap winding, wave winding, terms used in armature winding
12. Excitation of DC generator - Shunt generator, series generator and compound generator

Unit IV

13. Characteristics of DC, separately excited, shunt, series and compound generators
14. Conditions of a self-excited DC generator failing to build up voltage
15. Losses in DC generator, efficiency of DC generator and applications of DC generator
16. DC Machine - DC motor working principle, construction, back EMF, voltage equation

Unit V

17. Torque, armature torque, shaft torque and their equations, efficiency of DC motor
18. DC motor characteristics - Characteristics of DC, series, shunt and compound motors

19. Starters - Necessity of a starter for DC motor, 3-point starter, 4-point starter
20. Speed control methods - Field control, armature control and voltage control method

Unit VI

21. Three phase induction motor - Construction, operation, rotating magnetic fields
22. Types of three phase induction motor - Squirrel cage and phase wound rotor
23. Concept of slip - Slip speed and slip frequency, torque equation of 3 -phase induction motor
24. Torque - Speed and torque, slip characteristics, maximum torque for starting and running condition of 3-phase induction motor

Unit VII

25. Phasor diagram of 3-phase induction motor
26. Starting - DOL starter, star delta starter and auto transformer starter
27. Speed control methods – Control from stator side and control from rotor side
28. Applied voltage, rotor rheostat control

Unit VIII

29. Single phase induction motor principle of operation and construction
30. Double field revolving theory operation of single-phase induction motor
31. Types of single-phase induction motor, equivalent circuit of single-phase induction motor
32. Performance characteristics of single-phase induction motor, starting methodsof single-phase induction motor, phase split, shaded pole motors

Practical

No. Practical outline

1. To study different parts of DC/AC machines
2. To perform open circuit test on a single-phase transformer and determine its iron loss as well as open circuit parameters
3. To perform short circuit test on a single-phase transformer and hence find copper loss, equivalent circuit parameters, voltage regulation and efficiency
4. To study starting of the D.C motor using 3-point Starter
5. To start and run the D.C. motor (shunt, series & compound)
6. To control the speed of DC shunt motor using flux control method
7. To control the speed of DC shunt motor using armature voltage control method
8. To conduct brake test on DC shunt motor and to determine its performance curves
9. To obtain the load characteristics of DC shunt motor and draw its characteristics
10. To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection
11. To perform no load test on 3-phase induction motor and to determine its no-load losses

12. To perform blocked - rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters & to draw the circle diagram
13. To perform no load on1- phase induction motor to determine its no-load losses
14. To perform blocked rotor test on 1- phase induction motor
15. To determine the parameters of equivalent circuit on the basis of double revolving field theory
16. To perform load - test on 1-phase induction motor & plot torque - speed characteristic

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DEPARTMENT OF AGRICULTURAL SCIENCES

AEAS 171 Crop Production and Protection Technologies 4(3+1)

Course outlines

Objective

To enable the students to have basic idea on crop production and protection practices to understand the domain of agricultural sciences and to have an idea of the different types of machineries/ equipment that can be adopted for these operations

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; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture. Soil – water – plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping.

Soil forming processes; Classification and composition of soil, 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 of irrigation water.

Essential plants nutrients – their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility.

Types of horticultural crops; Sowing and planting times and methods; Seed rate and seed treatment for vegetable crops; Macro and micro propagation methods; Types of plant growing structures; Pruning and training; Water requirements and critical stages; Management of orchard; Major pests and diseases of horticultural crops and their management.

Practical

Identification of crops and their varieties, seeds and weeds; Study of different fertilizer application methods and weed control methods; Judging the maturity time for harvesting of crop; Study of seed viability and germination test; Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Identification and description of important fruits, flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); Seed extraction techniques; Visit to commercial greenhouse / polyhouse.

Lecture outlines

Theory

No.		Lecture outline
Unit I		
1	AGRO	Meaning and scope of Agronomy – History of agriculture development in ancient India agriculture in civilization era
2	AGRO	Classification of crops: Classification of field crops – according to origin, botanical, commercial, economical, seasonal, ontogeny, agronomic, leaf morphology and special purpose crops
3	AGRO	Definition of climate and weather – composition and structure of atmosphere
4	AGRO	Influence of weather parameters on crop growth and development
5	AGRO	Tillage and Tilth – objectives of tillage, characteristics of good seed bed and effect of tillage on soil properties (pore space, texture, bulk density, colour of the soil)
6	AGRO	Crop seasons – sowing – methods, time and depth of sowing of major field crops
Unit II		
7	AGRO	Methods and time of application of manures and fertilizers, fertigation
8	AGRO	Natural farming: definition – concept – objective and principles of natural farming – status of natural farming in World and India
9	AGRO	Organic farming – definition – principles – relevance to modern agriculture – Sustainable agriculture – definition – principles and current status of sustainable agriculture in India
10	AGRO	Soil – water relations – physical properties of soil viz., depth, soil texture, soil structure, particle density, bulk density and porosity influencing water retention, movement and availability
11	AGRO	Soil moisture constants – saturation – Field capacity (FC) – Permanent Wilting Point (PWP) – Available Soil Moisture (ASM) – hygroscopic coefficient
12	AGRO	Plant – water relationships – rooting characteristics – effective root zone depth – moisture extraction pattern – water requirement of crops and critical stages for irrigation

Unit III

13	AGRO	Weed – definition – importance – harmful and beneficial effects of weeds – classification of weeds
14	AGRO	Weed management – physical, mechanical, cultural, biological and chemical methods – Integrated weed management (IWM)
15	AGRO	Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping
16	SSAC	Soil forming processes: Elluviation – illuviation – humification – calcification – laterization – podzolization – salinization – alkalization and gleization
17	SSAC	Classification of soils – soil taxonomy – soil orders and their characteristics
18	SSAC	Soil physical properties – soil structure – definition – classification based on type, class and grade – importance and management of soil structure

Unit IV

19	SSAC	Soil texture – definition – particle size distribution – textural classes – methods of determination of soil texture – importance of soil texture
20	SSAC	Soil colloids – definition – inorganic and organic colloids – general properties – their composition – origin of charge on colloids
21	SSAC	Soil inorganic colloids / Secondary clay minerals – properties of Kaolinite, Montmorillonite and Illite
22	SSAC	Ion exchange in soil: Cation and Anion exchange – factors influencing ion exchange capacity of soils – importance of ion exchange– calculation of base saturation and exchange acidity and nutrient availability
23	SSAC	Soil organic matter – its composition and decomposition its importance effect on soil fertility
24	SSAC	Soil reaction, factors affecting pH of soil – influence of soil reaction on nutrient availability

Unit V

25	SSAC	Acid soils – Formation – characteristics & nutrient availability– reclamation – Lime requirement
26	SSAC	Saline soils – sodic/alkali soils – characteristics – formation and nutrient availability – Reclamation – gypsum requirement for reclamation of sodic/ alkali soils
27	SSAC	Quality of irrigation water – classification based on EC, SAR, Cl, RSC and Boron content – Use of saline and sodic water for crop production
28	SSAC	Essential plant nutrients – Arnon's criteria of essentiality – Nitrogen – Functions and deficiency symptoms in plants
29	SSAC	Phosphorus Potassium and Calcium – Their functions and deficiency symptoms in plants
30	SSAC	Magnesium, Sulphur, Zinc and Iron – Their functions and deficiency symptoms in plants

Unit VI

31	SSAC	Manganese Copper, Boron and Molybdenum – Their functions and deficiency symptoms in plants
32	SSAC	Soil fertility and productivity – definition and concepts – factors influencing availability of nutrients – deficiency symptoms of nutrients
33	SSAC	Inorganic chemical fertilizers – classification – and their reactions in soils
34	SSAC	Gypsum requirement for reclamation of sodic soils and neutralizing RSC
35	SSAC	Liquid fertilizers and their solubility and compatibility
36	SSAC	Beneficial soil microorganisms – Bio fertilizers and their use

Unit VII

37	HORT	Climate and soil requirements for horticultural crops – influence of environmental factors on horticultural crop production – temperature, humidity, wind, rainfall and solar radiation – influence of soil factors – soil type, pH
38	HORT	Principles of orchard establishment – points to be kept in mind while selecting site for the establishment of orchards – principles and steps in orchard establishment – layout of orchards – systems of planting – square, rectangle, quincunx, hexagonal and contour systems of planting – their merits and demerits
39	HORT	Plant propagation – methods – sexual and asexual – asexual method of propagation – cuttings – definition of cutting – stem cuttings – leaf cuttings – layering – propagating structures – separation, division – separation – method of division – bulbs and corms
40	HORT	Plant propagation – methods – sexual and asexual – asexual method of propagation – cuttings – definition of cutting – stem cuttings – leaf cuttings – layering – propagating structures – separation, division – separation – method of division – bulbs and corms
41	HORT	Grafting, budding – rootstock and scion selection – grafting methods – attached scion methods of grafting, simple or approach grafting, detached scion methods of grafting (side grafting, veneer grafting, epicotyl grafting, top working), budding – methods of budding, T – budding, inverted T – budding and patch budding
42	HORT	Seed rate – seed treatment and nursery raising for vegetable crops – Tomato, Chilli, Brinjal, Potato, Bhendi, Cucumber, Bitter gourd, Bottle gourd, Ridge gourd

Unit VIII

43	HORT	Plant growing structures – greenhouse, lath house, hotbed and cold frame
44	HORT	Principles and methods of training and pruning – definition of training, objectives and training, principles and methods of training of fruit crops – open centre, closed centre and modified leader systems their merits and demerits – definition of pruning, objectives of pruning, principles and methods of pruning of fruit crops

45	HORT	Irrigation methods in horticulture crops – different methods followed in horticultural crops (flood, basin, check basin, ring basin, furrow, pitcher, funnel, drip, sprinkler, bubbler etc.)
46	HORT	Pests and diseases and their management of Mango, Banana, Citrus, Grape and Papaya
47	HORT	Pests and diseases and their management of Tomato, Brinjal, Chilli, Bhendi, Cole crops and Cucurbitaceous crops
48	HORT	Pests and diseases and their management of Rose, Chrysanthemum, Marigold and Jasmine

Practical

No.		Practical outline
1	AGRO	Identification of crops and their varieties, seeds and weeds
2	AGRO	Study of different fertilizer application methods and weed control methods
3	AGRO	Identification of maturity symptoms of different crops
4	AGRO	Study of seed viability and germination test
5	SSAC	Identification of rocks and minerals
6	SSAC	Observation of soil profile in the field and collection of soil sample
7	SSAC	Determination of bulk density, particle density and porosity of soil
8	SSAC	Determination of organic carbon of soil
9	SSAC	Identification of nutrient deficiency symptoms of crops in the field
10	SSAC	Determination of gypsum requirement of sodic soil or alkali soil
11	HORT	Identification and description of important fruits, flowers and vegetables crops
12	HORT	Study of different garden tools
13	HORT	Preparation of nursery beds, seed extraction and seed sowing techniques
14	HORT	Practices of pruning and training in some important fruit crops
15	HORT	Study of intercultural operations for vegetable crops
16	HORT	Visit to commercial greenhouse / polyhouse

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AEAS 172 Environmental Studies and Disaster Management 3(2+1)

Course outlines

Objective

To expose and acquire knowledge on the environment and to gain the state –of – the – art – skill and expertise on management of disasters.

Theory

Introduction to Environment – Environmental studies - Definition, scope and importance – Multidisciplinary nature of environmental studies – Segments of Environment – Spheres of Earth – Lithosphere – Hydrosphere – Atmosphere - Different layers of atmosphere. Natural Resources: Classification – Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems – Concept of an ecosystem – Structure and function of an ecosystem – Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and 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 h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: 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 Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Disaster management – Disaster definition – Types – Natural Disasters – Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters – Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community – based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river / forest / grassland / hill / mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/ Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/ hills. Visit to areas affected by natural disaster.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Definition, scope and importance of Environmental studies, multidisciplinary nature of environmental studies – need for public awareness

2 Contribution of different scientists, social activists and institutions in relation to environmental studies. Segments of Environment: Spheres of Earth – Lithosphere, Hydrosphere, Atmosphere – Different layers of atmosphere. Natural Resources: classification

3 Forest resources: Forest functions – Ecological Significance – Deforestation – Causes and consequences of deforestation on environment – Mangroves protection and significance. Forest protection – Chipko movement and Joint forest management

4 Water resources: Sources of water – consumption pattern – reasons for decline of ground water – sustainable water management – Public water distribution system – Benefits and problems of dams – Environmental movements against large dams – Narmada Bachao Andolan

Unit II

5 Mineral resources: Types of Mineral Resources – Fuel, metallic and non-metallic mineral resources – uses and exploitation – distribution of mineral resources – Methods of Mineral Exploration and their effects on environment

6 Food resources: World food problems and environmental concerns – Concept of food security – Options to Achieve Food Security

7 Energy resources: Classification – Types of renewable energy resources – advantages and disadvantages – environmental impact of different renewable energy resources

8 Types of non-renewable energy resources – advantages and disadvantages – environmental impacts of different non-renewable energy resources

Unit III

9 Land resources: Land degradation – mechanisms and causes that initiate land degradation – Desertification – causes and control – Land use planning – policies in Land use planning – case studies

10 Soil resources: Types of soils – Types of soil erosion – causes and consequences of soil erosion – strategies for soil conservation – Role of an individual in conservation of natural resources

11 Ecosystems: Concept of an ecosystem – Structure and function of an ecosystem – Energy flow in the ecosystem – Types of ecosystems – Characteristic features of crop ecosystem

12 Biodiversity and its conservation: Introduction, definition, types of biodiversity, methods to measure biodiversity – Biogeographical classification of India

Unit IV

13 Importance and value of biodiversity: Biodiversity hot spots – Threats and conservation of biodiversity – Biodiversity Act 2022 – National Biodiversity Authority and its functions

14 Environmental Pollution: Definition, causes, effects and control measures of Air pollution – Air quality standards of Central Pollution Control Board

15 Definition, causes, effects and control measures of groundwater pollution and surface water pollution – Concepts of eutrophication and bio-magnification – Case studies

16 Definition, causes, effects and control measures of Marine pollution – Case studies on marine oil spills

Unit V

17 Definition, causes, effects and control measures of Soil pollution and Noise pollution

18 Definition, causes, effects and control measures of Thermal pollution and Light pollution

19 Solid Waste Management: Classification of solid wastes and management methods – Composting, Incineration, Pyrolysis, Biogas production – Causes, effects and control measures of urban and industrial wastes

20 Government policies and schemes on waste management – Swachh Bharat Mission – National Action Plan on waste management (Hazardous waste, E-waste, municipal solid waste, biomedical waste, plastic waste, and batteries management)

Unit VI

21 Social Issues and the Environment: Urbanization and urban problems related to energy – Water conservation, rainwater harvesting and watershed management – Case studies

22 Environmental ethics: Issues and possible solutions – Causes and consequences of global warming – Climate change and its influence on agricultural productivity – Measures to reduce GHGs – Acid rain – Ozone layer depletion

23 Salient features and provisions of Environment Protection Act, 1986 – Air (Prevention and Control of Pollution) Act – Water (Prevention and Control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act

24 Environment and Human Health: Human Population and the Environment – Various initiatives of government on Human Rights – Value Education – Women and Child Welfare

Unit VII

25 Role of Information Technology in Environment and Human Health – Case studies

26 Disaster: Definition and types of disasters – Natural Disasters – Floods, drought, cyclone, earthquakes – their effects and management

27 Natural Disasters: Landslides, avalanches, volcanic eruptions, heat and cold waves – El Niño – La Niña – their effects and management

28 Man-made Disasters: Nuclear disasters, nuclear accidents and holocaust, chemical disasters, biological disasters – their effects and management – Case studies

Unit VIII

29 Man-made Disasters: Forest fires, building fires, coal fires, oil fires, road accidents, rail accidents, air accidents, sea accidents – their effects and management

30 Concept of disaster management – International and National strategy for disaster reduction – National disaster management framework and financial arrangements

31 Role of NGOs – Community-based organizations and media in disaster management – Role of Central, State, District, and Local administration in disaster control

32 Role of armed forces in disaster response – Police and other organizations in disaster management – National Disaster Response Force – Their impact and management – Recent case studies

Practical

No.	Practical outline
1	Environmental sampling: Collection, processing, preservation, and storage of water samples
2	Water quality analysis: pH, EC, Acidity, and Alkalinity
3	Estimation of TDS in water samples
4	Estimation of temporary hardness of water samples
5	Estimation of total hardness of water samples
6	Estimation of DO and BOD in water samples
7	Determination of COD in water samples

8 Visit to a local area to document environmental assets (viz., river/forest/grassland/ hill/mountain) and visit to a local polluted site

9 Visit to windmill / hydropower / solar power generation units

10 Study of simple ecosystem – Visit to pond/river/hills

11 Assessment of biodiversity in farming systems – Estimation of species abundance

12 Assessment of Suspended Particulate Matter (SPM) in respirable and non – respirable dust

13 Enumeration of *E. coli* in water samples

14 Estimation of heavy metals in water samples using AAS

15 Estimation of sound pollution and light pollution

16 Visit to *in – situ* and *ex – situ* conservation sites

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AEAS 173 Farming based Livelihood Systems 3(2+1)

Course outlines

Objective

To make students aware about farming based livelihood systems in agriculture. To disseminate knowledge and skill how farming based systems can be a source of livelihood

Theory

Theory To disseminate the knowledge and skill how farming based systems can be a source of livelihood Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban & rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional & modern farming systems. Components of farming system/ farming based livelihood systems – Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro – forestry systems, Aqua culture Duck/ Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro – climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk & success factors in farming-based livelihood systems, Schemes &programmes by Central & State Government, Public & Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization & changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro –climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri – based enterprises & their functional aspects for integration of production, processing & distribution sectors and Study of agri – enterprises involved in industry and service sectors(Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost & profit analysis, Case study of Start-Ups in agri – sectors.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Status of agriculture in India and different states

2 Income of farmers and rural people in India

3 Livelihood – Definition and concept, Livelihood pattern in urban areas and rural areas

4 Agricultural Livelihood Systems (ALS) – Meaning, Concept, Approaches and Framework

Unit II

5 Indicators to study livelihood systems and Agricultural Livelihood Systems (ALS)

6 Definition of farming systems and farming based livelihood systems, Prevalent farming systems in India contributing to livelihood

7 Types of traditional and modern farming systems

8 Components of farming system/ farming based livelihood systems – Crops and cropping systems and horticultural crops

Unit III

9 Components of farming system/ farming based livelihood systems – Crops and cropping systems and horticultural crops

10 Components of farming system / farming – based livelihood systems – Livestock (Dairy)

11 Components of farming system / farming – based livelihood systems – Livestock (sheep and Goatry)

12 Components of farming system / farming – based livelihood systems – Livestock (Poultry and Duckry)

Unit IV

13 Components of farming system / farming – based livelihood systems – Livestock (piggery etc.)

14 Components of farming system / farming – based livelihood systems – Agroforestry systems

15 Components of farming system / farming – based livelihood systems – Aqua culture

16 Interaction of different crop and livestock – based livelihood systems

Unit V

17 Interaction of different crop and livestock – based livelihood systems

18 Interaction of different crop and livestock – based livelihood systems

19 Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers

20 Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers

Unit VI

21 Factors affecting integration of various enterprises of farming for livelihood

22 Risk & success factors in farming-based livelihood systems

23 Feasibility of different farming systems for different agro – climatic zones

24 Commercial farming-based livelihood models by NABARD, ICAR other organizations across the country.

Unit VII

25 Case studies on different livelihood enterprises associated with the farming.

26 Case studies on different livelihood enterprises associated with the farming.

27 Schemes &programmes by Central & State Government involved in promotion of farming-based livelihood opportunities

28 Schemes &programmes by Public & Private organizations involved in promotion of farming-based livelihood opportunities

Unit VIII

29 Role of farming-based livelihood enterprises in 21st Century in view of circular economy and green economy, Climate change

30 Role of farming-based livelihood enterprises in 21st Century in view of circular economy and green economy, Climate change

31 Digitalization & changing life style

32 Digitalization & changing life style

Practical

No.	Practical outline
1	Survey of farming systems and agriculture – based livelihood enterprises
2	Study of components of important Rainfed Farming based livelihood models / Systems in different Agro – climatic Zones (Wetland)
3	Study of components of important Rainfed Farming based livelihood models / Systems in different Agro – climatic Zones (lowland)
4	Study of components of important Rainfed Farming based livelihood models / Systems in different Agro – climatic Zones (gardenland)
5	Study of production and profitability of crop-based models
6	Study of production and profitability of crop based, livestock–based livelihood models (Diary)
7	Study of production and profitability of crop based, livestock–based livelihood models (sheep, goat, poultry)
8	Study of production and profitability of livestock–based livelihood models (Duckery / Aquaculture)
9	Study of production and profitability of processing-based livelihood models
10	Study of production and profitability of integrated farming–based livelihood models
11	Field visit to innovative Farming system models in farmers' fields
12	Visit of Agri – based enterprises & their functional aspects for integration of production, processing & distribution sectors
13	Study of agri – enterprises involved in industrial sectors (Value Chain Models)
14	Study of agri – enterprises involved in service sectors (Value Chain Models)
15	Concept of project formulation on farming-based livelihood systems – cost and profit analysis
16	Case study of startups in agri – sectors

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AEAS 174 Communication Skills 2(1+1)

Course outlines

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building selfesteem 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; Precise writing/Abstracting/Summarizing; Style of technical communication. Curriculum vitae/resume 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: precise 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.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Structural Grammar - Parts of speech, sentence structure, subjective case, possessive case and objective case. Modifiers, connecting words and verbals
2	Structural Grammar - Nouns, pronouns, antecedents, prepositions, adjectives and adverbs, phrase and clause
Unit II	
3	Functional grammar - Present past and future tenses, structures and usages of tenses and mood
4	Communication - Definition, meaning, concept, nature, significance, process and functions of communication and magic of effective communication. Characteristics and types of communication
Unit III	
5	Types of Communication - Verbal and non-verbal communication, characteristics, advantages and disadvantages. Barriers to communication, linguistics and non-linguistic barriers to communication and reasons behind communication gap/miscommunication
6	Self-esteem - Definition, building self-esteem and overcoming fears. Vocabulary - Homo phones, Homonyms, homographs, one word substitutes and idioms

Unit IV

7 In London - An Extract from M K Gandhi's autobiography, comprehension, and summary, hard words, short and long answer questions

8 Listening Skills - Definition, meaning, process, types and strategies of Listening. Techniques to improve listening skills. Speaking Skills: Meaning, types and steps in the preparation of speech and strategies to be an effective speaker

Unit V

9 Spoken English and Broken English by George Bernard Shaw. Text summary, comprehension, hard words short and long answer questions

10 Reading skills - Definition, meaning, levels, types and benefits of reading. Writing skills - Definition of style, importance and characteristics, principles, process, types of writing styles. Forms of written communication. Pointers and tips of effective written communication

Unit VI

11 Precise writing - Definition, meaning, characteristics of good precise, do's and don'ts of precise. Abstracting/summarizing. Choice of words, clichés, jargon, foreign words and redundancy

12 Letter Writing - Definition, importance and types of letters. Essential parts of a formal letter. Model letters

Unit VII

13 Functional Grammar - Agreement between subject and verb, common errors in English. Writing effective sentences

14 Functional Grammar - Active voice and passive voice, reported speech

Unit VIII

15 Vocabulary - Importance of building vocabulary, innovative methods to enhance vocabulary, synonyms, antonyms, words often confused, analogy, and collocations

16 Curriculum Vitae/Resume writing - Meaning of resume, parts of resume, how to prepare a good resume and profile making

Practical

No.	Practical outline
1	JAM (Just a Minute), stage manners, grooming, body language, extempore and impromptu presentation
2	Oral presentation - Definition, essential parts of presentation and how to prepare for a presentation. Allocation of topics for oral presentation
3	Phonetics - Meaning and elements of phonetics, vowel and consonant sounds, International Phonetic alphabet and speech symbols. Practicing proper pronunciation of words

4 Exercise on formation of words and formation of singulars and plurals. Exercise on silent letters in words

5 Stress and intonation - Word stress, sentence stress, discussion on challenges in learning English as a second language and exercise on challenges like vocabulary and grammar

6 Debate - Meaning, definition and significance of debate. The art of persuasion, allocation of topics for debate and oral activity

7 Group Discussion - Meaning, significance and prerequisites of a formal group discussion. Allocation of factual, debatable and abstract topics for Group discussion. Group discussion practice.

8 Exercise on listening skills - Recapitulation of meaning and characteristics of listening skills, listening to the given audio clips and answering questions

9 Vocabulary Building exercise - Recapitulation of importance of building vocabulary. Assigning topics to find out synonyms, antonyms, one-word substitutes, idioms phrasal verbs, homophones, homographs, homonyms, eponyms, portmanteaus and words often confused

10 Writing Skills - Recapitulation of definition, meaning, characteristics, and principles of written communication. Exercise on writing styles, assigning topics to write 15 to 20 sentences

11 Reading Skills - Reading and comprehension of general articles, research papers, exercise to make personal observations on writing styles followed in the journals/ magazines

12 Public Speaking - Lecture cum discussion on definition, meaning, benefits, elements and steps in preparation of public speaking - Assigning topics for public speaking

13 Note Taking - Definition, meaning, benefits and different methods of note taking. Do’s and don’ts of note taking. Assigning some chapters from popular books to take notes.

14 Precise writing, summarizing and abstracting - Recapitulation of definition, meaning and characteristic features of good precise. Allocation of topics and finding out the precise writing, abstracting/summarizing skills of students

15 Interview Techniques - Lecture cum discussion on definition, meaning, types, techniques and purpose of an interview. Role of body language in an interview. Discussion on commonly asked questions and strategies in an interview

16 Organization of events - Lecture cum discussion on definition, meaning purpose, steps and tips in organization and evaluation of event. Group exercise on organization and evaluation of event

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AEAS 271 Engineering Mathematics-I 3(2+1)

Course outlines

Objectives

To impart knowledge of different mathematical methods and to enable the students to apply for solving the engineering problems in the courses of Agricultural Engineering.

Theory

Matrices: Elementary transformations, rank of a matrix, Row Echelon form, Gauss-Jordan method to find the inverse of a matrix, solution of system of linear equations by Gauss elimination method, Eigen values and Eigen vectors, Cayley- Hamilton Theorem - it's use to find inverse of the matrix.

Partial Derivatives: Functions of two or more variables, partial derivative, Homogeneous functions and Euler's theorem, Composite functions, Total derivative, Maxima and Minima.

Complex Analysis: Functions of a complex variable, limit, continuity and analytic function, Cauchy-Riemann equations, Harmonic functions.

Differential calculus: Taylor's and Maclaurin's expansions.

Differential Equations: First order differential equations: linear differential equation and Bernoulli's equation, Exact and Equations reducible to Exact form by integrating factors, Equations of first order and higher degree, Clairaut's equation. Higher order differential equations: methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations.

Integral calculus: Double integrals, change of order of integration, triple integrals, applications of double and triple integrals to find area and volume.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Matrices - Review of matrices, elementary transformations
2	Rank of a matrix, finding the rank of a matrix by reduction to Echelon form
3	Gauss-Jordan method to find the inverse of a matrix
4	Nature of rank and solution of system of linear equations
Unit II	
5	Solution of system of linear equations by Gauss elimination method
6	Eigen values and Eigen vectors of a matrix
7	Cayley-Hamilton theorem and it's verification
8	Finding inverse of a matrix using Cayley-Hamilton Theorem
Unit III	
9	Partial Derivatives -Functions of two or more variables, partial differentiation
10	Homogeneous functions and Euler's theorem
11	Composite functions, total derivative
12	Maxima and minima of functions of two independent variables
Unit IV	
13	Complex Analysis - Functions of a complex variable
14	Limit and continuity of a function
15	Analytic functions, Cauchy-Riemann equations
16	Harmonic functions
Unit V	
17	Differential calculus - Taylor's series expansion
18	Maclaurin's series expansion
19	Differential equations -Review of ordinary differential equations: Order and degree of differential equations, formation of differential equations
20	First order differential equations - Variables separable, Linear &Bernoulli's differential equations

Unit VI

21 First order differential equations - Exact differential equations

22 Equations reducible to exact form by integrating factors

23 Equations of first order and higher degree

24 Solution of Clairaut's equation

Unit VII

25 Higher order differential equations - Methods of finding complementary functions

26 Methods of finding Particular integrals

27 Method of variation of parameters

28 Cauchy's and Legendre's linear equations

Unit VIII

29 Integral calculus - Double integrals

30 Triple integrals

31 Change of order of integration

32 Applications of double and triple integrals to find area and volume

Practical

No.	Practical outline
1	Problems on finding the rank of a matrix by reduction to Echelon form
2	Problems on Inverse of a matrix using Gauss Jordan method
3	Solutions of system of Linear equations by Gauss elimination method
4	Problems on Eigen values and Eigen vectors of a Matrix
5	Problems on Caley-Hamilton theorem
6	Problems on finding the maxima and minima of a function of two independent variables
7	Problems on Analytic and Harmonic functions
8	Problems on Taylor's and Macluarin's series expansion
9	Problems on linear & Bernoulli's Differential Equations
10	Problems on Exact and Non-Exact Differential Equations
11	Problems on Higher order Linear Differential equations, finding complementary functions and Particular integrals
12	Problems on solutions of differential equations by the method of variation of parameters
13	Problems on Cauchy's and Legendre's Differential equations
14	Problems on Double and Triple Integrals
15	Problems on applications of double integrals to find area and volume
16	Problems on applications of triple integrals to find area and volume

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4. Narayan S. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.

AEAS 272 Engineering Physics 3(2+1)

Course outlines

Objective

To make the students acquainted with application of physics in engineering and different physical process in agricultural engineering.

Theory

Magnetism: Dia, para and ferro-magnetism- classification; Langevin's theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory; Introduction to quantum mechanics: wave particles duality, deBroglie concept uncertainty principle, time dependent and time independent Schrodinger equation. Spectroscopy: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy; Solid state physics: statement of Bloch function, bands in solids, effective mass. Distinction between metals, insulators and semi-conductors.

Semiconductors: Intrinsic and extrinsic semi-conductors, law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels; Superconductivity: Critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids. Introduction to high Tc superconductors.

Lasers and Masers: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, He, Ne and Ruby lasers, Ammonia and Ruby masers; Holography and optical fiber: optical fiber- physical structure, basic theory, type of modes, characteristics of optical fiber and applications; Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To determine e/m of electron using magnetron valve method; To determine dielectric constant of material using De Sautys bridge; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; To determine the energy band gap in a semiconductor using a p-n junction diode; To study the LCR circuit; To find the wave length of light by using prism and spectrometer; To determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Classification of dia, para, and ferromagnetic substances, its characteristics, orbital angular momentum
2	Langevin's theory of dia magnetism (derivation)
3	Langevin's theory of para magnetism (derivation)
4	Weiss molecular field theory of para magnetism
Unit II	
5	Weiss theory of ferromagnetism domine theory adiabatic demagnetization
6	Wave nature of matter - Wave particle duality, de Broglie's concept, de-Broglie's wave length and properties of matter waves
7	Wave velocity, group velocity, particle velocity, their relation, uncertainty principle
8	Properties of wave function, Schrodinger's time dependent and time independent wave equation
Unit III	
9	Spectroscopy - Zeeman effect, classical theory of Zeeman effect related problems
10	Explanation of Paschen back effect and Stark effect, larmour precession, related problems
11	Raman effect, quantum theory of Raman effect and related problems
12	Band theory of solids - Energy bands in solids, free electron theory, one dimensional periodic potential
Unit IV	
13	Bloch's function, effective mass of electron and hole, velocity of block electron, variation of e, v, m* and fk with k
14	Semiconductors - Distinction between metals, insulators and semiconductors, intrinsic and extrinsic semiconductor
15	Donors and acceptors levels, law of mass action, determination of energy gap in semiconductor
16	Super conductivity - Qualitative explanation, critical magnetic field, Meissner effect, isotope effect
Unit V	
17	Type-I and Type-II superconductors
18	Josephsons effect, DC Josephsons effect, AC Josephson effect
19	Introduction to high temperature super conductors, SQUIDS
20	Lasers - Spontaneous emission, stimulated emission, Einstein's coefficients A and B their relation

Unit VI

21 Construction and working of He-Ne laser, construction and working of ruby laser

22 Construction and working of ammonia maser, Ruby maser Holography-Note

23 Optical Fiber - Physical structure, basic theory, numerical aperture acceptance angle

24 Types of optical fiber, characteristics and applications

Unit VII

25 Optics - Interference, interference at thin films, Newton rings

26 Michelson's interferometer, construction, working, measurement of wavelength

27 Diffraction - Fresnel diffraction, rectilinear propagation of light, Zone plate

28 Fraunhofer diffraction due to single slit, intensity distribution

Unit VIII

29 Diffraction grating, dispersive power, resolving power of grating

30 Polarization - Brewster's law, law of Malus, double refraction - Optical activity, polarimeter

31 Laws of Illumination - Lambert's law of inverse square, Lambert's cosine law, candle power

32 Luminous flux, lumen, brightness, Lummer - Brodhun photometer

Practical

No.	**Practical outline**
1	To verify the law of transverse vibrations along a string using electrical tuning fork
2	To find the low resistance using Carey Foster bridge without calibrating the bridge wire
3	To determine dielectric constant of material using De Sauty's bridge
4	To determine the (e/m) value of electron using magnetron valve method
5	To study the induced EMF as a function of velocity of the magnet
6	To obtain hysteresis curve (B-H curve) on a C.R.O and to determine related magnetic quantities
7	To study the variation of magnetic field with distance along the axis of a current carrying circular coil
8	To determine the radius of the coil
9	To determine the energy band gap in a semiconductor using a P-N junction diode
10	To determine the slit width from fraunhofer diffraction pattern using laser beam
11	To find the numerical aperture of optical fiber
12	To set up the fiber optic analog and digital link
13	To study the LCR circuit
14	To study the variation of thermo EMF of a copper-constantan thermo-couple with temperature
15	To find the wave length of light by prism
16	To determination of specific rotation of sugars

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AEAS 273 Engineering Chemistry 3(2+1)

Course outlines

Objective

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering.

Theory

Phase rule: phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. Pb-Ag system, desilverisation of Pb; Colloids: Classification, properties like optical activity-tyndall effect, brownian movement, electrical properties – electrophoresis, causes, types and methods of prevention - proper designing;Corrosion: Cathodic protection using pure metal and metal alloys, use of inhibitors; Water: Temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion, basic idea on thermogravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating; Fuels: Classifications, calorific value and its determination by bomb calorimeter; Principles of food chemistry: lipids, proteins, carbohydrates and their classifications, vitamins and their importance; Enzymes and coenzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method; Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavoring reagents of foods; Lubricants: Classifications, properties - viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability; Type of polymerization with examples (addition, free radical); Different properties of polymers-chemical resistance, crystallinity; Polymers: Effect of heat on polymers, general use, basic principles of determination of molecular weight by viscosity methods, basic principles of determination of molecular weight by light scattering methods; Introduction to IR spectroscopy: Basic principles of spectroscopy, Beer-Lambarts law, types of vibration, symmetric, asymmetric vibration and its types, absorbances of different functional group in IR.

Practical

To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; To study the different types of food preservatives and their active principles; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; To estimate chloride in water samples; To study the different properties of lubricants; To determine ë$_{max}$ and verification of Beer-Lambert law.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Phase rule - Phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, triple point

2 Two component system, viz. Pb-Ag system, eutectic point, desilverisation of Pb

3 Colloids - Classification, properties like optical activity, tyndall effect, brownian movement and electrical properties like electrophoresis, applications

4 Fuels - Classifications, calorific value and its determination by bomb calorimeter

Unit II

5 Corrosion - Causes, types - dry and wet corrosions, chemical theory reactions, factors influencing corrosion, galvanic series

6 Methods of prevention - Anodic and cathodic protection using pure metal and metal alloys, use of inhibitors, application of surface coatings metallic, inorganic, organic coating, proper designing

7 Water - Temporary and permanent hardness, units of hardness, equivalents of calcium carbonate, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion, priming & foaming

8 Thermo-gravimetric analysis, polarographic analysis, softening methods - Lime-soda process, zeolite process, ion exchange or deionization, mixed bed deionizer, advantages & limitations

Unit III

9 Lubricants - Classifications, functions, properties - viscosity, flash and fire point, cloud and pour point, emulsification, volatility, specific gravity, neutralization point, saponification number, precipitation number, ash content, aniline point, mechanical stability

10 Mechanism of lubrication - Thick film, thin film and extreme pressure

11 Nuclear radiation - Types of radiation, detectors of radioactivity - Ionization chamber, Geiger Muller Counter, Scintillation Counter

12 Analytical applications of radioactive materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating

Unit IV

13 Infrared spectroscopy - Introduction to IR spectroscopy, basic principles of spectroscopy

14 Beer - Lambert law, types of vibration, symmetric, asymmetric vibration and its types, absorbances of different functional group in IR

15 Polymers - Types of polymerization with examples – addition, condensation, copolymerization, free radical polymerization, plastics/ resins – types - thermo setting and thermoplastic resins, effect of heat on polymers, general use

16 Properties of polymers like chemical resistance, crystallinity, basic principles of determination of molecular weight of polymers by viscosity methods and light scattering methods

Unit V

17 Food chemistry - Definition, principles, importance and history of food chemistry

18 Lipids - Fatty acids - saturated and unsaturated, essential and non-essential fatty acids, importance

19 Classification of lipids – Simple, compound and derived lipids

20 Properties of lipids like rancidity, saponification, hydrogenation, iodine number, Reichert Meissl number, acid value

Unit VI

21 Carbohydrates - Introduction, definition, importance, structure & classification - mono, oligo and polysaccharides

22 Physical properties of carbohydrates - Stereo isomerism, enantiomers, epimers, anomers, mutarotation

23 Amino acids – Structures, classification – Protein and non-protein amino acids, essential and non - essential amino acids, oligo peptides

24 Proteins – Importance, properties of proteins - UV absorption, zwitterions, isoelectric point, denaturation, renaturation, solubility, structural organization - primary, secondary, tertiary and quaternary structures

Unit VII

25 Vitamins - Water soluble and fat soluble, importance, dietary sources and deficiency symptoms

26 Enzymes - Characteristics of enzymes - chemical nature, speed, specificity, active site activation energy, measurement of enzyme activity, coenzymes, prosthetic group, inorganic ions

27 Importance of enzymes and co-enzymes in food processing and storage, nomenclature and classification of enzymes

28 Manufacturing of ethanol and acetic acid by fermentation method

Unit VIII

29 Food preservatives - Introduction to food preservatives, definition, types -Natural and artificial preservatives and its use

30 Chemical action of food preservatives on foods and human system

31 Food colours - Natural food colours, synthetic food colours, chemical nature and impact on health

32 Flavoring agents - Natural flavors, synthetic flavors, examples, chemical nature and role in food processing

Practical

No.	**Practical outline**
1	To determine temporary hardness of water by EDTA method
2	To determine permanent hardness of water by EDTA method
3	To study different types of fuels and compare their characteristics
4	To determine calorific value of fuel - Bomb calorimeter
5	To estimate chloride in water sample
6	To estimate dissolved oxygen in water sample
7	To determine carbonate and bi-carbonate ions in water
8	To estimate acidity and alkalinity of water sample
9	To study the different properties of lubricants
10	To determine viscosity of oil
11	To determine ëmax
12	To verify Beer-Lambert law
13	To study different types of foods and their ingredients

14 To study the different types of food preservatives and their active principles

15 To estimate water activity of food sample

16 To identify functional groups (alcohol, aldehyde, ketones, carboxylic acid and amide) by IR spectroscopy-mode of operation

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AEAS 274 Engineering Mathematics-II 3(2+1)

Course outlines

Objective

To make the students acquainted with the application of various advanced Mathematics such as vector calculus, Fourier series and Laplace transforms and applications of Numerical methods in engineering.

Theory

Numerical Methods: Finite difference operators and their relationships, Factorial notation. Newton's Forward and Backward Interpolation formula, Newton's divided difference Interpolation and Lagrange's interpolation formula, Numerical Differentiation and Integration, Numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of fourth order.

Vector calculus: Scalar and vector point functions, vector differential operator Del, Gradient of scalar point function, Divergence and Curl of a vector point function and their physical interpretations. Line, Surface and Volume integrals. Green's, Stoke's and Gauss Divergence theorem (without proofs).

Fourier series: Periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, Even and Odd functions, Half range series: Fourier Sine and Cosine series, series expansion of functions with finite discontinuity.

Laplace Transforms: Rules for Laplace transform and inverse Laplace transform, applications of Laplace Transforms to find solutions of ordinary differential equations and simultaneous differential equations.

PDE: Formation of PDE, Linear Partial differential equations of first order, Lagrange's Method, higher order linear PDE with constant coefficients, solutions of Non-linear PDE, Charpit's method.

Lecture outlines

Theory

No. Lecture Outline

UNIT I

1. Numerical Methods: Finite differences
2. Various difference operators and their relationships, factorial notation
3. Interpolation with equal intervals, Newton's forward interpolation formula
4. Newton's backward interpolation formula

Unit II

5. Interpolation with unequal intervals: Newton's divided difference formula
6. Lagrange's interpolation
7. Numerical differentiation
8. Numerical integration: Trapezoidal Rule, Simpson's $1/3^{rd}$, $3/8^{th}$ rules and Weddle's rule

Unit III

9. Numerical solutions of ordinary differential equations by Taylor's series method and Picard's method
10. Numerical solutions of ordinary differential equations by Euler's, Modified Euler's methods
11. Runga - Kutta method of fourth order

UNIT IV

12 **Vector calculus:** Differentiation of vectors, Vector differential operator Del, Gradient of a scalar point function
13. Divergence and Curl of a Vector point function
14. Identities involving Del, Second order differential operator
15. Line, Surface and Volume integrals
16. Green's theorem, Stoke's theorem and Gauss Divergence theorem (without proofs)

UNIT V

17. **Fourier series:** Periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions

18. Fourier series of functions having arbitrary period 2L
19. Fourier series of Even and odd functions
20. Half range series: Fourier Sine and Cosine Series
21. Series expansion of functions with finite discontinuity

UNIT VI

22. **Laplace transforms:** Definition of Laplace transform, existence of Laplace transform
23. Laplace transforms of Elementary functions, Properties of Laplace Transforms
24. Laplace transform of derivative and integral of a function, L.T of a function multiplied by ‘t’ and divided by ‘t’

Unit VII

25. Inverse Laplace transforms
26. Convolution theorem
27. Applications of L.T to find the solutions of ordinary differential equations and simultaneous differential equations

Unit VIII

28. **Partial differential equations:** Formation of partial differential equations by elimination of arbitrary constants
29. Formation of partial differential equations by elimination of one or two arbitrary functions
30. Solutions of Linear Partial differential equations of first order (Lagrange’s Method)
31. Higher order linear partial differential equations with constant coefficients
32. Solution of non-linear partial differential equations and Charpit’s method

Practical

No. Practical outline

1. Problems on Newton’s Forward and Backward interpolation formulae
2. Newton’s divided difference formula, Lagrange’s interpolation
3. Problems on Numerical Differentiation, Numerical Integration
4. Problems on numerical solutions of ordinary differential equations by Picard’s and Taylor’s series methods
5. Problems on numerical solutions of ordinary differential equations by Modified Euler’s and Runge- Kutta methods
6. Problems on Gradient, Divergence and Curl of a vector point function
7. Problems on Line, Surface and Volume integrals
8. Problems on Fourier series for functions having arbitrary period 2L & 2ð
9. Problems on Fourier series of Even and Odd functions
10. Problems on Fourier Sine and Cosine Series (Half range series)
11. Problems on Laplace Transforms

12. Problems on Inverse Laplace Transforms
13. Problems on Laplace transforms and their applications to find solutions of ordinary & Simultaneous Differential equations
14. Problems on Lagrange's and solutions of Higher order linear partial differential equations with constant coefficients
15. Solutions of Non-Linear partial differential equations
16. Problems on Charpit's method

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AEAS 275 — Entrepreneurship Development and Business Management — 3(2+1)

Course outlines

Objective

To provide student an insight into the concept and scope of entrepreneurship, to expose the student to various aspects of establishment and management of a small business unit and to enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for 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/agro–industries, Interaction with successful entrepreneurs / agri – entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Development of Entrepreneurship and Factors influencing the development of entrepreneurship – social factors & environmental factors
2	Motivation – Theories and motivational factors in entrepreneurship
3	Characteristics of Entrepreneurs
4	Entrepreneurial attributes / competencies
Unit II	
5	Concept, need and importance of entrepreneurial development
6	Evolution of the concept of entrepreneurship
7	Entrepreneurial activities and objectives of entrepreneurial activities
8	Classification of entrepreneurs
Unit III	
9	Functions of Entrepreneurs
10	Process of Entrepreneurship Development.
11	Environment scanning and opportunity identification – Need for scanning, spotting of opportunity & scanning of environment
12	Identification of product / service: Starting a project; Factors influencing sensing the opportunities.
Unit IV	
13	Infrastructure and support systems: Good policies, Schemes for entrepreneurship development

14 Role of financial institutions and other agencies in entrepreneurship development.
15 Steps involved in functioning of an enterprise.
16 Selection of the product / services & selection of form of ownership;

Unit V

17 Registration, Selection of site, Capital sources, Acquisition of manufacturing knows how, Packaging and Distribution.
18 Planning of an enterprise, Project Identification & Selection
19 Formulation of project; Project Report Preparation, Enterprise Management.
20 Formulation of project; Project Report Preparation, Enterprise Management.

Unit VI

21 Production Management: Product, Levels of products, Product mix & Quality Control
22 Cost of production, Production controls & Material Management
23 Production Management: Raw Material Costing, Inventory Control
24 Personal Management: Manpower Planning, Labour Turn Over & Wages / Salaries

Unit VII

25 Financial management / Accounting: Funds, Fixed Capital and Working Capital, Costing and Pricing
26 Long Term Planning and Short –Term Planning, Book Keeping, Journal & Ledger
27 Subsidiary Books, Annual Financial Statement & Taxation
28 Marketing Management: Market & Types

Unit VIII

29 Marketing Assistance
30 Market Strategies
31 Crisis Management: Raw Material & Production,
32 Crisis Management: Leadership, Market, Finance, Natural Etc.

Practical

No. Practical outline

1 Visit to public enterprise
2 Visit to public enterprise
3 Visit to private enterprise
4 Visit to private enterprise
5 Visit to agro – processing / food business centers
6 Visit to agro – processing / food business centers
7 SWOT analysis of public enterprises
8 SWOT analysis of private enterprises

9 Study of sick agro – processing/food business centers
10 Case study and analysis of entrepreneurial failure due to environmental factors
11 Case study and analysis of social responsibilities of a business
12 Project proposal preparation
13 Project proposals as entrepreneur - group and individual
14 Project proposals as entrepreneur - group and individual
15 Presentations of project proposals
16 Presentations of project proposals

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AEAS 371 Personality Development 2(1+1)

Course outlines

Objective

To make students realize their potential strengths and to cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Lecture outlines

Theory

No. Lecture outlines

Unit I

1 Personality- Definition, nature of personality, Theories of personality and its types

2 The humanistic approach - Meaning, Maslow's self-actualization theory, shaping of personality & determinants of personality

Unit II

3 Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B behaviours, Personality and Organizational Behaviour

4 Foundations of individual behaviour, and factors influencing individual behaviour, models of individual behaviour

Unit III

5 Perception: Meaning, types, factors and importance in Agricultural extension, and attributes and factors affecting perception

6 Attribution theory: Meaning of attribution, types of attributions, Weiner model of attribution and case studies on perception and attribution

Unit IV

7 Learning: Meaning and definition, theories and principles of learning, learning and organizational behaviour, difference between learning and training, learning feedback

8 Attitude: Concept, significance, factors affecting attitude, positive and negative attitude, ways to develop positive attitude

Unit V

9 Values: Definition, importance of values in organization, characteristics and types of values

10 Intelligence: Meaning, types of intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence

Unit VI

11 Organizational Behaviour: Meaning, definition, scope and importance of organizational behaviour, models of organizational behaviour

12 Emotional Intelligence: Meaning, components and dimensions of emotional intelligence

Unit VII

13 Emotional Intelligence- State and trait, characteristics of persons with emotional intelligence and low emotional intelligence

14 Motivation: Meaning, types of motives, theories and principles of motivation and importance of motivation

Unit VIII

15 Teamwork: Meaning, concept, characteristic features of effective teams, types of teams, factors affecting and role of teamwork

16 Group Dynamics: Nature of groups, dynamics of group formation, types of groups, dynamics of formal & informal groups

Practical

No.	Practical outline
1	Assessing personality through MBTI personality analysis
2	Practicing learning style and Strategies
3	Assessing motivational need
4	Administering psychological tests to assess personality types of human beings, Experiment-1 Firo-B
5	Administering psychological tests to assess personality types of human beings, Experiment-2 Eysenk personality inventory
6	Administering psychological tests to assess personality types of human beings, Experiment-3 Edward's personality inventory
7	Practicing Interpersonal Communication
8	Practical exercise on teamwork and team building
9	Practical exercise on Group Dynamics
10	Practical exercise on Win-win Game
11	Measurement of emotional intelligence
12	Practical exercise on Leadership styles
13	Case studies on personality and organizational behaviour
14	Practical exercise on Negotiation skills and Stress management
15	Practical exercise on Time management
16	Practical exercise on Conflict management

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AEAS 471 Agricultural Statistics and Data Analysis 2(1+1)

Course outline

Objective

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering.

Theory

Introduction to statistics: definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts; Measures of central tendency: definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped & ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute & relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation; Probability: Definition and concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean; Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit & testing of independence of attributes (2x2 contingency table).

Practical

Practical Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known & unknown); SND test for two samples means (population SD known & unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit & testing of independence of attributes (2x2 contingency table) and m×n.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction to statistics-Definition, advantages and limitations.Presentation of data-Types of data, quantitative and qualitative dataVariables – discrete and Continuous.

2 Frequency distribution- Construction of frequency distribution table. Frequency curve, Ogive curve, different types of graphs and charts.

Unit II

3 Measures of Central tendency- Characteristics of ideal average. Types of averages (Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean) for Grouped and ungrouped data, Merits and demerits.

4 Measures of Dispersion- Definition, Types of dispersion (Range, Quartile deviation, Mean deviation and Standard deviation). Characteristics of S.D. Merits and Demerits of S.D. Variance and Coefficient of Variation.

Unit III

5 Probability-Definition and Concept of probability. Random variable and expectation.

6 Normal distribution-definition, density function, properties of area under curve. Standard normal distribution.

Unit IV

7 Concept of Skewness and Kurtosis

8 Binomial distribution-definition, density function, Conditions and properties.

Unit V

9 Poisson distribution- definition, density function, Conditions and properties.

10 Introduction to sampling-definition of population, sample, random sampling, parameter, statistic, sampling distribution and standard error of mean.

Unit VI

11 Testing of Hypothesis-types of hypotheses, level of significance, types of errors, critical region, one tail and two tail test, types of error and Degrees of freedom.

12 Large sample test(Z-test) Assumptions & Conditions -one sample and two sample mean (sigma known and unknown cases)

Unit VII

13 Small sample test(t-test)- Assumptions & Conditions-One sample mean and Two sample mean and Paired t-test.

14 Variance ratio test (F-test). Chi-square test- Assumptions, applications, conditions, goodness of fit, testing the independence of attributes and Yates correction.

Unit VIII

15 Simple linear correlation- definition, assumptions, types, properties and test of significance.

16 Simple linear regression- definition, assumptions, types, properties and test of significance. Comparison between simple correlation and simple regression.

Practical

No. Practical outline

1 Frequency distribution- Construction of frequency distribution table. Frequency curve, Ogive curve, different types graphs and charts.

2 Measure of Central tendency- Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean for Grouped and ungrouped data.

3 Measures of Dispersion- Range, Quartile deviation, Mean deviation. Standard deviation (Grouped and ungrouped data).

4 Coefficient of variation.

5 Probability- Simple problems based on probability theory and expectation.

6 Problems on Skewness

7 Binomial distribution- Fitting of Binomial distribution.

8 Poisson distribution- Fitting of Poisson distribution.

9 Large sample test(Z-test) - one sample (sigma known and unknown cases)

10 Large sample test(Z-test) - two sample mean (sigma known and unknown cases)

11 Small sample test(t-test)- One sample mean and Two sample mean.

12 Small sample test(t-test)- Paired t-test.

13 Variance ratio test (F-test).

14 Chi-square test- goodness of fit, testing the independence of attributes and Yates correction.

15 Simple linear correlation- Find correlation coefficient and test of significance.

16 Simple linear regression- Find two regression lines Yon X and X on Y, Regression coefficients and test of significance.

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DEPARTMENT OF FRSP

FRSP 101 Introduction to Agricultural Engineering 4(3+1)

Course Outlines

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post–harvest processing and allied activities.

Theory

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad.

Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

Introduction to renewable energy systems; Types of biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Wind mills and their different parts.

Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures. Use of topographical survey and contour maps. Different types of water harvesting structures.

Introduction to soil – plant – water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices and mouth pieces; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to planning of drainage systems; Introduction to centrifugal pumps and different components.

Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures. Classification of different types of agricultural commodities as durables, perishables, etc.; Moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods.

Practical

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements; Study of various types of biogas plants and operational parameters; Study of various solar energy application systems; Study on various components of sprinkler and drip irrigation; Study on various components centrifugal pump; Study of various post–harvest operations; Study of different food processing equipment; Value addition of common crops; Visit to a greenhouse with modern irrigation system; Visit to implement manufacturing unit; Visit to a mechanized farm; Visit to a watershed; Visit to a food processing industry.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction to Agricultural Engineering as a discipline, Major divisions of Agricultural Engineering, Importance of Agricultural Engineering in Today's Agriculture
2	Employment opportunities of Agricultural Engineering graduates in different sectors
3	Scope of research and higher studies in Agricultural Engineering in India and abroad
4	Farm mechanization needs and strategy; classification of farm machinery based on unit operations
5	Principles of selection of machinery for different sizes of land and matching power sources
6	Different types of equipment for tillage
Unit II	
7	Different types of equipment for sowing, planting, and transplanting, fertilizer application and weed control
8	Different types of equipment for plant protection
9	Harvesting and threshing equipment for rice and wheat

10 Harvesting and threshing equipment for maize, cotton, sugarcane, fruits, tuber crops and other locally important crops

11 Functions and capabilities of tractor and power tillers

12 Introduction to the basic parts of a tractor and power tiller

Unit III

13 Introduction to the IC engine components and systems

14 Introduction to the fuel and air supply systems of tractor

15 Introduction to the cooling and lubricating systems of tractor

16 Introduction to the electrical systems of tractor

17 Study of clutch, gear box, differential and final drive in the farm tractor

18 Introduction to the hitching and PTO systems of tractor

Unit IV

19 Classification of energy sources; conventional and non – conventional energy sources, importance of non – conventional sources, obstacles to implementation of renewable energy systems

20 Biogas plants; Introduction, working of KVIC, Janata, and Deenabandhu type biogas plants

21 Solar energy; introduction, solar flat – plate collectors, concentrated type collectors

22 Solar water heating system, solar grain dryers; solar cabinet dryer, solar convective dryer

23 Solar cell; components of solar photovoltaic system, solar photovoltaic water pumping system

24 Wind energy, components of wind energy conversion system, applications of wind energy

Unit V

25 Importance of Soil and Water Conservation, Definition and agents of soil erosion, Causes of soil erosion, Types of soil erosion

26 Different agronomic measures for control of Water erosion, Mixed cropping, crop rotation, tillage practices, mulching

27 Different engineering measures, Contour bunding and Graded bunding, Broad bed terraces, Bed and furrow system, Vegetative water ways

28 Gully control measures, Check dams, Drop spillways, Chute spillways, Drop inlet spillways

29 Use of topographical survey and contour maps, Contour lines, Methods of topographic surveying, Watershed location map

30 Different types of water harvesting structures, Lining of ponds, tanks and canal systems

Unit VI

31 Introduction to soil, plant, water relationship, Soil physical properties influencing irrigation, Kinds of soil water including field capacity and Wilting point

32 Importance of irrigation water measurements – Volumetric, area velocity, discharge methods – Weirs, orifice, flumes

33 Introduction to different surface irrigation methods as Border, furrow and check basin, Adaptability, Advantages and disadvantages, Technical specifications

34 Sprinkler, drip irrigation and their different components, Types and Adaptability, Advantages and limitations

35 Underground water conveyance methods in pipes, Different structures in underground pipe line system

36 Introduction to centrifugal pumps and different components, Introduction to planning of drainage systems

Unit VII

37 Different types of agricultural structures and Introduction to planning and layout of farmsteads, animal houses, poultry houses (Location of farmstead, Size and arrangement, Planning of farm residence)

38 Dairy barn and types of dairy barns; Poultry house and types of poultry houses; Sheep Housing – Space requirements, feeding and feeders

39 Different types of grain storage structures; Different types of traditional and modern storage structures (Introduction, the silo and its type, requirement of good storage structures, Bukhari, Kothar type, Morai Type, and bag storage structures)

40 Greenhouse and its different parts; and Low cost protected structures. Introduction to greenhouses – history, definition, greenhouse effect, advantages of green houses, brief description of types of greenhouses – greenhouses based on shape, utility, construction, covering materials and cost, shade nets

41 Plant response to greenhouse environments – light, temperature, relative humidity, ventilation and carbon dioxide and environmental requirement of agriculture and horticulture crops inside green houses

42 Classification of different types of agricultural commodities as durables (nonperishables), perishables, etc. Stable or non – perishable foods, Semi perishable foods and Perishable foods. Common reasons of food spoilage: Spoilage foods (Chemical Spoilage, Physical Spoilage, and Enzymatic Spoilage)

Unit VIII

43 Storage of perishable commodities, Food preservation methods (Keep out, Remove them, prevent or delay growth, kill or destroy, combination methods)

44 Moisture content and its importance in grain storage. Moisture content representation (wet basis and dry basis). Relationship between the dry basis and wet basis moisture contents. Moisture content and its determination methods (Direct methods and indirect methods)

45 Different primary processing operations and their necessity. Cleaning and Grading, Scalping, Screening, Mesh, Aperture, Aspiration

46 Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction. Double deck screen, Vibratory screen, fruit washer, color sorter, fruit grader, potato peeler, and hammer mill

47 Basic principles of value addition of food: Drying and dehydration, evaporation, thermal processing (pasteurization and sterilization), refrigerated and frozen storage, chemical preservation and other novel methods

48 Different types of packaging materials and their suitability for various food products (Definition of packaging, Levels of Packaging, Functions of packaging, packaging of milk products, Packaging of fruits and vegetables, Packaging of Meat, fish and poultry products, Bakery and confectionary products, Protein – Rich foods, Packaging of edible starches and starch products, Food grains and food grain products, Sugar and honey, Packaging of Stimulant foods, Alcoholic drinks and carbonated beverages, Spices and condiments)

Practical

No.	Practical outline
1	Familiarization with tillage, sowing, planting and transplanting equipment
2	Familiarization with inter – cultivation, pesticide application, harvesting and threshing machinery
3	Study of internal combustion engine components and engine systems
4	Study of basic parts of power tiller and farm tractor and their operation
5	Visit to agricultural implements or machinery manufacturing facility
6	Demonstration different biogas plants
7	Demonstration of solar water heater, solar cabinet dryer, solar Water pumping unit
8	Study on various components of sprinkler and drip irrigation.
9	Study on various components of centrifugal pumps
10	Visit to a greenhouse with modern irrigation system, Visit to a watershed
11	Study of various post – harvest operations, study of different food processing equipment (screens, cleaners or graders)
12	Value addition of common crops (moisture content determination)
13	Visit to a greenhouse with modern irrigation system (any farm houses or storage structures)
14	Study of different food processing equipment (screens, cleaners or graders)
15	Visit to a food processing industry (Any packing industry/ cold storage / green houses or any grain storage structure)
16	Final Practical examination

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DEEKSHARAMBH & PHYSICAL EDUCATION

COCA 102 Deeksharambh (Induction-cum-Foundation Programme) 0+2(NG)

* The activities to be taken under Deeksharambh, in addition to giving a broad view and application areas of the subject of study, also will aim at creating a platform f.or
* Helping students from different backgrounds for cultural integration
* Knowing about the operational framework of academic process in university
* Instilling life and social skills, leadership qualities, team working spirit
* Developing social awareness, ethics and values, creativity
* Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities/ schedules will be decided by the parent universities. The structure shall include, but not restricted to:

I. discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

II. creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario

III. interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences;

IV. group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences;

V. field visits to related fields/ establishments; and

VI. sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.

COCA 102 NSS – I / NCC – I 1(0+1)

Course outlines

Objective

To evoke social consciousness among students through various NSS activities and to increase awareness and desire to help sections of society.

Practical

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS. Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health. NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village / slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ 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 mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youthadult partnership. Social harmony and national integration. Indian history and culture, role of youth in nation building, conflict resolution and peace building. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman 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 organizations) and society.

Practical

No.	Practical outline
1	Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
2	Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health
3	NSS program activities. Concept of regular activities, special camping, day camps
4	Basis of adoption of village / slums, conducting survey, analyzing guiding financial patterns of scheme, youth program / schemes of GOI, coordination with different agencies and maintenance of diary
5	Understanding youth. Definition, profile, categories, issues and challenges of youth
6	Opportunities for youth who is agent of the social change
7	Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth – adult partnership
8	Social harmony and national integration. Indian history and culture
9	Role of youth in nation building, conflict resolution and peace building
10	Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints
11	Shaman as part of volunteerism
12	Citizenship, constitution, and human rights
13	Basic features of constitution of India fundamental rights and duties
14	Human rights and consumer awareness rights
15	Rights to information
16	Family and society. Concept of family, community (PRIs and other community-based organizations) and society

COCA 103 NSS-II/NCC-II 1(0+1)

Course Outlines

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilled in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical outlines

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, interpersonal communication. Youth development programs; Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations; Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs 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.

Practical

No.	Practical outline
1	Importance and role of youth leadership - Meaning, types and traits of leadership, qualities of good leaders
2	Importance and roles of youth leadership, life competencies
3	Definition and importance of life competencies, problem-solving and decision making
4	Interpersonal communication, youth development programs
5	Development of youth programs and policy at the national level, state level and voluntary sector
6	Youth-focused and youth-led organizations
7	Health, hygiene and sanitation
8	Definition needs and scope of health education
9	Role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health
10	National health programs and reproductive health
11	Youth health, lifestyle, HIV AIDS and first aid

12 Healthy lifestyles, HIV AIDS, drugs and substance abuse

13 Home nursing and first aid

14 Youth and yoga - History, philosophy, concept, myths, and misconceptions about yoga

15 Yoga traditions and its impacts

16 Yoga as a tool for healthy lifestyle, preventive and curative method

COCA 201 Physical Education, First aid, Yoga Practice and Meditation 2(0+2)

Course outlines

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and 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 and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga Asanas: Definition and Importance, Padmasan, Gaumukhasan, hadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan– left leg right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, SawasanSuryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari. Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh. Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. Role of yoga in sports. Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, Specifications of equipment, 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 equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Practical outlines

No.	Practical outline
1	Introduction about the development uses of physical education level of tournaments conducted in ANGRAU and colleges. How many games & sports to be taught for boys and girls separately - Importance of physical education
2	Training and coaching, meaning and concept
3	Methods of training
4	Aerobic and anaerobic exercises
5	Calisthenics, demonstration, explain and practice
6	Weight training - Introduction and practice
7	Circuit training - Introduction and practice
8	Interval training - Introduction and practice
9	Fartlek training - Introduction and practice
10	Effects of exercise on muscular and respiratory system
11	Effects of exercise on circulatory and digestive systems
12	Balanced Diet and Nutrition - Effects of diet on performance
13	Physiological changes due to ageing and role of regular exercise on ageing process
14	Personality, its dimensions and types
15	Role of sports in personality development, motivation and achievements in sports
16	Learning, theories of learning. Adolescent Problems and its management
17	Posture, postural deformities and exercises for good posture
18	Yoga and history of Yoga
19	Introduction and types of Yoga
20	Asanas: Definition and Importance, Padmasan, Gaumukhasan,Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan,
21	Asana - Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan - left leg right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
22	Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
23	Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
24	Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
25	Role of yoga in sports - Teaching of Asanas – demonstration, practice, correction and practice

26 History of sports and ancient games, Governance of sports in India; Important national sporting events

27 Awards in Sports; History, latest rules, measurements of playfield, Specifications of equipment, skill, technique, style

28 Coaching of major games (Cricket, football, and table Tennis, Badminton, Chess and Caroms)

29 Coaching of major games (Volleyball, Basketball, Ball badminton, tennikoit) and Athletics

30 Need and requirement of first aid. First aid equipment and upkeep. First AID Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries

31 First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons.

32 Sports injuries and their treatments

References

1. Sports training – Dr. Dhanajay Shaw.
2. Sports training – Dr. AK Uppal
3. Aerobics Fitness & Style Agarwal.M
4. Physiology of sport – Sivaramkrishnanan.S
5. Sports and Nutrition and Health – Anderson. H.S
6. Group Dynamics – Bonner.H
7. Sports Psychology and Training - Khanna. GI
8. Teaching of Yoga – Sharma JP
9. Encyclopedia of Yoga Sharma HL
10. Health and Yoga- Malik AK
11. The yoga sutras of Pathanjali – Johnston.C
12. Book of Games – Hebbert. FM
13. Sports Medicine – Valavan VM
14. Sports Injuries and Rehabilitation – Govindarajulu N
15. Book of rules of games and sports – Chakravar.PS

SKILL ENHANCEMENT COURSE

SRDY 181 — Skill Enhancement — 8(0+8)

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG – certificate, they can work as operators and technicians in the fields of food processing, etc. or can go for self – employment or start their own agro – service centre, agro – processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Module 1 — Operation and Maintenance of Farm Machinery — 2(0+2)

Lecture outline

Practical

No.	Practical outline
1	Familiarization with different farm tools, implements and machinery – visit to farm machinery laboratory and shed
2	Hitching and de – hitching of trailed type implement / trailer to the tractor
3	Driving and turning of tractor with trailer
4	Driving and turning of tractor with trailer
5	Hitching and de – hitching of mounted type implement to the tractor
6	Field operation and adjustments in mould board plough
7	Field operation and adjustments in disc plough
8	Field operation of cultivator (rigid tyne / spring tyne) and off – set disc harrow
9	Change of cultivator points for the cultivator
10	Seed bed preparation with rotavator
11	Change of blades in the rotavator
12	Repair and off – season maintenance of primary and secondary tillage equipment
13	Field operation of seed cum fertilizer drill and planter
14	Field operation of no – till drill, strip – till drill, happy seeder and super seeder
15	Study of driving controls in paddy transplanter and its operation.
16	Repair and off – season maintenance of sowing and planting equipment
17	Field operation of intercultural equipment for dryland and wetland agriculture.
18	Field operation of fertilizer broadcaster
19	Study of different functional components of plant protection equipment
20	Field operation of manually operated knapsack sprayer, compression knapsack sprayer, foot operated sprayer, rocker sprayer and duster

21 Field operation of power operated and tractor operated sprayers
22 Repair and off – season maintenance of plant protection equipment
23 Study of driving controls in paddy reaper and its operation
24 Maintenance of cutter bar in reaper and replacement of blades in cutter bar
25 Field operation of root crop harvester (groundnut digger / digger cum invertor)
26 Study of driving controls in combine harvester and operation of combine harvester
27 Adjustments in combine harvester and it's off – season maintenance.
28 Study of different functional components of multi – crop thresher and its operation
29 Trouble shooting, adjustments and maintenance of multi – crop thresher
30 Field operation of straw management machinery (rotary slasher and rotary mulcher)
31 Setting up of agricultural machinery workshop – visit to nearer farm implements manufacturing workshop
32 Final practical examination

References

1. Nakra, C.P. 2013. Farm Machines and Equipment. Dhanpat Rai Publication Company (P) Ltd., New Delhi.
2. Jain, S.C. and Grace Philip. 2017. Farm Machinery – An Approach. Standard Publishers Distributors, New Delhi.
3. Jagdishwar Sahay. 2019. Elements of Agricultural Engineering. Standard Publishers Distributors, New Delhi.
4. Surendra Singh. 2007. Farm Machinery Principles and Applications. Indian Council of Agricultural Research, New Delhi.
5. Surendra Singh and Verma, S.R. 2009. Farm Machinery maintenance and management. Indian Council of Agricultural Research, New Delhi.

Module 2 Installation and maintenance of micro – irrigation systems 2(0+2)

Practical outline

Practical

No. Practical outline

1 Study of components of sprinkler irrigation system
2 Field installation and operation of sprinkler irrigation system
3 Study of wetting pattern of a sprinkler in horizontal and vertical profile of soil
4 Field evaluation of distribution pattern requirement for overlapping of sprinkler
5 Field evaluation of uniformity coefficient
6 Study of cost economics of sprinkler irrigation
7 Study on maintenance of sprinkler irrigation system

8 Study on large scale sprinkler irrigation system (Center pivot irrigation system)
9 Study of perforated pipe irrigation system
10 Study of Pop up sprinkler irrigation system
11 Study of different components of drip irrigation
12 Study of different components of drip irrigation
13 Study of different components of drip irrigation
14 Study of layout of drip irrigation
15 Field visit of existing drip irrigation system
16 Installation of drip irrigation system
17 Installation of drip irrigation system
18 Determination of discharge uniformity of a drip irrigation system
19 Study of different types of filters and determination of filtration efficiency
20 Maintenance of primary and secondary filters in drip irrigation system
21' Study of types of fertigation equipment
22 Operation of fertigation equipment
23 Field visit to study various troubles and working out remedies in the drip irrigation
24 Study on removal of clogging of emitters
25 Study on maintenance of drip irrigation system
26 Study of cost economics of drip irrigation system
27 Study of components of micro sprinklers
28 Study of micro sprinkler irrigation system
29 Study of micro jet irrigation system and Bubbler irrigation
30 Study of foggers for polyhouse cooling
31 Study of components of automation in micro irrigation system
32 Study of components of automation in micro irrigation system

References

1. Principles of Drip irrigation – M.S.Mane, B.L.Ayane and S.S.Nagar. Jain Brothers, East park Road, Karol Bagh, New Delhi.
2. Irrigation Theory and Practices – A.M. Michel, Vikas Publishing, Noida.

Module 3 Operation and Maintenance of Agricultural Drones 2(0+2)

Practical

No. Practical outline

1 Drone Components Identification: Understanding frame, motors, propellers, GPS, sensors, and payload systems

2 Assembling Agricultural Drones: Hands – on assembly of drones with focus on electrical connections

3 Sensor and Camera Configuration: Calibration and testing of sensors for agriculture – specific tasks

4 Initial Drone Testing: Ensuring proper functioning post – assembly and resolving issues

5 Pre – Flight Checklist and Safety Protocols: Hands – on training for pre – flight readiness

6 Manual Flight Training: Basic navigation, take – off, hovering, and landing

7 Outdoor Flight Training: Operating drones in open fields for better control and awareness

8 Precision Navigation: Maneuvering drones through obstacle courses to improve control

9 Introduction to Flight Software: Learning mission planning tools (e.g., DJI GS Pro, Mission Planner)

10 Programming Waypoints: Creating and configuring flight paths for specific agricultural tasks

11 Simulated Autonomous Missions: Testing and refining flight plans in controlled settings

12 Field – Based Autonomous Missions: Executing automated flights in real agricultural environments

13 Drone Setup for Aerial Mapping: Configuring cameras and sensors for mapping tasks

14 Image and Video Capture: Collecting data over agricultural fields

15 Processing Drone Data: Generating NDVI maps and orthomosaic maps using tools like Pix4D or Drone Deploy

16 Data Analysis for Precision Agriculture: Identifying crop health, stress zones, and water management areas

17 Setting Up Drones for Spraying: Configuring liquid payloads for uniform application

18 Spraying Demonstration: Field demonstration of pesticide or fertilizer spraying

19 Seeding Configuration: Calibrating drones for solid payloads like seeds and granular fertilizers

20 Seeding Demonstration: Performing a precision seeding task in test plots

21‘ Routine Maintenance Practices: Cleaning, battery management, and propeller checks

22 Sensor and Camera Maintenance: Inspecting and calibrating for consistent performance

23 Battery and Power System Checks: Monitoring charging cycles and diagnosing power issues

24 Repairing Drone Parts: Replacing damaged propellers, motors, and payload systems

25 Troubleshooting Common Issues: Fixing GPS errors, sensor faults, and software glitches

26 Emergency Repairs: Handling drone crashes and critical malfunctions in the field

27 Pre – Flight Safety Drills: Ensuring compliance with safety protocols during operations

28 Understanding DGCA Regulations: Preparing registration and operational documentation

29 Environmental and Ethical Considerations: Safeguarding crops and the environment during drone use

30 Operational Compliance Demonstration: Conducting safe and regulation compliant drone operations

31 Field – Based Project Execution: Students execute a chosen agricultural task (mapping, spraying, or seeding) using drones

32 Project Presentation and Viva: Submission of project report and demonstration of findings in a viva

Module 4 Agro Processing Methods, Equipment Operation and Maintenance 2(0+2)

Course outlines

- Acquaintance with different unit operations involved in agro – processing
- Cleaning and grading of agricultural commodities: operation and maintenance of different cleaners, graders and destoners
- Operation and maintenance of dehusker, dehuller, degermer and dryer
- Operation and maintenance of rice milling machineries
- Operation and maintenance of dal mills and oil mill
- Operation and maintenance of flour mills and pulverisers
- Operation and maintenance of boiler, pasteurizer and sterilizer
- Operation and maintenance of peeler, slicer, pulper and juicer
- Operation and maintenance of canning machineries
- Operation and maintenance of packaging machineries

Practical

No. Practical outline

1 Introduction to various unit operations in Agro Processing

2 Operation and maintenance of Air Screen Cleaner

3 Operation and maintenance of Destoner

4 Operation and maintenance of Mini Rice mill

5 Operation and maintenance of Mini Rice mill

6 Operation and maintenance of Rice grader

7 Operation and maintenance of Mini dal mill

8 Operation and maintenance of Mini dal mill

9 Operation and maintenance of Pulses Grader

10 Operation and maintenance of Millet dehuller

11 Operation and maintenance of Millet dehusker

12 Operation and maintenance of Millet Grader
13 Operation and maintenance of Paddy dryer
14 Operation and maintenance of Paddy dryer
15 Operation and maintenance of Groundnut decorticator cum grader
16 Mid – Semester Practical Examination
17 Operation and maintenance of 4 bolt Oil expeller
18 Operation and maintenance of mini Oil expeller
19 Operation and maintenance of polyhouse solar dryer for chillies
20 Operation and maintenance of Steam boiler for turmeric
21 Operation and maintenance of on–farm turmeric polisher
22 Operation and maintenance of Pulveriser
23 Operation and maintenance of Flour mill (Burr/Plate mill)
24 Operation and maintenance of Vegetable slicer
25 Operation and maintenance of Potato/Onion peeler
26 Operation and maintenance of pulper
27 Operation and maintenance of Canning machinery
28 Operation and maintenance of milk pasteurizer
29 Operation and maintenance of Vacuum packaging machine
30 Operation and maintenance of Vertical form fill packaging machine
31 Operation and maintenance of Shrink-wrapping machine
32 Final Practical Examination

Module 5 Operation and Management of Multi–Commodity Agro– Processing Centre 2(0+2)

Course outlines

Practical

No. Practical outline

1 Acquaintance with different agro – processing models
2 Acquaintance with different agro – processing models
3 Site selection of Agro – Processing Centre
4 Site selection of Agro – Processing Centre
5 Plant layout of Agro – Processing Centre
6 Plant layout of Agro – Processing Centre
7 Project report preparation of Agro – Processing Centre
8 Project report preparation of Agro – Processing Centre
9 Manufacturing and management of primary processing centre

10 Manufacturing and management of primary processing centre
11 Preparation of grain-based products and acquaintance with operation of different equipment
12 Preparation of grain-based products and acquaintance with operation of different equipment
13 Preparation of pulse-based products and acquaintance with operation of different equipment
14 Preparation of pulse-based products and acquaintance with operation of different equipment
15 Preparation of oilseed-based products and acquaintance with operation of different equipment
16 Preparation of oilseed-based products and acquaintance with operation of different equipment
17 Preparation of products using flour mill
18 Spice processing and acquaintance with operation of different equipment
19 Spice processing and acquaintance with operation of different equipment
20 Operation and management of fruit and vegetable pack house
21 Preparation of different fruit-based products and acquaintance with operation of different equipment
22 Preparation of different fruit-based products and acquaintance with operation of different equipment
23 Preparation of different vegetable-based products and acquaintance with operation of different equipment
24 Preparation of different vegetable-based products and acquaintance with operation of different equipment
25 Manufacturing of snack foods
26 Acquaintance with food safety
27 Acquaintance with hygiene
28 Acquaintance with certifications
29 Record keeping for Agro – Processing
30 Inventory for Agro – Processing
31 Finance for Agro – Processing
32 Human resource management for Agro – Processing

Module 6 Repair and Maintenance of Tractors and Power Tillers 4(0+4)

* Study of different systems of tractor and power tiller
* Study of different components of engine: piston, cylinder, rings, fly wheel, firing interval, firing order

* Study of fuel system, working principle, repair and maintenance
* Working of fuel pumps, fuel filters and injectors
* Study of lubrication system, working principle, repair and maintenance
* Working of oil filters, oil pumps etc.
* Study of cooling system, working principle, repair and maintenance
* Working of thermostat valve
* Study of tractor/ power tiller engine system
* Study of power transmission system of tractor/ power tiller (different types of clutches/ gears/ sliding mesh gear box/constant mesh gear box/ planetary gear box etc. in tractor; power transmission in power tiller)
* Study of differential / final drive/ PTO drive, their working principle/ repair and maintenance
* Study of braking system: different types of brakes/ their components and working principle/ adjustment / repair
* Study of steering system, types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. working principle, adjustments, repair and maintenance
* Steering in power tiller: Dog clutch and other arrangements
* Study of hydraulic system of tractor, automatic draft and position control, hitch system, their working principle, practical hitching, repair and maintenance
* Study of tyres, rims, their construction and specification, repair and maintenance
* Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation
* Engine overhauling and assembling.
* Implement hitching and detaching from tractor as well as power tiller
* Safety rules

Module 7 Management of Agricultural Machinery Custom Hiring and Maintenance Facilities

* Terms associated with machinery management for correct understanding
* Different ways machinery can be obtained for use on the farm
* Factors that affect the purchase of machinery
* Advantages and limitations of two-wheel drive tractors
* Advantages and limitations of four-wheel drive tractors
* Calculation of the theoretical capacity of a farm machines
* General rules concerning field efficiency
* Calculation of field capacity of a farm machines
* Distinguishing between types of costs of machinery ownership
* Understanding how cost and machine use are related
* Calculation of salvage value of a farm machine

* Calculation of average machine investment of a farm machine
* Calculation of annual fixed cost of a farm machine
* Calculation of repair cost for a farm machine
* Calculation of fuel and lubrication costs for a tractor
* Calculation of labor cost for a farm machine
* Understanding causes of fatal tractor accidents
* Learning of procedures for safe machine operation
* Understanding the reasons for efficiency in tractor operation
* Preventative maintenance of farm Machinery
* List five areas of servicing machinery
* Calculate estimated variable cost of a farm machine
* Calculate overall cost per acre for farm machinery
* Calculate equipment width (size) to match tractor horsepower

Module 8 Fabrication, Operation and Maintenance of Renewable Energy Gadgets

* Acquaintance with different renewable energy sources (solar, wind, hydro, biomass, geothermal)
* Principles of photovoltaic (PV) technology, fabrication processes for solar panels and Installation and maintenance of solar power systems
* Grid-tied vs. off-grid solar systems
* Wind turbine technology and components, fabrication and installation of wind turbines., operation and maintenance practices for wind farms
* Pico hydro and their construction and maintenance
* Biomass sources and conversion technologies (combustion, gasification, anaerobic digestion)
* Fabrication of biomass energy systems like gasifier, Improved challah, etc.
* Routine maintenance procedures for renewable energy systems, Troubleshooting common issues
* Safety protocols for maintenance tasks; Monitoring and performance optimization
* Real-world examples of successful renewable energy projects, Hands-on projects to reinforce learning
* Acquaintance with the emerging trends in renewable energy, exploration of innovative technologies (tidal, wave, solar thermal, etc.)
* Renewable energy policies and incentives, regulatory compliance for renewable energy projects, environmental considerations and permitting processes

Module 9 Machine Vision, Sensors and Sensor Architectures

* Overview of machine vision systems and their applications, Importance of sensors in machine vision, Basic principles of image processing and analysis

* Classification of sensors based on various criteria (type of measurement, operating principle, etc.), Overview of common sensor types: optical sensors, proximity sensors, temperature sensors, pressure sensors, etc.
* Comparison of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications
* Components of a sensor system (sensor element, signal conditioning circuitry, interface electronics, etc.)
* Sensor characteristics: sensitivity, resolution, linearity, hysteresis, etc.
* Considerations in sensor selection and integration for specific applications
* Basics of image acquisition: sensors, lenses, lighting, Image processing techniques: filtering, edge detection, segmentation, feature extraction, etc., Role of algorithms in image analysis and interpretation
* Components and architecture of a typical machine vision system, Integration of sensors and vision systems for industrial automation and quality control
* Applications of machine vision in various industries (manufacturing, automotive, pharmaceuticals, etc.)
* Principles of 3D vision and depth sensing technologies, Types of 3D sensors: stereo vision, structured light, time-of-flight, etc.
* Applications of 3D vision in robotics, metrology, object recognition, etc.
* Examples of multisensor systems in real-world applications
* Overview of smart sensors and their capabilities (self-calibration, self-diagnosis, etc.), Integration of sensors into IoT (Internet of Things) platforms
* Case studies of IoT applications in agriculture
* Introduction to sensor networks, Communication protocols for sensor networks (Bluetooth, Zigbee, LoRaWAN, etc.)
* Basics of embedded vision systems, Integration of sensors and vision processing capabilities into embedded systems
* Applications of embedded vision in autonomous vehicles, drones, consumer electronics, etc.
* Real-world examples of sensor systems and machine vision applications, Hands-on exercises and projects involving sensor integration and image processing, Industry visits or guest lectures from professionals working in the field
* Emerging trends in sensor technology and machine vision, Challenges in developing advanced sensor systems (miniaturization, power efficiency, cost reduction, etc.), Ethical and societal implications of widespread sensor deployment and data collection

Module 10 Design of Solar PV Systems Using Softwares

* Overview of software tools commonly used for solar PV system design (e.g., PV*SOL, Helioscope, PVSyst, SAM), Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares

* Features for designing a solar PV system (location, load requirements, shading analysis, etc.), Gathering necessary input data: site location, solar irradiance data, system specifications, electrical load profile, etc.
* Conducting a site analysis to assess the solar potential and available space for PV system installation, using software tools to perform shading analysis and identify potential obstructions or shading issues
* Determining the appropriate size of the solar PV system, Selecting PV modules, inverters, mounting structures, and other system components. Optimizing the system configuration to maximize energy production and efficiency
* Creating a layout for the solar PV array using the software's design tools, Placing PV modules on the roof or ground in optimal orientations and configurations
* Designing the electrical wiring and connection scheme for the PV array, inverters, and other components
* Running simulations to estimate the performance and energy yield of the proposed PV system, analyzing simulation results to evaluate the system's energy production, capacity factor, and f financial viability
* Fine-tuning system parameters to optimize performance and maximize energy output
* Performing a financial analysis to assess the economic feasibility of the solar PV project, Calculating the return on investment (ROI), payback period, net present value (NPV), and other financial metrics, Considering incentives, subsidies, and financing options for solar PV installations
* Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., module efficiency, system size, electricity tariffs) on project economics, iteratively refining the system design to achieve the desired performance and economic outcomes
* Generating detailed reports and documentation summarizing the design process, simulation results, and project economics
* Case studies based on real-world projects to apply learned concepts and techniques
* Addressing common challenges and troubleshooting issues encountered during the design process.

Module 11 Installation and Maintenance of On-Grid and Off-Grid Solar Systems

* Overview of solar photovoltaic technology and its applications, Explanation of on-grid and off-grid solar systems
* Identification and explanation of key components in solar PV systems (solar panels, inverters, charge controllers, batteries, wiring, etc.)
* Understanding the differences between on-grid and off-grid system configurations
* Component identification and system layout design
* Conducting site assessments to determine solar potential and suitability for PV system installation. Considerations for system sizing, orientation, and tilt angle, Planning the layout of solar panels, mounting structures, and electrical components

* Installation of solar panels, inverters, and other components for on-grid systems, Techniques for mounting solar panels on rooftops or ground-mounted structures
* Wiring and connection of components to the electrical grid
* Setting up off-grid solar systems, including battery-based energy storage, Installation of charge controllers, batteries, and DC loads
* Designing and configuring off-grid systems for reliable and efficient operation
* Electrical wiring practices for solar PV systems
* Understanding safety precautions and regulations related to electrical installations
* Wiring solar panels, inverters, charge controllers, and battery banks
* Commissioning and testing of solar PV systems to ensure proper functionality, conducting performance tests and verifying system parameters
* Troubleshooting common issues and addressing installation errors
* Routine maintenance tasks for on-grid solar PV systems, including cleaning, inspection, and performance monitoring, Diagnosis and troubleshooting of grid-connected system components
* Specialized maintenance requirements for off-grid solar systems, including battery maintenance and charge controller calibration
* Techniques for integrating additional solar panels, batteries, or other components into existing systems
* System modification and expansion
* Introduction to remote monitoring systems for tracking the performance of solar PV systems, using data analytics tools to diagnose issues and optimize system performance, Hands-on practice in accessing system data and interpreting performance metrics

Module 12 Design and Maintenance of Agrivoltaic Systems

* Overview of agrivoltaic systems and their benefits, Explanation of how solar panels and agriculture can coexist synergistically
* Factors to consider when selecting a site for an agrivoltaic system (climate, soil, topography, etc.), Conducting site assessments to determine solar potential and suitability for agricultural activities
* Design principles for integrating solar panels with agricultural crops or livestock, Planning the layout and configuration of the agrivoltaic system to maximize energy production and crop yield
* Selection of appropriate crops and planting strategies for agrivoltaic systems
* Installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture
* Safety protocols and best practices for working with solar panel arrays
* Crop selection and management practices suitable for agrivoltaic systems, Monitoring soil moisture, nutrient levels, and crop health

- Implementing irrigation, fertilization, and pest management strategies tailored to agrivoltaic conditions
- Designing the electrical layout for connecting solar panels to the grid or off-grid systems, Installation of wiring, inverters, combiner boxes, and other electrical components, Compliance with electrical codes and safety standards
- Routine maintenance tasks for solar panels, support structures, and electrical components, Monitoring system performance and troubleshooting common issues, equipment inspection, cleaning, and maintenance
- Introduction to data monitoring systems for tracking energy production, crop yield, and environmental conditions, Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns
- Overview of regulations, permits, and incentives related to agrivoltaic installations, Compliance with zoning laws, land use regulations, and environmental regulations, Advocacy for supportive policies and incentives to encourage the adoption of agrivoltaics
- Visits to agrivoltaic installations and research sites for hands-on learning opportunities, Practical demonstrations of agrivoltaic techniques and technologies, Interaction with practitioners and experts in the field

Module 13 Valorisation of Agri-biomass and Organic Waste

* Concept of valorization and its role in waste-to-value processes, Introduction to the types of agri-biomass and organic waste commonly generated in agriculture and food production
* Methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.), Understanding the properties and potential uses of different types of biomass and waste materials
* Sample collection, preparation, and analysis
* Introduction to biological conversion methods such as anaerobic digestion and composting, Principles of microbial decomposition and fermentation in biomass conversion
* Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing, Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes
* Introduction to biochemical and biotechnological approaches for valorizing biomass and organic waste, Utilization of enzymes, microorganisms, and fermentation processes in bioconversion
* Methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.)
* Valorization of agri-biomass and organic waste into value-added products such as biochar, bio based chemicals, and biomaterials

* Strategies for waste minimization, reuse, and recycling in agricultural and food production systems
* Emerging trends such as agri-biomass and organic waste valorization technologies, precision biomass conversion and integrated bio-refinery concepts
* Overview of regulations, standards, and policies governing the valorization of agri-biomass and organic waste

Module 14 Energy audit, Energy Conservation and Energy Efficiency

* Key concepts and definitions related to energy conservation and efficiency
* Introduction to the principles of energy auditing and analysis
* Methods for collecting and analyzing energy consumption data
* Interpretation of energy bills, utility data, and meter readings
* Conducting energy audits for residential, commercial, and industrial facilities
* Introduction to energy auditing tools and equipment (e.g., power meters, data loggers, thermal imaging cameras)
* Use of software tools for energy data analysis and visualization
* Identifying potential areas for energy savings and efficiency improvements, Evaluation of building systems, equipment, and operations
* Hands-on exercises in identifying ECOs through site inspections and data analysis
* Overview of energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc, Demonstration of energy-saving devices and equipment, Case studies of successful energy efficiency projects
* Analysis of building energy performance using energy modelling software
* Integration of renewable energy systems (solar PV, wind, geothermal, etc.) with energy conservation and efficiency measures
* Overview of energy efficiency policies, regulations, and incentives at local, national, and international levels
* Energy efficiency standards, labeling programs, and building codes
* Cost-benefit analysis, return on investment (ROI) calculations, and lifecycle cost analysis
* Use of measurement and verification (M&V) protocols and reporting

Module 15 Repair and maintenance of pumps and irrigation systems

* Acquaint with different pumps and motors used in irrigation system
* Study of various water lifting devices and their limitations
* Study of components of centrifugal pump and its function
* Study of components of submersible pump and its function
* Components of reciprocating pump and its function
* Dismantling and assembling of irrigation pumps
* Performance testing of centrifugal pumps

* Preparation of pump housing
* Pump alignment and troubleshooting
* Knowing different accessories for electric pump
* Winding of 3-phase and single-phase electric motor
* Causes of trouble shooting in electrical pump set and their remedial measures
* Dismantling and assembling of diesel pump set
* Causes of trouble shooting in diesel pump set and their remedial measures
* Regular maintenance and overhauling, lubrication of pumps
* Study of solar pump set, and its components
* Step-wise installation of solar pump set including earthing

Module 16 Application of Remote Sensing and GIS for Agricultural Water Management

* Basics of remote sensing
* Remote sensing sensors and platforms
* Introduction to GIS
* Types of projection systems
* Study of Image resolutions and coordinate system
* Source of remote sensing data and accessibility
* Operations in Google earth platform
* Introduction to basic modules of ArcGIS
* Introduction to basic modules of QGIS
* Georeferencing, rectification, digitization and shape file creation
* Basic raster/vector data operations
* Map projection and re-projection
* Preparation of contour maps and rainfall Thiessen polygons
* Map layout and styling
* Preparation of various vegetation index maps
* Preparation of various wetness index maps
* Delineation of watershed and derivation of morphological parameters

Module 17 Operation and Maintenance of Hydro-meteorological Instruments

* Study and operation of Weather Monitoring Instruments: Thermometer, Barometer, Hygrometer; Anemometer, Pyranometer and others
* Components of an automatic weather station (AWS)
* Installation of AWS and its maintenance
* Calibration and installation of Tipping bucket raingauge
* Installation of open pan evaporimeter and periodic maintenance

* Study of infiltration process using ring infiltrometer
* Measurement of flow in open channels using various methods
* Study of different weirs and flumes for flow measurement
* Installation of weirs and flumes in the channel
* Measurement of soil moisture using gravimetric method
* In-situ measurement of soil moisture using different soil moisture sensors
* Installation of digital water level recorder (DWLR)
* Measurement of groundwater level using ground water level recorder
* Study of multi-slot divisor and Coshocton wheel silt sampler for measurement of soil loss
* Measurement of flow velocity using digital current meter
* Procedure for recording field observations
* Troubleshooting of hydro-meteorological instruments

Module 18 Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/ Bore Well

* Learn about different features of groundwater system
* Study of different types of geophysical survey
* Components of a resistivity meter
* Wenner-Schlumberger arrangement and comparison
* Process of geophysical survey in field
* Surveyed data analysis and interpretation
* Different types of well log and preparation of commonly used well log
* Study of different types of wells
* Study the components of a tube well/ bore well
* Study of different types of drilling methods/ equipment
* Installation of well assembly: types of casing, screen
* Study on gravel packing
* Study of well development process
* Sanitary protection of tube wells

Module 19 Installation and Maintenance of Rooftop Rainwater Harvesting System

* Survey and site selection for RRWH
* Computation of rooftop RWH potential and runoff coefficient
* Study of components of RWH system
* Catchments: grading and plastering of rooftop
* Coarse mesh, gutters; roofing materials
* Conduit: material, size of conveyance pipe

* Types of filter system used in RWH system
* Study of storage tank: capacity, overflow pipe
* Study of suitable recharge structure for groundwater
* Study of constructional details of recharge pits, recharge trench
* Types of contaminants in RWH system
* Hand pumps and its application in RWH system
* Preparation of Detail Project Report

Module 20 Operation and Maintenance of Soil Conservation Structures

* Survey for slope, stream order and land use/land cover
* Site selection of soil conservation structures based on survey
* Ground truthing of various structures
* Study of different types of soil conservation structures
* Trenching and diversions structures
* Study of types bunding and its features
* Study of types of terracing and its features
* Study of drop spill way: components, function, site suitability
* Study of drop inlet spillway: components, function, site suitability
* Study of chute spillway: components, function, site suitability
* Study of check dams- construction, site suitability
* Study of construction materials of different structures
* Cost estimation of different conservation structures
* Preparation of Detail Project Report

Module 21 Construction, Management and Maintenance of protected cultivation structures

* Study of different protected structures and their uses
* Acquaint with different components of protected structures
* Construction of different protected structures
* Study of glazing materials and their properties
* Selection of different construction materials and their specifications
* Management of micro climate parameters in protected structures
* Monitoring of micro climate inside protected structures
* Automatic monitoring of micro climate inside protected structure
* Use of Irrigation and fertigation in protected cultivation
* Visit to different hydroponics systems under protected structures

Module 22 Primary Processing and Value Addition and Cold Chain Logistics

* Primary processing of fruits and vegetables
* Operation and maintenance of washer and graders

* Study of refrigeration system and freezing equipment
* Operation of precooling systems
* Operation and maintenance of cold storage and solar cold room
* Operation and maintenance of ripening chamber
* Cool chain logistics and cold transport: chilled transport van, semi chilled transport, refrigerated van system
* Cooling systems/ cold chain technology: Gel pack, dry ice, liquid nitrogen, eutectic plates, reefers, cold chain standards and regulations
* Supply chain management systems planning, sourcing, manufacturing, delivering, returning, types of SCM models • Supply chain logistics, contract logistics

Module 23 Food Grain Godown and Warehouse Management

* Conversant with technical terms of grain storage, measurement of temperature, relative humidity, grain sampling and moisture content measurement, grain quality
* Acquaintance with different factors for grain deterioration during storage and main insects of stored commodities
* Acquaintance with warehouse equipment and different storage structures
* Cleaning, drying and aeration of stored products
* Determination of dimension of warehouse for bag storage
* Acquaintance with constructional features, maintenance, sanitation and hygiene of warehouses
* Study on integrated pest management, chemical and non-chemical pest and rodent control measures in grain storage system
* Detection methods of insect infestation in food grains and prevention and control of storage fungi
* Acquaintance with inventory, logistics, and collateral management
* Guideline for procurement and disposal of food grains
* Quality control of food grains

Module 24 Post-harvest Value Chain Management Including Logistics

* Understanding the concept of post-harvest value chain
* Study of existing supply chain of different commodities
* Case study and analysis of value chain of food grains
* Case study and analysis of value chain of horticultural commodities
* Sourcing and material management
* Handling, packing and storage of agricultural commodities
* Transportation and marketing of agricultural commodities
* Ware house management
* Cold storage management
* Cold chain logistics and supply chain management system
* Quality management and tracking food supply chain

ELECTIVE COURSES

FMPE 411 Mechanics of Tillage and Traction 3(2+1)

Course outlines

Objective

To enable the students to know various engineering properties of soil and to understand the effect of these properties on the performance of tillage tools. To know the application of dimensional analysis on soil dynamics and traction. Understand the effect of soil compaction on crop growth and to know the use of GIS in soil dynamics.

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, tyres-functions, size, lug geometry and their effects, tyre selection and testing; Soil compaction and plant growth and variability; 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.

Lecture outlines

Theory

No. Lecture outline

Unit-I

1. History of tillage
2. Soil-machine crop system
3. Mechanics of tillage tools
4. Analysis of soil-machine dynamics in tillage

Unit-II

5. Physical properties of soils
6. Mechanical properties of soils
7. Assessment of the dynamic properties of soils
8. Assessment of the dynamic properties of soils

Unit-III

9. Design of tillage tools
10. Design of tillage tools
11. Mould board plough surfaces
12. Principles of soil cutting

Unit-IV

13. Design equation
14. Dimensional Analysis
15. Development of prediction equations
16. Methods of dimensional analysis

Unit-V

17. Application of dimensional analysis and similitude to soil mechanics
18. Traction
19. Traction mechanics
20. Off road traction

Unit-VI

21. Traction model
22. Traction improvement and traction prediction
23. Cone index and tire basics
24. Tires for agricultural tractors

Unit-VII

25. Tire terminology and selection of tires
26. Ballasting
27. Soil compaction
28. Mechanical and hydraulic properties of compacted soil

Unit-VIII

29. Soil physical properties and plant growth
30. Measures for optimizing crop growth by avoiding excessive soil compaction
31. Geo-statistics / kriging
32. GIS for soil variability studies

Practical

No. Practical outline

1. Measurement of static and dynamic soil parameters related to tillage.
2. Measurement of soil parameters related to puddling and floatation.
3. Measurement of draft for passive, rotary and oscillating tools.
4. Measurement of slip and shrinkage under dry and wet soil conditions.
5. Measurement of load and fuel consumption for different farm operations.
6. Economics of weight transfer and tractor loading including placement and traction aids.
7. Studies on tyres, tracks and treads under different conditions.
8. Studies on compaction and number of operations.
9. Problems on mechanics of tillage tools.
10. Problems on design of traction devices.
11. Problems on design of transport devices.
12. Problems on soil dynamics in soil machine systems.
13. Problems on determination of stress and strains.
14. Study of the techniques for evaluating soil structure.
15. Application of GIS in soil dynamics.
16. Application of GIS in soil dynamics

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1. Gill and Vandenberg. 1968. *Soil Dynamics in Tillage and Traction*. Agricultural Research Service, USDA, Govt. Printing Press, Washington, D.C.
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3. Macmillan R H. 2002. *The Mechanics of Tractor-Implement Performance*. International Development Technologies Centre, University of Melbourne.
4. Terzaghi K and Peck R B and Mesri G. 1996. *Soil Mechanics in Engineering Practices*. John Willey & Sons.

FMPE 412 Farm Machinery Design and Production 3(2+1)

Course outlines

Objective

To enable the students to design farm machinery and to understand the production principles.

Theory

Introduction to design parameters of agricultural machines and design procedure, characteristics of farm machinery design, research and development aspects of farm machinery; Introduction to safety in power transmission; Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units; Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill, reaper, thresher and digger; Critical appraisal in production of agricultural machinery, advances in material used for agricultural machinery; Cutting tools including CNC tools and finishing tools; Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits and tolerances, jigs and 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 and equipment; Visit to agricultural machinery manufacturing industry, tractor manufacturing industry; Study of jigs and fixtures in relation to agricultural machinery; Study of 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.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Introduction to design parameters of agricultural machines and design procedure.
2. Characteristics of farm machinery design.
3. Research and development aspects of farm machinery.
4. Introduction to safety in power transmission.

Unit II

5. Design of standard power transmission components used in agricultural machines – Gear drives.
6. Design of standard power transmission components used in agricultural machines – Flat and V-belt drives.
7. Design of standard power transmission components used in agricultural machines – Chain drives.
8. Design of standard power transmission components used in agricultural machines – Introduction to hydraulics and hydraulic power transfer in farm machinery systems.

Unit III

9. Application of design principles to the systems of selected farm machines – Disc plough and cultivator.
10. Application of design principles to the systems of selected farm machines – Seed drill.
11. Application of design principles to the systems of selected farm machines – Digger and reaper.
12. Application of design principles to the systems of selected farm machines – Thresher.

Unit IV

13. Critical appraisal in production of agricultural machinery.
14. Various metallic materials used for manufacturing of agricultural machinery components.
15. Various non-metallic materials used for manufacturing of agricultural machinery components.
16. Characteristics and chronological development of cutting tools.

Unit V

17. Cutting tools for CNC machines.
18. Cutting tools for finishing operations.
19. Introduction to advanced manufacturing techniques
20. Different heat treatment methods for steel.

Unit VI

21. Pack carburizing process for steel.
22. Shot piping process for steel.
23. Limits, fits and tolerances.
24. Jigs and fixtures.

Unit VII

25. Industrial layout planning – Space planning, activity centres, factors for consideration in space planning, determination of space requirements.
26. Industrial layout planning – area allocation, factors considered for area allocation, plant layout, factors affecting layout, layout of services, types of layout problems, methods of layout.
27. Quality production management and reliability.
28. Reliability.

Unit VIII

29. Economics of process selection.
30. Techno economic feasibility of project report.
31. Familiarization with project report – case study of cultivator shovels.
32. Familiarization with project report - case study of weeders

Practical

No.	Practical outline
1.	Familiarization with different aspects of farm machinery and selected components.
2.	Solving design problems on farm machinery and equipment.
3.	Solving design problems on farm machinery and equipment.
4.	Visit to agricultural machinery manufacturing industry.
5.	Visit to agricultural tractor manufacturing industry.
6.	Jigs and fixtures – study in relation to agricultural machinery.
7.	Jigs and fixtures – study in relation to agricultural machinery.
8.	Agricultural machines – Fits, tolerances and limits.
9.	Agricultural machines – Fits, tolerances and limits.
10.	Layout planning of a small-scale industry.
11.	Problems on economics of process selection.
12.	Problems on economics of process selection.
13.	Preparation of project report.
14.	Case study for manufacturing of simple agricultural machinery.
15.	Case study for manufacturing of simple agricultural machinery.
16.	Case study for manufacturing of simple agricultural machinery

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6. Singh, S. 2016. *Mechanical Engineer's Handbook*. Khanna Publications, New Delhi.

FMPE 413 Tractor Design and Testing 3(2+1)

Course outlines

Objective

To enable the students to understand the parameters for balanced design of tractor for stability and weight distribution, to study the special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc. and learn the procedure for testing of tractor.

Theory

Procedure for design and development of agricultural tractor; Study of parameters for balanced design of tractor for stability and 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 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 center/ industry.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction - design and development of agricultural tractor, classifications and selection of tractors.

2 Parameters to be considered for design of tractors and trends in tractors.

3 Study of parameters for balanced design of tractor for stability, weight distribution, weight transfer in tractors, location of center of gravity.

4 Study of parameters for balanced design of tractor for stability, weight distribution, weight transfer in tractors, location of center of gravity.

Unit II

5 Traction theory, hydraulic lift and hitch system design.

6 Traction theory, hydraulic lift and hitch system design.

7 Complete drive train, transmission types, friction brakes and clutches.

8 Bevel gears and gear design.

Unit III

9 Differentials and transmission shafts.

10 Design of single disc, multi disc and cone clutches.

11 Design of single disc, multi disc and cone clutches.

12 Design of rolling friction and anti-friction bearings.

Unit IV

13 Design of rolling friction and anti-friction bearings.

14 Steering system, qualities of steering system, steering geometry, design of ackerman steering.

15 Working of hydraulic and power steering, maintenance, steering and front end trouble shooting.

16 Working of hydraulic and power steering, maintenance, steering and front end trouble shooting.

Unit V

17 Study of special design features of tractor engine and their selection.

18 Study of special design features of tractor engine and their selection.

19 Design of engine cylinder, piston, piston pin, crank shaft.

20 Design of engine cylinder, piston, piston pin, crank shaft.

Unit VI

21 Design of engine cylinder, piston, piston pin, crank shaft.

22 Design of seat and controls of agricultural tractor.

23 Design of seat and controls of agricultural tractor.

24 Tractor hydraulic systems, principles of hydraulics, working of hydraulic system, components of hydraulic circuits, different valves in hydraulic system.

Unit VII

25 Tractor hydraulic systems, principles of hydraulics, working of hydraulic system, components of hydraulic circuits, different valves in hydraulic system.

26 Hydraulic controls, position control system, draft control system, maintenance and repair of hydraulic system.

27 Hydraulic controls, position control system, draft control system, maintenance and repair of hydraulic system.

28 Tractor engines, types, special design features, technical terms and specifications.

Unit VIII

29 Tractor testing; introduction, testing and evaluation system in India, testing facilities in India.

30 Types of tests; commercial and confidential tests, OECD test, test code for tractor testing.

31 Instruments for testing tractor; dynamometers, sound meters, accelerometers, load cell etc.,

32 Tractor testing; PTO performance test, drawbar performance test, hydraulic power test, hydraulic lift test, brake test, noise test, vibration test etc.,

Practical

No.	Practical outline
1	Design problem of tractor clutch.
2	Design problem on spur gears.
3	Design problem of bevel gears.
4	Design problems of helical gears.
5	Design of gear box (synchromesh/ contact mesh).
6	Design of variable speed contact mesh drive.
7	Selection of tractor tires- Problem solving.
8	Problem on design of governor.
9	Problem related to selection of hydraulic pump.
10	Engine testing as per BIS code.
11	Drawbar performance in the lab.
12	PTO test and measurement of tractor power in the lab/field
13	Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test.
14	Design of seat and controls of agricultural tractor.
15	Visit to local tractor service center/ industry.
16	Visit to local tractor service center/ industry.

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FMPE 414 Hydraulic Drives and Controls 3(2+1)

Course outlines

Objective

To enable the students to understand the basic principles of hydraulic power system and tractor hydraulic system and different control measures.

Theory

Basics of hydraulics: Pascal's law, flow, energy, work, and power; Hydraulic systems, colour coding, reservoirs, strainers and filters, filtering material and elements, accumulators, pressure gauges and volume meters; Hydraulic circuit, fittings and connectors; Pumps and its classifications, operation, performance, displacement; Design of gear 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; USA Standards Institute (USASI) symbols; Tractor hydraulics, nudging system, ADDC, application of hydraulics and pneumatics drives in agricultural systems.

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.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Introduction to Hydraulics, Pascal's Law and its role in fluid power systems
2	Hydraulic Flow, Energy, Work, and Power, Examples of Hydraulic power transfer in agricultural systems
3	Hydraulic System -Components like reservoirs, strainers, accumulators, pressure gauges, volume meters, nipples, connectors, and hydraulic hoses and filters
4	Properties of fluids used in hydraulic system, Colour coding in hydraulic systems
Unit II	
5	Types of hydraulic pumps: gear, vane, and piston pumps, Operational principles and uses in agricultural systems.
6	Gear Pumps:Construction, design, operation, application and performance characteristics of gear pumps.
7	Vane Pumps:Construction, design, operation, application and performance characteristics of vane pumps
8	Piston Pumps: Construction, design, operation, applications and performance characteristics of vane pumps
Unit III	
9	Hydraulic Actuators-Definition, types, working principles and role of actuators in converting hydraulic energy into mechanical motion.
10	Hydraulic Cylinders- Components, construction, working principle, types, applications and its Performance and Efficiency

11 Hydraulic Motors- Components, construction, working principle, types, applications and its Performance and Efficiency

12 Trouble shooting and maintenance of Hydraulic cylinders and motors

Unit IV

13 Introduction to Hydraulic Valves-Overview, types and functions of valves and their importance in controlling flow, pressure, and direction.

14 Directional Control Valves- Function, types and their operation, Valve Actuation Methods, Installation and Maintenance Considerations.

15 Pressure and Flow Control Valves- Functions, types and their operation, Valve Actuation Methods, Installation and Maintenance Considerations.

16 Valve Selection, Troubleshooting, and Maintenance

Unit V

17 Basic concepts and functions of hydraulic fittings in fluid power systems, types, Selection and design of fittings

18 Nipples, Pipes, and Connectors in Hydraulic Systems, unction's and selection criteria

19 Hydraulic Hoses- Design, Construction, types, Selection, and Application

20 Troubleshooting Hydraulic Fittings and Hoses

Unit VI

21 Basic concepts, types and applications of hydraulic circuits.

22 Components of a Hydraulic Circuit

23 Understanding USASI symbols and their usage in hydraulic circuit diagrams.

24 Designing a hydraulic circuit-factors and case study

Unit VII

25 Overview of hydraulic systems in tractors and their importance in agricultural operations

26 Working principle and application of nudging systems in tractors for improved control.

27 Automatic Draft and Depth Control (ADDC)-Principle, working and construction

28 Maintenance techniques for hydraulic systems in tractors

Unit VIII

29 Introduction to Hydraulics and Pneumatics in Agriculture- overview, differences, key components and importance

30 Hydraulics in Agricultural Equipment-Hydraulic drives, actuators and steering systems

31 Pneumatics in Agricultural Systems-Pneumatic drives, actuators

32 Combined Use of Hydraulics and Pneumatics in Agricultural Automation Integration, working, challenges and benefits

Practical

No.	Practical outline
1	Study the basic components of a hydraulic system
2	Study the operation of different types of hydraulic pumps
3	Study the operation of hydraulic cylinders and hydraulic motors as actuators
4	Study different types of hydraulic valves
5	Study of hydraulic colour codes and circuits
6	Design and assemble basic hydraulic circuits
7	Troubleshooting of Hydraulic Circuits
8	Operation and maintenance of tractor hydraulic and steering system
9	Study the hydraulic system of tractor front hoe and back dozer
10	Study the basic components of a pneumatic system
11	Design a simple pneumatic circuit using pneumatic cylinders and control valves
12	Study the Comparative performance of hydraulic and pneumatic systems
13	Study the Maintenance of Hydraulic and Pneumatic Systems
14	Study the Hybrid Hydraulic-Pneumatic System
15	Study of Electro-hydraulic systems in robotic
16	Case study on Pneumatic applications in robotic systems

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FMPE 415 Human Engineering and Safety 3(2+1)

Course outlines

Objective

To enable the students to understand the importance of human factors/ human engineering in farm machine design as well as for Implementation of ODMR and other safety aspects in farm operation.

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 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, thermo – regulation in human, thermal comfort, environmental factors, air pollution; Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims; Safety gadgets for spraying, threshing, chaff cutting and tractor and 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, anthropometric measurements of a selected subject; 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; Studies on drudgery of farm women in manual drawn equipment.

Lecture outlines

Theory

No.	**Lecture outline**
Unit I	
1	Human factors in system development- concept of systems
2	Human factors in system development- concept of systems
3	Basic processes in system development
4	Performance reliability
Unit II	
5	Human performance
6	Information input process
7	Visual displays
8	Major types and use of displays
Unit III	
9	Auditory displays
10	Speech communications
11	Biomechanics of motion
12	Types of movements

Unit IV

13 Range of movements

14 Strength and endurance

15 Speed and accuracy

16 Human control of systems

Unit V

17 Human motor activities

18 Human controls and tools

19 Human related devices

20 Human related devices

Unit VI

21 Anthropometry: arrangement and utilization of work space

22 Anthropometry: arrangement and utilization of work space

23 Atmospheric conditions, thermo – regulation in human

24 Thermal comfort, environmental factors

Unit VII

25 Air pollution

26 Dangerous machine (Regulation) act – Duties and Responsibilities

27 rehabilitation and compensation to accident victims

28 Safety gadgets for spraying

Unit VIII

29 Safety gadgets for threshing operation

30 Safety gadgets for chaff cutting operation

31 Safety gadgets for tractor operation

32 Safety gadgets for trailer operation

Practical

No. Practical outline

1. Calibration of the subject in the laboratory using bi-cycle ergo-meter
2. Calibration of the subject in the laboratory using bi-cycle ergo-meter
3. Study and calibration of the subject in the laboratory using mechanical treadmill
4. Study and calibration of the subject in the laboratory using mechanical treadmill
5. Use of respiration gas meter from human energy point of view
6. Use of respiration gas meter from human energy point of view
7. Use of heart rate monitor
8. Study of general fatigue of the subject using Blink ratio method

9. Anthropometric measurements of a selected subject
10. Optimum work space layout and locations of controls for different tractors
11. Familiarization with the noise and vibration equipment
12. Familiarization with safety gadgets for various farm machines
13. Studies on drudgery of farm men for manual operated small tools
14. Studies on drudgery of farm women for manual operated small tools
15. Studies on drudgery of farm men/women in manual drawn equipment
16. Studies on drudgery of farm men/women in manual drawn equipment

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FMPE 416 Precision Agriculture and System Management 3(2+1)

Course outlines

Objective

To enable the students to understand the principles of precision agriculture and system management and the use of different equipment in precision agriculture. To learn the GIS based precision agriculture, sensors and application of sensors for data generation.

Theory

Precision agriculture- need and functional requirements; Familiarization with issues relating to natural resources; Equipment for precision agriculture including sowing and planting machines, power sprayers, air blast sprayers, drone sprayer, land scaping machines, laser guided land levelers, harvester, straw-balers, multi crop thresher, grain combines, robotic harvester, 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; Applications of IoT in agriculture; Application of PERT and CPM in machinery system management; Review of Cost/Benefit of precision agriculture.

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, inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money, etc, Development of a business plan for integrating of Precision Agriculture technology.

Lecture outlines

Theory

No	Lecture outline
Unit I	
1	Precision agriculture- need and functional requirements
2	Precision agriculture- need and functional requirements
3	Familiarization with issues relating to natural resources
4	Familiarization with issues relating to natural resources
Unit II	
5	Familiarization of equipment for precision agriculture with sowing machines
6	Familiarization of equipment for precision agriculture with planting machines
7	Familiarization of equipment for precision agriculture with power sprayers
8	Familiarization of equipment for precision agriculture with air blast sprayer
Unit III	
9	Familiarization of equipment for precision agriculture with drone sprayer
10	Familiarization of equipment for precision agriculture with land scaping machine
11	Familiarization of equipment for precision agriculture with laser guided land levelers
12	Familiarization of equipment for precision agriculture with harvesters
Unit IV	
13	Familiarization of equipment for precision agriculture with straw baler
14	Familiarization of equipment for precision agriculture with multi crop thresher
15	Familiarization of equipment for precision agriculture with grain combine
16	Familiarization of equipment for precision agriculture with robotic harvester

Unit V

17 Introduction to GIS based precision agriculture and its applications

18 Introduction to GIS based precision agriculture and its applications

19 Introduction to sensors and application of sensors for data generation

20 Introduction to sensors and application of sensors for data generation

Unit VI

21 Database management

22 Database management

23 System concept, system approach in farm machinery management

24 System concept, system approach in farm machinery management

Unit VII

25 Problems on machinery selection

26 Problems on machinery selection

27 Maintenance and scheduling of operations

28 Applications of IoT in agriculture

Unit VIII

29 Application of PERT in machinery system management

30 Application of PERT in machinery system management

31 Application of CPM in machinery system management

32 Review of Cost/Benefit of precision agriculture

Practical

No Practical outline

1. Familiarization with precision agriculture problems and issues
2. Familiarization with precision agriculture problems and issues
3. Familiarization with various machines for resource conservation
4. Familiarization with various machines for resource conservation
5. Solving problems related to various capacities, pattern efficiency, system limitation
6. Solving problems related to various capacities, pattern efficiency, system limitation
7. Solving problems related to various capacities, pattern efficiency, system limitation
8. Problems related to cost analysis
9. Problems related to cost analysis
10. Problems related to inflation
11. Problems related to inflation
12. Problems related to selection of equipment
13. Problems related to selection of equipment
14. Problems related to replacement, break-even analysis, time value of money

15. Development of a business plan for integrating of Precision Agriculture technology
16. Development of a business plan for integrating of Precision Agriculture technology

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REEN 451 Photovoltaic Technology and Systems 3(2+1)

Course outlines

Objective

To enable the students to understand the basic elements of photovoltaics, working of PV cells, designs of PV systems and to know the installation of PV system both off grid and on grid.

Theory

Solar PV Technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: 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; Solar PV system designing and cost estimation;

Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) 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.

Lecture outlines

Theory

No.	Lecture outline
Unit I: Solar PV Technology	
1	Introduction to solar energy, advantages, limitations of PV technology
2	current status of PV technology
3	SWOT analysis of PV technology
Unit II: Types of solar cells	
4	Wafer based silicon cell
5	Thin film amorphous silicon cell,
6	Thin Cadmium Telluride (CdTe) Cell
7	Copper Indium Gallium Selenide (CiGS) Cell
8	Thin film crystalline silicon solar cell
Unit III: Solar photo voltaic module	
9	solar cell and its fundamentals
10	solar module, solar array
11	series connections of cell
12	Parallel connections of cell
13	mismatch in cell, fill factor
14	effect of solar radiation and temperature on power output of module
15	I-V and power curve of module
Unit IV: Balance of solar PV system	
16	Introduction and Definition of Balance of System
17	Solar PV system designing and cost estimation
Unit IV: Introduction to batteries	
18	Types of batteries, battery classification, lead acid battery,
19	Nickel Cadmium battery, comparison of batteries
20	battery parameters

Unit V: Charge controller

21 types and function of charge controller

22 PWM (Pulse width modulation) type

23 MPPT (Maximum Power Point Tracking) type charge controller

Unit VI: Converters

24 DC to DC converter

25 DC to AC type converter

Unit VII: Application of solar PV system

26 solar home lighting system,

27 solar lantern,

28 solar fencing,

29 solar street light,

30 solar water pumping system,

31 roof top solar photovoltaic power plant and

32 smart grid technology

Practical

No	Practical outline
1	Study of V-I characteristics of solar PV system
2	Smart grid technology
3	Application of smart grid technology
4	Manufacturing technique of solar array
5	Converters DC to DC
6	Converters DC to DC
7	Converters DC to AC
8	Converters DC to AC
9	Domestic solar lighting system
10	Various solar module technologies
11	Various solar module technologies
12	Study of MAP
13	Safe measurement of PV modules electrical characteristics
14	Safe measurement of PV modules electrical characteristics
15	Commissioning of complete solar PV system
16	Visit of solar farm/Practical Examination

References

1 Rai G D. 1998. Non-conventional Sources of Energy. Khanna Pub.

2. Rathore N S, Kurchania A K and Panwar N L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications.

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5. Derrick A, Francis C and Bokalders V. 1991. Solar Photo-voltaic Products. Intermediate Technology Publications.

REEN 452 Wind Power Technology and Systems 3(2+1)

Course outlines

Objective

To enable the students to calculate and analyse wind resource and energy production from a wind turbine, to understand the typical control methods for wind turbines and the modes of wind power generation.

Theory

Introduction to wind energy-Wind Characteristics, Wind Data Analysis, Wind Prediction and Forecasting,Wind Measurement and Instrumentation

Aerodynamic operations of wind turbines; Wind energy extraction and wind turbine power generation;

Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator; Types of wind energy systems, wind to electrical energy conversion alternatives, grid interfacing of a wind farm, grid connection, energy storage requirements with wind energy system

Economics of wind energy system; Modes of wind power generation; standalone mode, wind diesel hybrid system, solar wind hybrid system; Control and monitoring system of a wind farm, wind farm sitting; Wind map of India, wind-electric energy stations in India.

Practical

Detailed design and drawing of wind turbine; Study of horizontal axis wind turbine; Study of vertical axis wind turbine; Study of variation of wind speed with elevation; Study of validation of Weibull probability density function; Study of wind power density duration curve; Electrical characteristics and commissioning of complete aero-generator wind power system; Visit to a wind farm.

Lecture outlines

Theory

No.	Lecture outline
Unit I: Introduction to wind energy	
1	Wind energy, wind turbine, uses of Wind energy
2	Wind Characteristics, Wind Data Analysis
3	Wind Prediction and Forecasting
4	Wind Measurement and Instrumentation
Unit II: Aerodynamic operations of wind turbines	
5	Working of Wind turbine
6	One-dimensional Momentum Theory
7	Ideal Horizontal Axis Wind Turbine
8	Blade Design,Aerodynamics of Vertical Axis Wind Turbines
Unit III: Wind turbine rotors	
9	Methods for Modelling Wind Turbine Structural Response.
10	Design of wind turbine rotors
11	estimation of wind turbine power rating,
12	selection of optimum wind energy generator
Unit IV: Wind energy systems	
13	Types of wind energy systems
14	wind to electrical energy conversion alternatives
15	grid interfacing of a wind farm
16	grid connection
Unit V: Economics of wind energy system	
17	energy storage requirements with wind energy system
18	Wind Energy System Economics - Capital Costs
19	Operation Costs
20	Maintenance Costs
Unit VI: Modes of wind power generation	
21	standalone mode
22	wind diesel hybrid system
23	solar wind hybrid system
24	Wind Turbine Control- Supervisory Control
Unit VII: Control and monitoring system of a wind farm	
25	Dynamic Control Theory and Monitoring wind farm
26	Wind Turbine Siting, Installation and Operation Issues

27 Wind Farms

28 Wind Turbines and Wind Farms in Electrical Grids

Unit VIII: Wind farm sitting

29 Wind Energy Applications

30 Wind Energy Applications

31 Wind map of India and installed capacity

32 wind-electric energy stations in India.

Practical

No.	Practical outline
1	Study of Wind data and analysis
2	Study of wind energy measuring instruments
3	Types of wind energy systems
4	Modes of wind power generation
5	Control and monitoring system of a wind farm
6	Study of pitch and yaw control system used in a windmill
7	Detailed design and drawing of wind turbine
8	Study of horizontal axis wind turbine
9	Study of vertical axis wind turbine
10	Study of variation of wind speed with elevation
11	Study of validation of Weibull probability density function
12	Study of wind power density duration curve
13	Electrical characteristics and commissioning of complete aero-generator wind power system
14	Study of cost economics for wind energy-based power generation system
15	Visit to a wind farm**.**
16	Practical Examination

References

1. Rai G D. 1998. Non-conventional Sources of Energy. Khanna Publisher, New Delhi.
2. Tiwari G N and Ghosal M K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Publishing House, New Delhi.
3. Powar A G and Mohod, A G. 2010. Fundamentals of wind energy utilization. Jain Brothers Publisher, Karol Bagh, New Delhi.
4. Kothari D P, Singal K C and Ranjan R. 2012. Renewable energy sources and emerging technologies. PHI Learning Private Limited. New Delhi.
5. Rao S and Parulekar B.B. 2007. Energy Technology. Khanna Publishers, New Delhi.

6. Rathore N S, Kurchania A K and Panwar N L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications, Udaipur.

REEN 453 Waste and By-Products Utilization 3(2+1)

Course outlines

Theory

Types and formation of by-products and waste; Magnitude of waste generation in differentfood processing industries; Uses of different agricultural by-products from rice mill, sugarcaneindustry, oil mill etc.Concept, scope and maintenance of waste management and effluent treatment; Wasteparameters and their importance in waste management- 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 electricityusing surplus biomass, producer gas generation and utilization; Waste treatment and disposal:Design, construction, operation and management of institutional community and family size biogasplants, vermi-composting.Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondarytreatments: biological and chemical oxygen demand for different food plant waste– tricklingfilters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiarytreatments: advanced waste water treatment process- sand, coal and activated carbon filters,phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal ofsolid waste. 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 ofbriquettes; 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 wasteand food by-products.

Lecture outlines

Unit I

1 Types and formation of by-products and waste

2 Types and formation of by-products and waste

3	Magnitude of waste generation in different food processing industries

4	Uses of different agricultural by-products from rice mills, sugarcane industry

Unit II

5	Uses of different agricultural by-products from oil mill

6	Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD)

7	Concept, scope and maintenance of waste management and effluent treatment, fat, oil and grease content, metal content

8	Forms of phosphorous and sulphur in waste waters

Unit III

9	Microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues

10	Microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues

11	Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by-products

12	Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts.

Unit IV

13	Briquetting of biomass as fuel, production of charcoal briquettes

14	Generation of electricity using surplus biomass

15	Generation of electricity using surplus biomass

16	Producer gas generation and utilization

Unit V

17	Producer gas generation and utilization

18	Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants

19	Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants

20	Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants

Unit VI

21	Concept of vermin-composting

22	Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation

23	Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation

24	Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation

Unit VII

25 Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons

26 Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological hear contractors, lagoons

27 Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons

28 Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal

Unit VIII

29 Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal

30 Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants

31 Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants

32 Environmental performance of food industry to comply with ISO-14001 standards

Practical

1 Demonstration of temperature and P^H of waste water

2 Demonstration of turbidity and solids content of waste water

3 Demonstration of BOD of waste water

4 Demonstration of BOD of waste water

5 Demonstration of COD of waste water

6 Demonstration of COD of waste water

7 Demonstration of Ash content of Agricultural Waste

8 Determination of un-burnt carbon in ash

9 Study about briquetting of agricultural residues

10 Estimation of Excess air for better combustion of briquettes

11 Study of extraction of oil from rice bran

12 Study of bio-conversion of agricultural waste

13 Recovery of germ and germ oil from by-products of cereals

14 Visit to various industries using waste and food by-products

15 Visit to various industries using waste and food by-products

16 Final Practical examination

References

1. Bhatia, S. C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.
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SWCE 442 Floods and Control Measures 3(2+1)

Course outlines

Objective

To enable the students to understand the flood forecasting and warning systems, different permanent and temporary control measures of flood, and to design of storage structures and dams.

Theory

Floods- causes of occurrence, flood classification- probable maximum flood, standard project f lood, 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; 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; Planning of flood control projects and their economics.

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 f lood 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; Designing, planning and cost- benefit analysis of a flood control project; Design 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; 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; Study of reservoir rule curve; Visit to earthen dam and flood control reservoir.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction to Floods - Causes of occurrence (natural & anthropogenic), flood impacts, need for control.

2 Flood Classification & Design Terms - Classification by type (fluvial, pluvial, coastal), Probable Maximum Flood (PMF), Standard Project Flood (SPF), Design Flood.

3 Flood Estimation Overview - Purpose of estimation, general methods: field investigation, empirical formulae, hydrograph methods.

4 Estimation of Flood Peak: Rational Method - Theory, applicability, assumptions, estimation of runoff coefficient and rainfall intensity.

Unit II

5 Estimation of Flood Peak: Empirical Methods - Introduction to regional and global empirical formulae (e.g., Dicken's, Ryves').

6 Unit Hydrograph (UH) Method I - Definition, assumptions, derivation of Unit Hydrograph from a storm hydrograph.

7 Unit Hydrograph (UH) Method II - Limitations, S-curve derivation, use of convolution for flood estimation.

8 Depth-Area-Duration (DAD) Analysis - Concept, procedure, application in converting point rainfall to areal rainfall for design storms.

Unit III

9 Statistics in Hydrology I - Basic probability, return period, plotting position formulae.

10 Statistics in Hydrology II: Distributions - Introduction to frequency analysis, theoretical basis of the Log-Normal distribution.

11 Gumbel's Extreme Value Distribution - Theory, parameter estimation, application in extreme flood frequency analysis.

12 Log-Pearson Type-III Distribution - Theory, estimation of parameters (skewness), practical application in flood design.

Unit IV

13 Flood Forecasting and Warning Systems - Components (data, modeling, dissemination), types of forecasts, lead time.

14 Flood Routing: Principles - Concept, continuity and momentum equations, distinction between hydrologic and hydraulic routing.

15 Channel Routing: Muskingum Method - Derivation, storage equation, parameters, step-by-step application.

16 Reservoir Routing: Modified Pul's Method - Procedure, setup of the routing equation, graphical and numerical solutions.

UnitV

17 History and Overview of Flood Control - Evolution of flood control philosophy, shift to Integrated Flood Risk Management.

18 Structural vs. Non-Structural Measures - Detailed classification, advantages, disadvantages, and combined approaches.

19 Storage and Detention Reservoirs - Functions in flood control, reservoir zoning (flood pool), operational rules.

20 Levees and Channel Improvement - Design of levees (freeboard, stability), purpose and methods of channel deepening, widening, and straightening.

UnitVI

21 Gully Erosion and Control Structures - Causes and types of gully erosion, design and implementation of temporary and permanent check dams (e.g., brushwood, gabion, masonry).

22 Earthen Embankments I: Functions & Classification - Functions (flood control, storage), classifications: hydraulic fill vs. rolled fill dams.

23 Earthen Embankments II: Types - Detailed study of Homogeneous, Zoned, and Diaphragm (core wall) type earthen dams.

24 Foundation Requirements and Treatment - Importance of foundation, methods of foundation investigation, and grouting techniques.

UnitVII

25 Seepage Through Dams: Introduction - Seepage effects, methods of seepage control (cutoffs, impervious blankets).

26 Flow Net and its Properties - Darcy's Law application, drawing of flow nets, properties of flow lines and equipotential lines.

27 Seepage Pressure and Line - Calculation of seepage pressure, determination of the seepage line (phreatic line) in homogeneous sections.

28 Seepage Line in Composite Dams - Determination of the phreatic line in zoned earth embankments (Kozeny's parabola).

UnitVIII

29 Drainage Filters and Piping - Role and design criteria of drainage filters, causes and prevention of piping failure.

30 Design and Construction of Earthen Dam - Typical cross-section, construction methodology (zoning, compaction control).

31 Stability of Embankments against Failure - Analysis of embankment stability against tension, overturning, and sliding failures (e.g., translational block failure).

32 Slope Stability Analysis & Project Economics - Methods of slope stability analysis (e.g., Swedish Circle/method of slices), planning of flood control projects and their economics (Cost-Benefit Analysis).

Practical

No.	**Practical outline**
1	Determination of stage–discharge relationship in a watershed
2	Determination of flood peak–area relationships
3	Determination of frequency distribution functions for extreme flood values using **Gumbel's method**
4	Determination of confidence limits of flood peak estimates for **Gumbel's distribution**
5	Determination of frequency distribution functions for extreme flood values using **Log-Pearson Type-III distribution**
6	Estimation of **Probable Maximum Flood (PMF)** and **Standard Project Flood (SPF)**
7	Calculation of **spillway design flood** using standard methods
8	Design of **levees** for flood control
9	Designing, planning, and **cost-benefit analysis** of a flood control project
10	Design of **earthen dams** – dimensions and stability checks
11	Determination of **phreatic line** in earth dams for different conditions
12	Determination of **phreatic line** in earth dams for different conditions
13	Stability of slopes of earth dams by **Friction Circle and Swedish Slip methods**
14	Construction of **flow net** for isotropic and anisotropic soils
15	Computation of **seepage and settlement** in earth dams
16	Study visit to **earthen dam and flood control reservoir** - preparation of field report

Suggested Readings

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2. Hydrology for Engineers by Ray K. Linsley, Max A. Kohler, and Joseph L.H. Paulhus (McGraw Hill)
3. Applied Hydrology by V.T. Chow, D.R. Maidment, and L.W. Mays (McGraw Hill)
4. Flood Control and Drainage Engineering by S.N. Ghosh (A.A. Balkema/Taylor & Francis)
5. Water Resources Engineering by Larry W. Mays (Wiley)
6. Garg, S. K. 2018. Irrigation Engineering and Hydraulic Structures. Khanna Publishers, Delhi
7. Design of Hydraulic Structures by D.V. Varshney and M.V. Varshney (Khanna Publishers)
8. Soil and Water Conservation Engineering by Glenn O. Schwab et al. (John Wiley & Sons)
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13. Murthy, V. V. N. 2010. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
14. Stephens, Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

SWCE 443 Remote Sensing and GIS Applications 3(2+1)

Course outlines

Objective

To enable the students to know about the remote sensing methods and applications in NRM, digital image processing and concepts of GIS and data management.

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 stereopair- vertical measurement 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, GIS and 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.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 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

2 Electromagnetic spectrum- different bands –Resolutions

3 Energy interactions in the atmosphere and with the Earth’s surface

4 Major atmospheric windows; Principal applications of different wavelength regions

Unit II

5 Typical spectral reflectance curve for vegetation, soil and water; Spectral signatures

6 Different types of sensors and platforms

7 Important features of Indian Remote Sensing Satellites

8 Contrast of an image and possible causes of low contrast

Unit III

9 Aerial photography; types of aerial photographs

10 Scale of aerial photographs, planning aerial photography- end lap and side lap

11 Stereoscopic vision, requirements of stereoscopic photographs

12 Aerial photo interpretation- elements of interpretation

Unit IV

13 Photogrammetry- Measurements on a single vertical aerial photograph

14 Measurements on a stereo-pair- vertical measurements by the parallax method

15 Ground control for aerial photography;

16 satellite remote sensing: Multispectral scanner- types -Whiskbroom and pushbroom scanner; different types of resolutions

Unit V

17 Analysis of digital data- Image restoration

18 Image enhancement, Information extraction

19 Image classification: Unsupervised classification

20 Supervised classification

Unit VI

21 Important consideration in the identification of training areas, types of vegetation indices

22 Introduction to microwave remote sensing

23 GIS and basic components

24 Different sources of spatial data

Unit VII

25 Basic spatial entities; Major components of spatial data

26 Basic classes of map projections and their properties

27 Methods of data input into GIS

28 Data editing, spatial data models and structures

Unit VIII

29 Attribute data management

30 Integration of spatial data (Map overlay operations) in GIS

31 Application of remote sensing and GIS for the management of land and water resources

32 Application of remote sensing and GIS in water resources development

Practical

No.	**Practical outline**
1	Familiarization with remote sensing and GIS hardware
2	Use of software for image interpretation
3	Interpretation of aerial photographs and satellite imagery

4 Basic GIS operations such as image display
5 Study of various features of GIS software
6 Scanning & Digitization of maps
7 Digitization of maps and data editing
8 Digitization of maps and data editing
9 Data base query and map algebra
10 Data base query and map algebra
11 Classification of an image by supervised classification technique
12 Classification of an image by supervised classification technique
13 Application of remote sensing and GIS in water resources development
14 Mapping of salt affected soils and water-logged areas
15 Application of remote sensing and GIS in watershed management
16 Application of remote sensing and GIS in watershed management

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SWCE 444 Information Technology for Land and Water Management 3(2+1)

Course outlines

Objective

To enable the students to understand the application of IT natural resources management and design and application of decision support system and expert systems for NRM

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 programs; Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management; Videoconferencing 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 programs; 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 software's; Exercises on development of information system on selected theme(s); Video-conferencing of scientific information.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Information Technology (IT) – Introduction- Users' needs in terms of land and water information systems and decision-support systems
2	Information Technology concepts and its application in land and water information systems
3	Role of IT in natural resources management in modern irrigation sector
4	Existing system of information generation in land water management and organizations involved in the field of land and water management
Unit II	
5	Multimedia technologies – introduction - Applications
6	Role of multi-media in the development of natural resources
7	Internet application tools in water management planning

8 Web technology- Introduction – study of websites available for information on land and water resources

Unit III

9 Networking system of information- Introduction- types – study of water supply networks

10 Global network on water and development information for arid lands (G-WADI)

11 Communication technology - the role of communication technology in land and water information systems

12 Problems and prospects of new information and communication technology

Unit IV

13 RS & GIS - Application of remote sensing, geographic information system (GIS) and GPS in thematic mapping like soil, water, ground water, resource, ground water, drainage

14 Application of GPS in natural resource inventory& assessment, changes in land and water

15 Application of remote sensing, GIS and GPS in soil mapping

16 Application of remote sensing, GIS and GPS in Watershed characterization, Watershed prioritization

Unit V

17 Multiple criteria decision analysis for integrated land resources planning and management

18 Database- introduction- types of database management systems

19 Different data base systems in land and water management

20 Development of database concept for effective natural resources management

Unit VI

21 Relational data base management system- Principle- Application in land and water management

22 Object oriented approach – Principle- Application in land and water management

23 Information system – overview- types of information systems- development – integrated land and water information systems

24 Introduction to Information Systems: Definition, types, functions and applications

Unit VII

25 Decision support systems- over view, components, types and applications in water resources management

26 Expert systems – definition, components, application in water resources management

27 Agricultural information management systems (AIMS) – Key functions and applications weather forecast and irrigation planning

28 Mathematical models in irrigation, optimization and water resource management - Crop growth models (e.g., DSSAT, APSIM), Climate and water resource models

Unit VIII

29 Application of Decision Support Systems (DSS) in Natural Resource Management

30 Multi-Sensor Data Loggers in Natural Resource Management

31 Overview of software packages in natural resource management: ArcGIS, QGIS, ENVI, SWAT, HEC-RAS etc.

32 Video-Conferencing for Dissemination of Scientific Information

Practical

No.	Practical outline
1	Study of role of IT in natural resources management
2	Study of Internet applications: E-mail, voice mail, web tools and technologies
3	Study of Handling and maintenance of new information technologies and exploiting their potentials
4	Exercises on database management using database programs and spreadsheet programs
5	Exercises on database management using database programs and spreadsheet programs
6	Study of RS satellites for land and water information generation
7	Study of GIS tools for image processing
8	GPS survey, information generation and and processing
9	Exercise on "Simulation of Water Balance Using CROPWAT Software"
10	Exercises on Modeling Crop Production with DSSAT (Decision Support System for Agrotechnology Transfer)
11	Exercises on Optimization of Land and Water Resource Allocation Using WEAP (Water Evaluation and Planning System
12	Exercises on Watershed Analysis with SWAT (Soil and Water Assessment Tool)
13	Exercises on Resource Allocation and Risk Assessment Using Simple Decision Support Models
14	Exercises on Developing a GIS-Based Information System for Soil and Water Resources
15	Video-conferencing of scientific information
16	Video-conferencing of scientific information

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SWCE 445 Wasteland Development 3(2+1)

Course outlines

Objective

To enable the students to plan for wasteland development keeping in view agro-climatic conditions, development options, contingency plans, conservation measures, water harvesting and recycling methods in consideration. It will also help the student to know the different land reclamation and rehabilitation measures for wasteland development and use of micro irrigation for sustainable wasteland development against adverse situations like drought and water-scarce situations.

Theory

Land degradation- concept, classification, arid, semiarid, humid and sub-humid regions, Troll's climatic classification, denuded range land and marginal lands; Wastelands- factors causing waste lands, classification and mapping of wastelands, planning of wasteland 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; Participatory approach in wasteland management; 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, semi-arid and humid conditions; Planning and design of micro-irrigation in wasteland development; Study on utilization of fly-ash in hydraulic structures; Study on mine spoil areas by plantation; Study on mine spoil areas by back filling of fly-ash; Study on environmental impact assessment (EIA) of mine spoil areas; Cost estimation of the various wasteland development measures; Study on PRA exercise on wasteland management; Preparation of DPR of wasteland development projects; Visit to wasteland development project sites.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Land degradation-concept, causes of land degradation-Deforestation, Agricultural Practices, Industrialization, Urbanization, forest degradation, rangeland degradation.
2	Classification of land degradation in arid, semiarid, humid and sub-humid regions.
3	Denuded range land and marginal lands
4	Natural degradation hazards-water erosion, wind erosion, water logging, salinization, decline in soil fertility.
Unit II	
5	Land degradation assessment-land, population, poverty and degradation.
6	Wastelands-factors causing, types of waste lands (NWDB) classification.
7	Mapping of wastelands of different categories in India.
8	Planning of wastelands development-ongoing waste land development schemescriteria for site selection, constraints, agro- climatic conditions.
Unit III	
9	Development options, estimation of financial requirements and contingency plans.
10	Conservation structures-gully stabilization, ravine rehabilitation.
11	Sand dune stabilization
12	Water harvesting and recycling methods.
Unit IV	
13	Afforestation-land preparation methods, agro-horti-forestry-silvipasture methods.
14	Afforestation-forage and fuel crops-socioeconomic constraints.
15	Shifting cultivation, optimal land use options.
16	Waste land development-hills

Unit V

17 Wasteland development-semi arid areas-in-situ conservation measures

18 Wasteland development-coastal areas

19 Wasteland development-water scarce areas

20 Wasteland development- reclamation of waterlogged and salt affected lands.

Unit VI

21 Mine spoils-impact, land degradation, impact on environment.

22 Reclamation and rehabilitation slope stabilization of mind spoils.

23 Management of mine environment

24 Micro irrigation in waste lands development

Unit VII

25 Sustainable wasteland development-drought situations, tree based farming, horticulture, cash crops, use of bio-fertilizers.

26 Sustainable wasteland development of pasture 0n village common lands and improved livestock management

27 Socio-economic perspectives of sustainable waste and development.

28 Government policies in wasteland development

Unit VIII

29 Participatory approach for wasteland development

30 Impact assessment of wasteland development

31 Preparation of proposal for wasteland development

32 Analysis of benefit-cost of wasteland development.

Practical

No.	Practical outline
1	Mapping of wastelands using RS and GIS techniques
2	Identification of factors causing wastelands
3	Estimation of vegetation density and classification
4	Planning and design of engineering measures for reclamation of wastelands
5	Design and estimation of different soil and water conservation structures under arid conditions.
6	Design and estimation of different soil and water conservation structures under semiarid conditions
7	Design and estimation of different soil and water conservation structures under humid conditions
8	Planning and design of micro-irrigation in wasteland development
9	Study on Utilization of fly-ash in hydraulic structures

10 Study on mine spoil areas by plantation

11 Study on mine spoil areas by back filling of fly-ash

12 Study on environmental impact assessment (EIA) of mine spoil areas

13 Cost estimation of measures/structures of wasteland development

14 Study on PRS exercise on wasteland management

15 Preparation of DPR of wasteland development projects

16 Visit to wasteland development project sites

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IDEN 432 Minor Irrigation and Command Area Development 3(2+1)

Course outlines

Objective

To enable the students to understand the principles and to acquire knowledge on minor irrigation projects, plan, design and execute tanks, wells, pumping houses, diversion schemes, open field channels for efficient conveyance and application of irrigation water and for development of command areas of different sources under minor irrigation

Theory

Major, medium and minor irrigation projects, factors affecting performance of irrigation projects; Types of minor irrigation systems in India, surface water and groundwater projects; 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; Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams; Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities; On farm development works, design of lined and un-lined field channel and its cost estimation; Farmers' participation in command area development, PIM, water user's association;

Reclamation works, cross drainage works; Use of remote sensing techniques for CAD works; Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water; Water productivity: concepts and measures for enhancing water productivity

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops of command area; 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; Planning and design of OFD works; Cost estimation of OFD work; Study of cross drainage works; Design and cost estimation of earthen dams for minor irrigation project; Estimation of seepage in field channels; Visit to a minor irrigation project; Visit to a command area and study of OFD works; Study of reclamation of waterlogged areas inside command area.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Major, medium and minor irrigation projects, factors affecting performance of irrigation projects
2	Introduction to Minor Irrigation, Types of minor irrigation systems in India, surface water and groundwater projects
3	Lift Irrigation systems- Assessment of feasibility of lift irrigation projects, water availability, water lifting from canals, water lifting permission, Types of river and canal pumping systems and their site selection

4 Design of lift irrigation systems, intake structure and main points to be considered for designing intake structure and intake pipe supporting strength and vertical load, design problem

Unit II

5 Tank Irrigation- Components of irrigation tanks, earthen bund, surplus weir, sluices and channels, basis for formation of tanks

6 Grouping of tanks, Storage capacity and number of fillings of tanks, number of rainy days and working table

7 Supply works and sluices, Earthen Bunds- Reasons for general failure- Filter criteria, cut off, upstream blanket, prevention of breaching of tanks

8 Bank section, stability of side slopes, top widths and free boards, failure by slipping or sliding, failure by over topping

Unit III

9 Diversion Schemes-Hydrology, components of diversion schemes, locations and design of weirs

10 Surplus weirs-estimation of flood discharge entering the tanks, design of surplus weirs, length, crest width and base width

11 Earthen dams: components, types, methods of construction

12 Causes of failure of earthen dams, seepage control in earthen dams

Unit IV

13 Basic Concepts of command area development (CAD) programme – definition, need, scope and development

14 Technical details about various components of CAD water management programme

15 Historical perspective, command area development authorities-functions and responsibilities

16 Approach to planning, construction and maintenance of on farm development works

Unit V

17 Survey and investigation of on farm development activities within the scope of command area development

18 Layout and alignment of field channels

19 Water delivery system – channel design

20 Water delivery system – control structures

Unit VI

21 Water delivery system – control structures for black cotton soils

22 Flow measuring devices for field channels

23 Materials for lining water courses and field channels, Cross drainage works

24 Reclamation components of waterlogged areas in irrigation commands

Unit VII

25 Management components of waterlogged areas in irrigation commands

26 Use of remote sensing techniques for command area development works

27 Basics of Remote sensing and Geographic information systems

28 Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water

Unit VIII

29 Water productivity- Definitions and conceptual framework, Methodology to work out water productivity

30 Measures for enhancing water productivity

31 Farmers participation in command area development, PIM, Water Users Association

32 Case study of farmers participation in Andhra Pradesh

Practical

No.	Practical outline
1	Preparation of command area development layout plan
2	Irrigation water requirement of crops
3	Preparation of irrigation schedules
4	Planning and layout of water conveyance system
5	Design of surplus weir of tanks
6	Determination of storage capacity of tanks
7	Design of intake pipe and pump house
8	Design of lift irrigation systems
9	Planning and design of OFD works; Cost estimation of OFD work
10	Study of cross drainage works
11	Design and cost estimation of earthen dams for minor irrigation project
12	Estimation of seepage in field channels
13	Visit to nearby Tank irrigation system and Lift irrigation system
14	Visit to nearby Command area and study of OFD works
15	Study of reclamation of waterlogged areas inside command area
16	Study of reclamation of waterlogged areas inside command area

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IDEN 433 Management of Canal Irrigation System 3(2+1)

Course outlines

Objective

To enable the students to analyze water requirement and availability in a canal command, to take up design of lined and unlined canals and enable to control of losses of water in canal commands and for design and layout of different canal outlet structures.

Theory

Typical network of canal irrigation system and its physical components; Canal classifications based on source of water, financial output, purpose, discharge and alignment; Canal alignment: general considerations; Different parts of canal sections, performance indicators for canal irrigation system evaluation; Estimation of water requirements for canal command areas and determination of canal capacity; Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve 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 warabandi, rotational irrigation, pre-requisite of warabandi; 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, types of canal falls; Sources of surplus water in canals and types of canal escapes; Requirements of a good canal outlet and types of outlet; Participatory irrigation management (PIM), water user's association: necessity, structure, function and duties.

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; Design of canal by full banking and partial cutting; Determination of longitudinal section (Lsection) of canals; Design of irrigation canals based on silt theories (unlined canal); Design of lined canals; Formulation of warabandi system in canal command areas; Study of various types of canal outlet; Study of various types of canal regulators; Study of canal escapes;

Study of various types of canal falls; Visit to a canal off taking site; Visit to a canal command area; Visit and discussion with functionaries of water user association.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Canal irrigation- Typical network of canal irrigation system and its physical components, Canal classifications based on source of water, financial output, purpose, discharge and alignment
2	Canal alignment: General conditions for alignment of canals, factors affecting the canal alignment, different parts of canal sections and curves in channels
3	Performance indicators for canal irrigation system evaluation
4	Certain important definitions related to command area: GCA, CCA, Intensity of irrigation, Net and gross sown areas, Net and gross irrigated areas, area to be irrigated, Time factor, capacity factor, full supply coefficient, nominal duty etc.
Unit II	
5	Crop period, Base period, Water duty and delta, flow duty and quantity duty, factors affecting duty and methods to improve duty, duty of some important crops
6	Relationship between duty, base period and delta, numerical problems on relationship between duty, base period and delta
7	Estimation of water requirement- Consumptive use or evapotranspiration, critical growth period, effective rainfall, gross irrigation requirement and net irrigation requirement
8	Cross – section of an irrigation canal and determination of canal capacity
Unit III	
9	Estimation of water losses in canals: Evaporation, Seepage with empirical formulas and canal regulation
10	Design of channels –Terms associated with canal design; Silt Theories, design of unlined irrigation canals
11	Design of channels by Kennedy's theory
12	Lacey's regime theory and basic regime equations
Unit IV	
13	Design of channels by Lacey's theory
14	Drawbacks of Kennedy's theory and Lacey's theory, Comparison of Kennedy's theory and Lacey's theory
15	Maintenance of unlined irrigation canals: silting of canals, weed and plant growth, failure of weaker banks and canal breaches
16	Measurement of discharge in channels – Stage measurement, area – velocity method, dilution technique and numerical problems

Unit V

17 Measurement of discharge in channels – Electromagnetic method, Ultrasonic method, Hydraulic structures and slope – area method

18 Canal water distribution - Rostering (canal running schedule) and Warabandi – Need of warabandi, objectives and design of warabandi, pre-requisite of warabandi for implementation

19 Warabandi on outlet, Process of preparing warabandi, format for preparation of warabandi

20 Canal lining: Necessity, advantages and disadvantages

Unit VI

21 Types of canal lining and desirable characteristics for the suitability of lining materials- In-situ concrete lining, precast concrete lining, Cement mortar lining, lime concrete lining

22 Brick lining, stone block lining or boulder lining, asphaltic lining, buried membrane lining, earth lining and porous lining

23 Design of lined canals- design principles of lined canal, difference between lined and unlined canals, numerical problems on design of lined canal

24 Canal regulation works: Advantages of regulation works, functions of distributary head regulator and it's design

Unit VII

25 Functions of cross regulator and it's design, sediment and silt control devices

26 Canal falls: Necessity & location and factors affecting canal fall

27 Classification of canal falls depending on the ground level conditions and shape of the fall

28 Sources of surplus water in canals and types of canal escapes - Surplus water escape, canal scouring escape and tail escape

Unit VIII

29 Canal outlets: Requirements of a good canal outlet and Types of canal outlets – Non – modular, Semi – modules and rigid modules

30 Criteria for judging the performance of modules – Flexibility, Proportionality, Setting and Sensitivity, relationship between sensitivity & flexibility, types selection of outlet capacity, Non-modular and modular outlets

31 Participatory irrigation management (PIM) – Objectives of PIM, Necessity of PIM, Provisions in PIM acts and Constraints in implementation of PIM

32 Water user's association - Necessity, structure, function and duties of WUA

Practical

No. Practical Outline

1 Estimation of water requirement of canal commands

2 Determination of canal capacity
3 Layout of canal alignments on topographic maps
4 Drawing of canal sections in cutting
5 Design of canal by full banking and partial cutting
6 Determination of longitudinal section (L-section) of canals
7 Design of irrigation canals based on silt theories (unlined canal)
8 Design of lined canals
9 Formulation of warabandi system in canal command areas
10 Study of various types of canal falls
11 Study of various types of canal regulators
12 Study of canal escapes
13 Study of canal escapes
14 Study of various types of canal outlet
15 Study of various types of canal outlet
16 Visit to a canal off taking site

IDEN 434 Water Quality and Management Measures 3(2+1)

Course outlines

Objective

To enable the students to understand the quality of surface and ground water, water contamination due to inorganic and organic compounds and the water decontamination technologies and the cultural and management practices for using poor quality water for irrigation.

Theory

Natural factors affecting quality of surface water and groundwater, sources and pollution of groundwater; Water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and 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 saline water ingress in coastal areas; Study of contamination movement and transport in soil profile; Study of turbidity of water through turbidity meter; Study of different water decontamination techniques; Study of different cultural and management practices for using poor quality water for irrigation; Visit to a water treatment plant; Visit to a water quality laboratory; Field visit to industrial effluent disposal sites.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Definition of water quality, Importance of water quality and standards of water quality for different uses.
2	Natural factors affecting quality of surface water and groundwater and pollution of groundwater
3	Water quality objectives in relation to domestic, industrial and agricultural activities
4	Water quality objectives in relation todrinking water quality standards, irrigation water quality classification as per USSL and AICRP criteria;
Unit II	
5	Point and non-point water pollution sources, Classes of point and nonpoint water pollution sources
6	Quality of irrigation water: Parameters for water quality assessment
7	Salinity hazard, sodicity hazard and toxicity hazard
8	Water quality criteria for its suitability and Quality of surface and groundwater sources
Unit III	
9	Water contamination due to inorganic and organic compounds
10	Water contamination related to agricultural chemicals: Fertilizers as water pollutants and control measures
11	Water contamination related to agricultural chemicals: Pesticides as water pollutants and control measures
12	Water contamination due to food industry, hydrocarbon and synthetic organic compounds
Unit IV	
13	Water contamination due to hydrocarbon and synthetic organic compounds
14	Characteristics of water: Physical characteristics of water and their measurement
15	Chemical characteristics of water and their measurement
16	Bacterial and microscopical characteristics of water

Unit V

17 Pathogenic and non-pathogenic bacteria and their testing through MPN index

18 Arsenic contamination and its removal from water

19 Fluoride contamination and its removal from water

20 Introduction to water decontamination technologies

Unit VI

21 Screening: Course and fine screens and their working

22 Plain sedimentation: Theory of sedimentation and Sediment tanks

23 Sedimentation aided with coagulation: Analysis of flocculent settling and Chemicals used for coagulation

24 Flocculation in wastewater treatment.

Unit VII

25 Filtration: Theory of filtration, filter materials, type of filters and their classification

26 Sterilization: Methods of disinfection and chlorination

27 Water softening: Methods of removing temporary hardness

28 Water softening: Methods of removing permanent hardness

Unit VIII

29 Removal of colors, odours and tastes from water

30 Desalination: Removal of salts and dissolved solids from water

31 Cultural and management practices for using poor quality water for irrigation

32 Management practices for sustained saline water use, Irrigation with poor quality of water and Water quality Guidelines for irrigation

Practical

No.	Practical outline
1	Study of water quality analysis and classification according to USSL and AICRP criteria
2	Water quality analysis: Determination of temporary hardness
3	Soil chemical analysis: Estimation of N, P and K
4	Soil chemical analysis: Estimation of Na, Mg and Ca
5	To estimate the lime requirements for reclamation of the problematic soils
6	To estimate the gypsum requirements for reclamation of the problematic soils
7	Soil chemical analysis and estimation of lime and gypsum requirements
8	Study of salinity development under shallow and deep-water table conditions
9	Study of saline water ingress in coastal areas
10	Study of contamination movement and transport in soil profile
11	Study of turbidity of water through turbidity meter

12 Study of different water decontamination techniques

13 Study of different cultural and management practices for using poor quality water for irrigation

14 Visit to a water treatment plant

15 Visit to a water quality laboratory; Field visit to industrial effluent disposal sites

16 Visit to a water quality laboratory; Field visit to industrial effluent disposal sites

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IDEN 435 Landscape Irrigation Design and Management 3(2+1)

Course outlines

Objective

To enable the students to know about the different conventional and modern methods of landscape irrigation, various types of landscapes and their suitability with regard to different irrigation methods, design the modern landscape irrigation systems, automation of the landscape irrigation system and irrigation scheduling with proper methods of irrigation for different landscapes.

Theory

Conventional method of landscape irrigation- hose irrigation 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; Use of sensors for irrigation automation and use of IOT in landscape irrigation; Use of AutoCAD in irrigation design; Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems

Practical

Study of irrigation equipment 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 equipment; Use of AutoCAD in irrigation design; Study of blocks & symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.; Study of various types of sensors for irrigation automation; Study of IOT in landscaping irrigation; Visit to landscape irrigation system and its evaluation.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Definition of landscape, Historical importance of Indian gardens and history of gardening in different eras
2	Famous gardens of India and study of their method of irrigation systems
3	Conventional methods of landscape irrigation, study of hose irrigation system and their components.
4	Study of components of portable sprinkler with hose pipes
Unit II	
5	Study of modern methods of landscape irrigation: Pop up sprinklers and their components and selection criteria.
6	Design criteria for pop-up sprinkler system and their accessories
7	Study of shrub adopter sprinkler system and their accessories
8	Types of drip irrigation methods adopted in landscaping and their components
Unit III	
9	Design and layout of drip irrigation system in landscaping
10	Design of bubbler irrigation system, selection in landscaping
11	Study of merits and demerits of conventional landscape irrigation systems
12	Types of modern landscape irrigation method sand their merits and demerits.
Unit IV	
13	Landscape- Types of landscapes; Natural landscapes, Human made landscapes

14 Landscape-Basic theme of gardens viz, circular, rectangular and diagonal themes

15 Factors affecting landscape design viz. initial approach, view, human choice, simplicity and topography

16 Suitability of different types of irrigation systems for landscapes

Unit V

17 Water requirement for different landscapes

18 Numerical problems on water requirements of landscapes

19 Segments of landscape irrigation systems

20 Main components of modern landscape irrigation systems and their selection criteria.

Unit VI

21 Types of pipes and pressure ratings in landscape irrigation and their selection criteria

22 Study of economics of pipes used in landscape irrigation and their selection.

23 Numerical problems on economics of pipe selection

24 Study of different automation systems for landscape irrigation

Unit VII

25 Study of main components, types of controllers and their application in automation system

26 Design and layout of modern landscape irrigation systems

27 Problems on design and layout of modern landscape irrigation systems

28 Operation of landscape irrigation systems

Unit VIII

29 Maintenance of landscape irrigation systems

30 Use of soft-wares in irrigation design: AutoCAD and Archi-CAD

31 Design of landscape irrigation systems using AutoCAD

32 Design of landscape irrigation systems using Archi-CAD

Practical

No. Practical outline

1 Study of various irrigation equipment for landscapes

2 Determination of water requirement for different landscapes

3 Design and installation of irrigation system for landscape

4 Determination of power requirements for irrigation systems

5 Tutorial problems on pump selection and power requirement

6 Preparation of irrigation scheduling of landscapes

7 Study of irrigation controllers and other equipment

8 Study of blocks & symbols, head layout

9 Study of zoning and valves layout
10 Study of pipe sizing, Pressure calculations
11 Acquaintance in use of AutoCAD and Archi-CAD
12 Use of AutoCAD in designing of gardens
13 Use of AutoCAD in design of irrigation systems
14 Visit to nearby landscape irrigation system
15 Evaluation of landscape irrigation system observed in field visit
16 Evaluation of landscape irrigation system observed in field visit

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IDEN 436 Application of Plastics in Agriculture 3(2+1)

Course outlines

Objective

To enable the students to understand the applications in moisture conservation, canal and pond lining, use of plastic pipes in irrigation and drainage; know about soil solarisation, mulching, covering materials in green houses, shade houses, poly houses, surface covered cultivation, plastic fencing, nets for insects, birds etc. and in food grain structures, packaging materials, aquaculture, etc.

Theory

Introduction of plasticulture- types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, present status and future prospective of plasticulture in India, quality control measures; 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 plasticulture 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 device for food grain storage; Study of innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP; 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/ poly-house/ shade-house/ net- house etc; Visits to farmers' fields with these installations.

Lecture outlines

Theory

No. Lecture outline

Unit I

1 Introduction of plasti-culture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management

2 Quality control measures, Present status and future prospective of plasticulture in India

3 Different types of the plastic material and its raw material

4 Characteristics of different plastic materials and its market potential

Unit II

5 Use of plastics in in-situ moisture conservation as water management technique

6 Use of plastics in rain water harvesting

7 Plastic film lining in canal, pond and reservoir

8 Plastic pipes for irrigation water management

Unit III

9 Plastic pipes for bore-well casing

10 Plastic pipes for subsurface drainage

11 Plastic pipes use in sprinkler irrigation system- Advantages and various components of sprinkler irrigation systems

12 Plastic pipes use in drip irrigation system - Advantages and various components of drip irrigation systems

Unit IV

13 Manufacturing of plastic pipes - The various process steps involved in the manufacture of plastic pipes

14 Use of polymers in control of percolation losses in fields.

15 Plastics' used in soil conditioning - soil solarization

16 Effects of different colored plastic mulching in surface covered cultivation

Unit V

17 Nursery management - Use of plastics in nursery raising, nursery bags, trays

18 Controlled environmental cultivation - plastics as cladding material in green/ poly houses

19 Controlled environmental cultivation - plastics as cladding material in shade net houses

20 Controlled environmental cultivation - plastics as cladding material in poly tunnels

Unit VI

21 Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing

22 Plastics use in drying of agricultural produce

23 Plastics use in preservation of food

24 Handling and storage of agricultural produce

Unit VII

25 Innovative plastic packaging solutions for processed food products

26 Plastic cap covers for storage of food grains in open

27 Use of plastics as alternate material for manufacturing farm equipment and machinery

28 Plastics for aqua cultural engineering for inland fisheries

Unit VIII

29 Plastics for animal husbandry - animal shelters, vermi-beds

30 Silage film technique for fodder preservation

31 Agencies involved in the promotion of plasti-culture in agriculture at national and state level

32 Human resource development in plasti-culture applications

Practical

No.	Practical Outline
1	Design, estimation and laying of plastic films in lining of canal
2	Design, estimation and laying of plastic films in water harvesting ponds
3	Study of plastic components of sprinkler irrigation system

4 Study of plastic components of drip irrigation system
5 Study of components of subsurface drainage system
6 Study of different colour plastic mulch laying
7 Design, estimation and installation of green / poly houses
8 Design, estimation and installation of shade net houses
9 Design, estimation and installation of low tunnels
10 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
11 Study on use of plastics in nursery and plant protection
12 Study on use of plastics in aquaculture
13 Study on use of plastics in animal husbandry
14 Study of plastic parts in making farm machinery
15 Visit to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse / shade net house
16 Visit to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse / shade net house

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PFEN 422 Precision Farming Technologies for Protected Cultivation 3(2+1)

Course outlines

Objective

To enable the students to design and construction of greenhouses in different agro climatic zones, greenhouse cooling and heating systems, environmental parameter and control, ventilation systems, to assess different root media, micro-irrigation, fertigation, planting techniques in green house cultivation and to know about hydroponics, post-harvest management, pest management and economic aspects of a green house.

Theory

Protected cultivation: introduction, history, origin, development, national and international scenario;Types of green houses, components of green house, 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 greenhouses- site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods, design of heating system; Root media- types, soil and soilless 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 postharvest 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; 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.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Protected cultivation: introduction, history, origin, development, national and international scenario
2	Greenhouses – Definition- History - Advantages of greenhouses- Types of greenhouses based on shape, utility, construction and cladding material, shade nets.
3	Components of greenhouse, polyhouses/shade nets
4	Different types of cladding material, for greenhouse, polyhouses/ shade net houses.
Unit II	
5	Plant environment interactions- principles of limiting factors, solar radiation and transpiration
6	Greenhouse effect- light, temperature, relative humidity, carbon dioxide enrichment
7	Construction of greenhouse – Site selection, orientation and construction
8	Equipment required for controlling greenhouse environment – Summer cooling and winter cooling, natural ventilation, forced ventilation and computers. Design for ventilation requirement using exhaust fan system and selection of equipment
Unit III	
9	Greenhouse cooling system- methods, ventilation with roof and side ventilators, different shading materials
10	Greenhouse cooling system- evaporative cooling system
11	Greenhouse cooling system- fogging, combined fogging and fan-pad cooling system
12	Design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.
Unit IV	
13	Greenhouse heating and distribution systems
14	Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation
15	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.
16	Study of nutrient film technique (NFT) / hydroponics

Unit V

17 Selection of crops for greenhouse cultivation

18 Planting techniques for greenhouse cultivation

19 Irrigation in greenhouse and net house- water quality, types of irrigation systems used and their components

20 Design, installation and material requirement and maintenance for Irrigation systems used in greenhouse and shadenets

Unit VI

21 Fogging system for humidity control in greenhouses and net houses- introduction, benefits and design

22 Installation and material requirement for fogging system and their maintenance

23 Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, methods for fertilizer application

24 Principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers,

Unit VII

25 Automated fertilizer application in greenhouse and net houses

26 Greenhouse climate measurement, control and management

27 Insect management in greenhouse and net houses

28 Disease management in greenhouse and net houses

Unit VIII

29 Major crops in greenhouse cultivation, irrigation requirement, fertilizer management

30 Cultivation, harvesting and post-harvest techniques for different crops under greenhouse

31 Economic analysis of greenhouse cultivation

32 Economic analysis of shadenet cultivation

Practical

No. Practical outline

1 Study of different types of Greenhouses

2 Estimation of material requirement for construction of greenhouse

3 Determination of fertilization schedule

4 Rate of application for various crops

5 Estimation of material requirement for preparation of root media

6 Root media preparation

7 Bed preparation and disinfection methods

8 Study of different planting techniques

9 Design and installation of irrigation system
10 Design and installation of fogging system
11 Study of different greenhouse environment control instruments
12 Insect and disease management in greenhouse and net houses
13 Study of operation and maintenance and fault detection in irrigation system
14 Study of operation, maintenance and fault detection in fogging system
15 Economic analysis of greenhouses and net houses
16 Visit to nearby greenhouses.

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SWCE 446 Environmental Engineering 3(2+1)

Course outlines

Objective

To enable the students to understand the water requirements for domestic, industrial and commercial demand and sources of water supply, analysis of water quality. Importance to sanitation, domestic waste water treatment, sewer design, disposal of waste water in urban and rural areas; and the air pollution, types of pollutants, and their abetments.

Theory

Importance of safe water supply system; Water requirements for urban and rural areas; domestic, industrial and commercial demand, per capita demand- variation in demand, population estimation-design period, population forecasting methods; Sources of water supply- surface and sub-surface sources of water, surface sources lakes, rivers, reservoirs; Intakes and transportation of water- various types of conduits including gravity conduits such as canals, flumes, aqueducts, pressure conduits - design of pressure pipes as gravity mains, Darcy-Weisbach, Manning, Hazen-William formula, flow in pipes system- forces acting on pressure conduits cast iron pipes, steel, RCC, PVC, asbestos and concrete pipes, laying of pipes and testing of pipes, testing of pipes; Selection of pumps, efficiency of pumps, economic diameter of pumping mains; Drinking water quality: Indian standards of drinking water; Introduction to water treatment: purification of water supply, sedimentation, filtration-coagulation, water softening, water treatment methods Importance to sanitation, domestic waste water: quantity, characteristics, disposal in urban and rural areas; Sewer: types, design discharge and hydraulic design, Introduction to domestic waste water treatment. Design of septic tank, sewerage system- domestic and municipal wastes, storm sewage, flow through sewers, design of sewers, manhole, sewage characteristics, BOD, COD, dissolved oxygen, nitrogen; Solid water collection and disposal, Solid waste quantity, characteristics and disposal for urban and rural areas Introduction to air pollution, types of pollutants, properties and their effects on living beings, BIS standards for pollutants in air and their abetments

Practical

Study of population forecasting problems; Determination of turbidity, pH and EC of water; Study of suspended solids, dissolved solids and total solids; Study of temporary and permanent hardness; Determination of fluorides and chlorides in drinking water; Determination of dissolved oxygen, COD and BOD of water; Study of hydraulics of pipe lines and distribution network design; Visit to a water treatment plant; Study of maintenance of distribution system; Collection of air samples and their analysis; Design of septic tank, sewer pipe lines and waste disposal measures; Visit to a sewage treatment plant; Visit to a municipal solid waste management plant; Visit to a community bio gas plant.

Lecture outlines

Theory

No. Theory outline

Unit I

1. Importance of safe water supply system
2. Water requirements for urban and rural areas domestic, industrial and commercial demand
3. Per capita demand- variation in demand
4. Population estimation-design period, population forecasting methods

Unit II

5. Sources of water supply- surface and sub-surface sources surface sources lakes, rivers, reservoirs
6. Intakes and transportation of water - various types of conduits including gravity conduits such as canals, flumes
7. Types of conduits - aqueducts, pressure conduits
8. Design of pressure pipes as gravity mains, Darcy-Weisbach, Manning, Hazen-William formula

Unit III

9. Flow in pipes system-forces acting on pressure conduits-cast iron pipes, steel, RCC
10. Forces acting on pressure conduits - PVC, asbestos and concrete pipes
11. Laying of pipes and testing of pipes
12. Selection of pumps, efficiency of pumps, economic diameter of pumping mains

Unit IV

13. Drinking water quality: Indian standards of drinking water
14. Introduction to water treatment: purification of water supply
15. Sedimentation, filtration- coagulation, water softening
16. Water treatment methods

Unit V

17. Importance to sanitation, domestic waste water: quantity, characteristics
18. Domestic waste water disposal in urban and rural areas
19. Sewer: types, design discharge and hydraulic design
20. Introduction to domestic wastewater treatment

Unit VI

21. Design of septic tank
22. Sewerage system- domestic and municipal wastes
23. Storm sewage, flow through sewers
24. Design of sewers, manhole

Unit VII

25. Sewage characteristics, BOD, COD
26. Sewage characteristics, dissolved oxygen, nitrogen
27. Solid water collection and disposal
28. Solid waste quantity, characteristics

Unit VIII

29. Solid waste disposal for urban and rural areas
30. Introduction to air pollution, types of pollutants
31. Pollutants and their properties and their effects on living beings
32. BIS standards for pollutants in air and their abetments

Practical

No Practical outline

1. Study of population forecasting problems
2. Determination of turbidity, pH and EC of water
3. Study of suspended solids, dissolved solids and total solids
4. Study of temporary and permanent hardness
5. Determination of fluorides and chlorides in drinking water
6. Determination of dissolved oxygen, COD and BOD of water
7. Study of hydraulics of pipe lines and distribution network design
8. Visit to a water treatment plant

9. Study of maintenance of distribution system
10. Collection of air samples and their analysis
11. Design of septic tank.
12. Design of Sewer pipe lines
13. Design of waste disposal measures
14. Visit to a sewage treatment plant
15. Visit to a municipal solid waste management plant
16. Visit to a community bio gas plant

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PFEN 423 Development of Processed Food Products 3(2+1)

Course outlines

Objective

To enable the students to know about the

1. Unit operations and equipment used for different food processing operations
2. Processing technologies for value addition of cereals, pulses, oilseeds, vegetables, fruits, milk, fish, meat and poultry products

Theory

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products; Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract; Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind; Technology for processing of animal produce, viz. meat, poultry, fish, egg products; Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing

Practical

Process design and preparation of process flow chart; Preparation of different value added products; Visit to roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/ vegetable processing plant, sugar mill and other food processing industries & study of operations and machinery.

Lecture outlines

Theory

No. Theory outline

Unit I

1. Defining and characterizing new food products; basis for new product development; marketing characteristics of new products, new product life cycle, Need for new product development
2. The Product development process-strategy, product design and process development process, product commercialization, product launch and evaluation and service in food process development
3. Process flow chart with mass and energy balance
4. Unit operations and equipment for processing

Unit II

5. Technology for value addition of cereals, Pulses and Oil seeds – Processing technology of milling: operations involved in milling; technology in baking, baked products
6. Technologies for Malting, brewing
7. Technology for production of pasta, macaroni products, spaghetti, noodles and 3D snacks using extrusion technology: Breakfast cereals – Flaking, puffing and roasting
8. Technologies in oil extraction from different types of oil seeds, expellers types, principles, oil extraction process, refining of oils

Unit III

9. Technology for value added products from fruit and vegetables- preparation and preservation of unfermented fruit beverages like Juices, Nectar, Cordial, Squash, syrup, fruit juice concentrate, fruit juice powder, sugarcane juice and carbonated beverages
10. Technology for production of fermented food products and beverages. Sauerkraut, Kimchee, pickles and wine, Champagne, Toddy, Port, Neera
11. Canning: Definition, principles, equipment and process for various fruits and vegetables, shelf life, defects
12. Technology for production of Jam, Jellies and marmalades and vegetables; their problems associated during production

Unit IV

13. Technology for production of preserve, Candies, Crystallized fruits and glazed fruits

14. Technology for production of sauces/ketchups, chutneys, tomato puree, tomato soup, cocktails, potato flour, mango slices (aamchur), mango leather, fruit cheese, fruit toffee and fruit butter
15. Technology for value added products from spices – dry ginger from green ginger, dehydrated onions, onion powder, Garlic powder, Processing of turmeric for powder,
16. Production technology for extraction of oleoresins and volatile essential oils from chilli, ginger, turmeric

Unit V

17. Process of manufacture and formulae for production of - garam masala, chat masala, sambar powder, curry powder, Jal jeera, Meat masala, Chicken masala, Panipuri masala, Fish pulav masala,
18. Technology for value added products from milk and milk products – Special milks viz., Flavored milk, Irradiated milk, frozen concentrated milk, fermented milk, Reconstituted milk, Recombined milk, Toned milk, Double toned milk, Humanized milk
19. Technology for production of butter, paneer
20. Technology for production of ice cream, butter oil

Unit VI

21. Technology for production of condensed milk, dried milk powder Buttermilk powder, Butter powder, sugarcane juice powder
22. Technology for production of Khoa, Srikhand, Basundi, Kheer, Lassi, Ghee residue
23. Technology for value added products from forest produce – Mahua powder, mahua RTS drink, Tamarind seed powder, Tamarind concentrate
24. Technology for cocoa for drinking, instant cocoa, drinking chocolate cocoa

Unit VII

25. Technology for chocolate manufacturing, Chocolate bars and covered confectionery
26. Principles of various meat preservation techniques - Chilling - Freezing- Curing - Smoking- Thermal processing - canning - Dehydration - Irradiation and Hurdle concept
27. Processing technology of meat products – Meat comminution, emulsifiers, extenders, sausages, smoked meat, Production of Intermediate moisture meat products and Restructured meat products - tumbling - massaging - chunking - forming - tearing and forming
28. Production technology of poultry and fish products: Chicken patties, Chicken barbecue, chicken sausage, meat balls and pickling and Fish protein concentrate, Fish protein hydrolysates and Fish protein extracts

Unit VIII

29. Production technology of egg powders, scrambled egg, poached eggs, refrigerated egg whites, yolks, egg crepes and frozen eggs
30. Difference between functional foods and nutraceuticals, functional foods and their bioactive compounds

31. Technologies for production of functional foods – microencapsulation, and nano encapsulation of food ingredients
32. Principles and concepts of organic food processing

Practical

No. Practical outline

1. Preparation of process flow chart and Tutorials on mass and energy balance
2. Experiments on production of breakfast cereals
3. Experiments on production of squash from locally available fruits
4. Experiments on production of fermented beverage from fruits
5. Experiments on production technology of jam
6. Experiments on production of tomato sauces/ketchup
7. Experiments on production of aamchur
8. Experiments on production of garam masala/masala mixes
9. Experiments on production of flavoured milk
10. Experiments on production of paneer
11. Experiments on production technology of milk products (basundi)
12. Experiments on production of fruit juice powder
13. A visit to fruit processing plant
14. A visit to spices processing plant
15. A visit to dairy plant
16. Report writing

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15. Sharma, B D. Meat and meat Products Technology (Including Poultry Products Technology), Jaypee Publications
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PFEN 424 Food Packaging Technology 3(2+1)

Lecture outlines

Objectives

To enable the students to

1. Understand the interaction of food, packaging and environment
2. Understand the different methods of package development and packaging
3. Select the best type and form of packaging of specific food for specific end users

Theory

No. Lecture outline

Unit I

1. Factors affecting shelf life of food material during storage.
2. Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc.
3. General principles of control of the spoilage agents.
4. Difference between food infection, food intoxication and allergy.

Unit II

5. Packaging of foods, requirement, importance and scope,
6. Environmental considerations of packaging.
7. Packaging systems, types: flexible and rigid.
8. Retail and bulk; levels of packaging.

Unit III

9. Different types of packaging materials, their key properties and applications.
10. Metal cans- manufacture of two piece and three piece cans.
11. Plastic packaging- different types of polymers and lamination used in food packaging and their barrier properties.
12. Manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion.

Unit IV

13. Blow molding
14. Stretch blow molding
15. Glass containers- types of glass used in food packaging
16. Manufacture of glass containers

Unit V

17. Paper and paper board packaging and paper and paper board manufacture process.
18. Modification of barrier properties and characteristics of paper/ boards.
19. Relative advantages and disadvantages of different packaging materials.
20. Effect of these materials on packed commodities.

Unit VI

21. Nutritional labelling on packages.
22. CAS and MAP, shrink and cling packaging.
23. Vacuum and Gas packaging.
24. Active packaging, Smart packaging.

Unit VII

25. Packaging requirement for raw and processed foods and selection of packaging materials.
26. Disposal and recycle of packaging waste.
27. Package testing- testing methods for flexible materials, rigid materials and semi rigid materials.
28. Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.).

Unit VIII

29. Tests for plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.).
30. Tests for aluminium foil (thickness (thickness, pin holes, etc.).
31. Tests for glass containers (visual defects, colour, dimensions, impact strength, etc.).
32. Tests for metal containers (pressure test, product compatibility, etc.).

Practical

No.	Practical outline
1.	Identification of different types of packaging materials.
2.	Identification of different types of packaging materials.
3.	Determination of tensile strength of given material/ package.
4.	Determination of compressive strength of given material/ package.
5.	To perform different destructive for glass containers.
6.	To perform non-destructive tests for glass containers.
7.	Vacuum packaging of agricultural produces.
8.	Determination of tearing strength of paper board.
9.	Measurement of thickness of packaging materials.
10.	To perform grease-resistance test in plastic pouches.
11.	Determination of bursting strength of packaging material.
12.	Determination of water-vapour transmission rate.
13.	Shrink wrapping of various horticultural produce.
14.	Testing of chemical resistance of packaging materials.
15.	Determination of drop test of food package.
16.	Visit to relevant industries.

References

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2. Gosby, N.T. 2001. Food Packing Material. Applied Science Publication.
3. John, P.J. 2008. A Handbook on Food Packing. Narendra Publishing House, Delhi.
4. Mahadevia,M., Gowramma, R. V. 2007. Food Packing Materials.Tata McGraw Hill,Delhi.
5. Robertson, G.L., 2001.Food Packing and Self life: A Practical Guide. Narendra Publishing House, Delhi.
6. Robertson, G.L., 2005.Food Packing; Principles and Practice. Second Edition. Taylor and Francis Pub, Abingdon.

PFEN 425 Food Plant and Equipment Design 3(2+1)

Lecture outlines

Objectives

To enable the students to

1. Understand the managerial aspects of food processing plant
2. Understand Govt. policy on small and medium scale food processing enterprise 3. Understand the procedure of obtaining license and registration for operating food processing business

Course outlines

Theory

Food plant location, selection criteria for plant location; Selection of processes and plant capacity; Requirements of plant building and its components, flow diagrams; Selection of equipment, process and controls; Objectives and principles of food plant layout; Different types of plant layout; Consideration of salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products for equipment selection and layout. Application of design engineering for processing equipment; Design parameters and general design procedure; Material specification, types of material for process equipment; 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 grain dryers; Design of milling equipment; Optimization of design with respect to process efficiency, energy and cost; Computer Aided Design

Practical

Study of salient features and layout of pre-processing house; Study of salient features, design and layout of different types of food processing industries, viz. milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit; Evaluation of given layout; Design of pressure vessel; Design of cleaners; Design of milling equipment; Design of tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger; Design of grain dryer; Design of belt conveyor, bucket elevator, screw conveyor.

Lecture outlines

Theory

Lecture No. Lecture outline

Unit I

1. Plant design concepts, differences in design of food Processing and non-food processing plants - Food plant design process – General design considerations
2. Food plant location, selection criteria for plant location; Selection of decision processes, factors affecting selection of food plant location
3. Food plant size, plant capacity; Requirements of plant building and its components, list of equipment and machinery required for different unit operations in food processing plant- flow diagrams: process and piping diagram- Selection of equipment, process and controls
4. Objectives and principles of food plant layout; Different types of plant layout; Layout design procedures

Unit II

5. Consideration of salient features of processing plants for cereals, pulses, oilseeds for equipment selection and layout

6. Salient features of processing plants for horticultural and vegetable crops for equipment selection and layout
7. Salient features of processing plants for dairy plant and milk products for equipment selection and layout
8. Salient features of processing plants for poultry, fish and meat products for equipment selection and layout

Unit III

9. Application of design engineering for processing equipment; sizing of the equipment, materials of construction, hygienic design of equipment; fabrication of equipment
10. Selection of food processing equipment, Design parameters and general design procedure; symbols used for representing process equipment
11. Design of cleaners
12. Design of cleaners

Unit IV

13. Design of plate heat exchanger
14. Design of plate heat exchanger
15. Design of shell and tube heat exchanger
16. Design of shell and tube heat exchanger

Unit V

17. Design of tubular heat exchanger
18. Design of tubular heat exchanger
19. Design of belt conveyors
20. Design of bucket elevators

Unit VI

21. Design of screw conveyors
22. Design of grain dryer – fixed bed type
23. Design of grain dryer – fixed bed type
24. Design of grain dryer – re-circulatory type

Unit VII

25. Design of grain dryer – re-circulatory type
26. Design of pressure vessel
27. Design of pressure vessel
28. Design of milling equipment – abrasion type huller

Unit VIII

29. Design of milling equipment – Rubber roll Sheller
30. Design of milling equipment – Centrifugal de-huller
31. Optimization of design with respect to process efficiency, energy and cost
32. Computer aided process engineering design – software/simulation programs

Practical

No.	Practical outline
1.	Study of salient features and lay out of pre-processing house
2.	A visit to modern rice mill and study of layout of the machinery and various components of the plant
3.	A visit to dairy plant and study of layout of the machinery and components of the plant
4.	A visit to fruit processing industry and study of layout of the machinery and components of the plant
5.	A visit to spices processing industry and study of layout of the machinery and components of the plant
6.	Design of a pressure vessel
7.	Design of cleaners
8.	Design of tubular heat exchanger
9.	Design of a shell and tube heat exchanger
10.	Design of plate heat exchanger
11.	Design of a LSU type recirculatory grain dryer
12.	Design of belt conveyor
13.	Design of bucket elevator
14.	Design of screw conveyor
15.	Design of milling machinery
16.	Field visit

Suggested Reading

1. Bhattacharyya, B C. 2008. *Introduction to Chemical Equipment design*. CBS Publishers and Distributors.
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3. Geankoplis, C J. 1993. *Transport processes and unit operations*. Prentice-Hall.
4. Hall, H S and Rosen, Y S. 1963. *Milk Plant Layout*. FAO Publication, Rome.
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6. Mahajani, V V and Umarji, S B. 2009. *Process equipment design*. Macmillan.
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8. Maroulis, Z B. 2003. *Food Process Design*. Marcel Dekker, Inc, Cimarron Road, Monticello, New York 12701, USA.
9. Robberts Theunis, C. 2016. *Food plant engineering systems.* CRC Press, Washington.
10. George D. Saravacos and Athanasios E. Kostaropoulos.2002. Handbook of food processing equipment. Springer Science+Business Media, LLC.

11. Antonio López-Gómez, Gustavo V. Barbosa-Cánovas. 2005. Food Plant Design. Taylor & Francis Group, LLC.

12. Groover, M and Zimmers, E. CAD/CAM Computer aided design and manufacturing, Pearson Education Inc, New Delhi

PFEN 426 Emerging Technologies in Food Processing (2+1)

Lecture outlines

Objectives

To enable the students to

1. To know about various emerging technologies in food processing.
2. To know the practical applications of various emerging technologies in food processing.

Theory

Introduction, different emerging technologies and their scope and applications.

Principle, equipment and applications of ohmic heating, infrared heating, dielectric heating, microwave heating systems, radio frequency heating equipment, combined microwave vacuum drying new hybrid drying technologies.

Principles and equipment for Vacuum processing, High pressure processing, Pulsed electric field processing, Ultrasonication, Gamma irradiation/ ionizing radiation, Ultraviolet radiation processing.

Pulsed X-ray processing, Pulsed light processing, Cold plasma processing, Ozone treatment, Electron beam processing, Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge.

Nano-material utilization in food processing, manufacture of nano-materials, applications.

Practical

Study of Ohmic heating equipment; Infrared drying of biological materials; Study of Microwave oven and use of Microwave oven for various applications; Study of Radio frequency heating equipment and its applications; Vacuum Drying of biological materials; Study of Heat pump construction and drying of biological materials; Freezing and freeze drying of biological materials; Study of High pressure processing equipment;

Study of Pulsed electric field processing equipment; Ultrasonication application for oil extraction; Ultraviolet treatment for reducing microbiological load; Study of cold plasma treatment equipment and application of cold plasma; Ozone treatment of leafy vegetables and study of their shelf life; 3-D printing of foods; Super critical fluid extraction of high value compounds; Practical examination.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Different emerging technologies and their scope and applications in food processing
2. Introduction to different emerging technologies
3. Ohmic heating principle, equipment and applications
4. Infrared heating

Unit II

5. Dielectric heating
6. Microwave heating systems
7. Radio frequency heating equipment and applications
8. Combined microwave vacuum drying new hybrid drying technologies

Unit III

9. Principles and equipment for Vacuum processing
10. Heat pump drying, construction and working of the equipment
11. Refractive window drying
12. Freezing and freeze drying

Unit IV

13. Multistage evaporation, economy in evaporation and reduction of green stack losses
14. High pressure processing
15. Pulsed electric field processing
16. Ultrasonication and their applications

Unit V

17. Gamma irradiation/ ionizing radiation
18. Ultraviolet radiation processing
19. Pulsed X-ray processing
20. Pulsed light processing

Unit VI

21. Cold plasma processing principles and working of equipment
22. Applications of Cold plasma processing in foods
23. Ozone treatment of foods and shelf life enhancement
24. Electron beam processing

Unit VII

25. Static and oscillating magnetic fields and their application in foods
26. Dense phase carbon dioxide processing

27. High voltage arc discharge processing of foods
28. 3-D printing of foods

Unit VIII

29. Super critical fluid extraction of high value compounds
30. Nano-material utilization in food processing
31. Manufacture of nano-materials and their applications
32. Enzymes and their application in food processing

Practical

No.	Practical outline
1.	Study of Ohmic heating equipment
2.	Experiment on Infrared drying of biological materials
3.	Study of Microwave oven and use of Microwave oven for various applications
4.	Study of Radio frequency heating equipment and its applications
5.	Experiment on Vacuum Drying of biological materials
6.	Study of Heat pump construction and drying of biological materials
7.	Study of Freezing and freeze drying of biological materials
8.	Study of High pressure processing equipment
9.	Study of Pulsed electric field processing equipment
10.	Experiment on Ultrasonication application for oil extraction
11.	Ultraviolet treatment for reducing microbiological load
12.	Study of cold plasma treatment equipment and application of cold plasma
13.	Experiment on Ozone treatment of leafy vegetables and study of their shelf life
14.	Study of 3-D printing of foods
15.	Study of Super critical fluid extraction of high value compounds
16.	Field visit

References

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2. Passos and Ribeiro. Innovation in Food Engineering – New Techniques and Products. CRC Press.
3. Sun Da-Wen. Thermal Food Processing – New technologies and Quality Issues. CRC Press.
4. SunDa-Wen. Emerging technologies in food processing. Elsevier
5. Tewari and Juneja. Advances in Thermal and Non-Thermal Food Preservation. Blackwell.

PFEN 427 Processing of Livestock, Fish and Marine Products 3(2+1)

Lecture outlines

Objectives

Enable the students to

1. Learn various processes and methods for processing of livestock, fish and marine products, and
2. Understand the livestock and marine product processing and its applications in industries.

Theory

Production, economics, and processing scenario of meat, fish, and poultry; Processing and preservation of eggs, production of egg yolk and egg yellow powder; Poultry processing: Unit operations for various poultry products; Fish processing: Unit operations for various fish products; Preservation of meat by dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meat using antibiotics and chemical additives; Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; Meat texture and tenderness: measurement, factors affecting texture and tenderness, artificial tenderizing; Abattoir design and layout, meat plant sanitation and safety; By-products utilization.

Practical

Hands on exercise on the processing of fish, meat and egg and preparation of value added products; Visit to processing plants.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Production, economics and processing scenario of meat
2. Production, economics and processing scenario of fish
3. Production, economics and processing scenario of poultry
4. Processing of eggs – Egg structure, composition, structural components of egg and their functions, egg white protein and egg yolk composition

Unit II

5. Processing of eggs – Quality characteristics – candling of eggs, albumen index, yolk index, haugh's unit, grading of eggs
6. Processing of eggs–Processing of liquid eggs, pasteurization, dehydration, albumen flakes

7. Preservation of eggs – freezing of eggs, shell eggs, oil coating, thermal stabilization, water glass and lime immersions
8. Production process of egg yolk

Unit III

9. Production process of egg yellow powder
10. Poultry processing –pre-slaughter operations for poultry – ante mortem inspection of meat animals
11. Poultry processing – Slaughtering operations – scientific and ritual methods of slaughter
12. Factors affecting post-mortem changes – rigor mortis, properties and shelf life of meat

Unit IV

13. Mechanical deboning – mechanism and equipment used for deboning
14. Grading and ageing of meat – USDA grades – Ageing – Effect of ageing on myofibrilar proteins
15. Unit operations for various poultry products – Poultry carcass, Cut-up poultry; Poultry meat products – chicken nuggets, cured/smoked meat products, meat sausages
16. Fish processing – Classification of fish (fresh water and marine) - composition of fish - characteristics of fresh fish

Unit V

17. Fish processing –Spoilage of fish – Factors affecting spoilage of fish – microbiological – physiological: post mortem changes in fish – biochemical: Enzymatic changes
18. General aspects of fish freezing –factors affecting – freezing time of fish – IQF of shrimps - slow freezing methods – equipment used
19. Principles of canning and effect of heat processing on fish – storage of canned fish
20. Unit operations for various fish products: cleaning, scaling, gut removal, chilling, packaging; Fish products - Surimi (traditional and modern methods), fish fingers, smoked fish, Canned fish, fish paste

Unit VI

21. Packaging of fish and marine products – MAP, Vacuum packaging and gas packaging
22. Sea food quality assurance, HACCP, EU hygienic regulations and ISO: 9000 standards
23. Preservation of meat by chilling and freezing – equipment used
24. Preservation of meat by pickling and curing – methods of curing – effect of curing on meat structure and colour

Unit VII

25. Preservation of meat by cooking and smoking – dry heat and moist heat techniques – smoke house – conventional smoking – liquid smokes
26. Preservation of meat by dehydration, ionizing radiation, chemical and antibiotics additives

27. Eating quality of meat – meat quality parameters – colour, marbling, waterholding capacity and juiciness in cooked and uncooked meat
28. Meat texture and tenderness: measurement, factors affecting texture and tenderness

Unit VIII

29. Meat artificial tenderization – physical/mechanical and chemical methods of tenderization
30. Abattoir design and layout – types of abattoirs, facilities required and various sections in abattoir and their significance
31. Meat plant sanitation and safety
32. By-products utilization

Practical

No. Practical outline

1. Cutting and filleting of fish either manually or mechanically
2. Processing technology of sun dried and salt cured fish
3. Processing technology of fish sauce and fish cutlet
4. Processing technology of fish patties and fish nuggets
5. Slaughtering and dressing of meat animals - poultry
6. Meat cutting and handling – poultry
7. Processing technology of salami and sausages
8. Processing technology of enrobed eggs
9. Preservation of meat by curing and pickling
10. Preservation of meat by dehydration
11. Process technology of value-added poultry meat products – Chicken nuggets
12. Process technology of value-added poultry meat products – meat patties
13. Value added egg products – hollandaise sauce and mayonnaise
14. Visit to fish and prawn processing industry
15. Visit to an abattoir
16. Field visit

Suggested reading

1. Bechtel, P J. *Muscle as Food*, Academic Press
2. Gopa Kumar, K and Sankar, T.V. Text book of Fish Processing Technology. Publisher: Indian Council of Agricultural Research, ISBN: 9788171642779.
3. Hui, Y H. *Hand book of Meat and Meat Processing*. CRC Press
4. Lawrie, R A and Ledward D. *Lawrie's. Meat Science*, WoodHead Publishing
5. Stadelmen, W J and Cotterill, O J. *Egg Science and Technology*. CRC press.

AEBE 464 MATLAB Programming 3(1+2)

Course outlines

Objectives

To enable the students

To know the different features of MATLAB

To have hands-on exercise on Programming and Simulink

To use the MATLAB for different agricultural engineering applications.

Theory

Introduction: platform & features, prerequisites & system requirements, advantages & disadvantages; Commands, environment, working with variables & arrays, workspace, variables & functions, data types, operator, formatting text.

MATLAB Control Statements: if statement, if-else statement, if-else if statement, nested if-else, switch; MATLAB loops: for loop, while loop, nested loop, break, continue; MATLAB error control: error control statement-try & catch. Arrays and functions: matrices & arrays, multi-dimensional arrays, compatible array, sparse matrices;

Functions: normal functions, predefined functions, user-defined functions, anonymous Function\2D Plots: fplot (), Semilogx (), Semilogy (), loglog (), fill (), Bar (), errorbar (), barh (), plotyy (), area (), Pie (), hist (), stem (), Stairs (), compass (), comet (), contour (), quiver (), pcolor (); 3D Plots: plot3(), fill3(), contour3 (), surf (), surfc (), mesh (), meshz (), waterfall (), stem3 (), ribbon (), sphere (), ellipsoid (), cylinder (), slice ().

Practical

Hands on experience with MATLAB functionalities and its installation on different platforms; MATLAB project based on real time Agricultural Engineering problems

Lecture outlines

Theory

No. Lecture outlines

Unit I

1. Platform & features, prerequisites & system requirements, advantages & disadvantages;
2. Commands, environment, working with variables & arrays, workspace

Unit II

3. Variables & functions, datatypes, operator, formatting text
4. if statement, if-else statement

Unit III

5. If-else if statement, nested if-else, switch;
6. For loop, while loop

Unit IV

7. Nested loop, break, continue
8. Error control statement-try & catch

Unit V

9. Matrices & arrays, multi-dimensional arrays
10. Compatible array, sparse matrices

Unit VI

11. Normal functions, predefined functions
12. User-defined functions, anonymous Function

Unit VII

13. Fplot(), Semilogx(), Semilogy(), loglog(), fill(), Bar(), errorbar(), barh(), plotyy()
14. Area (), Pie (), hist (), stem(), Stairs(), compass(), comet(), contour(), quiver(), pcolor();

Unit VIII

15. Plot3(), fill3(), contour3(), surf(), surfc(), mesh(), meshz()
16. Waterfall(), stem3(), ribbon(),sphere (), ellipsoid(), cylinder(), slice()

Practical

No. Practical outline

1. Introduction to MATLAB for Scientists and Engineers
2. MATLAB Installation
3. Understanding MATLAB and its Environment
4. MATLAB Commands, working with variables & arrays, workspace
5. MATLAB functions, datatypes, operator, formatting text
6. MATLAB Logical statements: if statement, if-else statement
7. MATLAB Logical statements: if-elseif statement, nested if-else, switch.
8. MATLAB loops: for loop, while loop
9. MATLAB loops: nested loop, break, continue
10. MATLAB Arrays: Creating One, multi-dimensional arrays
11. MATLAB Matrices: Study of basic matrix operations
12. MATLAB as Mathematical Calculator
13. MATLAB Application Project: Solving System of Linear Equations, Integration and Roots of Polynomial Equations.
14. MATLAB code for plotting basic graphs: 2D Plots

15. MATLAB3-D Plots
16. Interfacing MATLAB with Microsoft Word and Excel
17. Creating the Function Files in MATLAB.
18. MATLAB error control
19. Introduction to SIMULINK.
20. Introduction to MATLAB Toolboxes:MATLAB Tools for Crop Monitoring
21. Introduction to Image Processing Toolbox
22. Introduction to fuzzy logic tool box
23. Introduction to GA tool box
24. Modeling of basic systems in SIMULINK
25. MATLAB for Plant Classification
26. Study of Optimizing Precision Farming using MATLAB
27. Study of Irrigation Control and Yield Prediction with MATLAB
28. Study of Smart Agriculture SystemsUsing MATLAB
29. Study of Plant modelling using MATLAB
30. Study of Plant disease Detection using MATLAB
31. Construction of crop growth functions using MATLAB
32. Construction of crop growth functions using MATLAB

References

1. MATLAB for Beginners (Learning the Fundamentals with Practical Examples) By Jace Morrison
2. The Math Works Inc.
3. MATLAB and SIMULINK (A Basic Understanding for Engineers) By Pooja Mahindra and Pankaj Mohindru
4. A Guide to MATLAB for Beginners and Experienced UsersBrian R. Hunt Ronald L.Lips manJonathan M.Rosenberg

AEBE 465 Python Programming 3(1+2)

Course outlines

Objective

To enable the students to know the different features of Python programming and usage of different inbuilt libraries for performing the fieldoriented tasks. Hands of programming of Python language for different use cases in agricultural engineering applications.

Theory

History, applications, installation. Variables, data types, keywords, literals, operators, comments. Conditional statements: if else, loops, for loop, while loop, break, continue, pass, strings, lists, tuples, listvs tuple. Functions: functions, built-in functions, lambda functions. Files I/O, modules, exceptions, date, Regex, read CSV File, write CSV File, read excel file, write excel file, assert, list comprehension, collection. Module, math module, OS module, random module, statistics module, sys module, IDEs, arrays, command line arguments, stack and queue. Python OOPs: OOPs concepts, object class, constructors, inheritance, abstraction.

Practical

Hands on experience with Python and its installation on different platforms; Accessing python from GUI and from command prompt / terminal, a project based on real time agricultural engineering problems.

Lecture outlines

Theory

No. Lecture outlines

Unit I

1. History of python, applications, features and installation
2. Python variables, data types and keywords.

Unit II

3. Literals, Operators and comments – single line comment and multiline comments.
4. Python constructs- lists, tuples, Boolean, sets andstrings

Unit III

5. Python conditional statements - if, if-else and if-elif-else
6. Transfer statements- break, continue, and pass. Iterative statements – for and while loops.

Unit IV

7. Python Functions: Functions- types, built-in functions, lambda function
8. Files I/O, exceptions, date and Regex (Regular expression) in python

Unit V

9. Read CSV File, write CSV File, read excel file and write excel file
10. Appending to files, list patterns, list comprehensions- mapping and filtering

Unit VI

11. Modules- Math module- trigonometric, logarithmic functions. OS module- name (), getcwd(), error, popen(), rename (). Random module

12. Statistics module- mean, media, mode, standard deviation, skewness, percentile and range.

Unit VII

13. Arrays module- creating, removing, indexing, slicing, searching and updating the elements in array.
14. Sys module - line arguments. Differences between array, stack and queue

Unit VIII

15. Python OOPs: OOPs (object Oriented Programming) concepts, class, attribute, object, instances of classes, creating classes, functions in classes.
16. Attributes, constructors, inheritance and creating subclasses.

Practical

No. Practical outline

1. Installing of python- pycharm, jupyterIDEfor windows OS. Setting working directory and creating script file
2. Exercises on variables selection, type casting and strings.
3. Exercises on initializing of data types and different operators.
4. Exercises on lists – creating lists, accessing elements of lists, inserting joining and sorting of list.
5. Creating tuples – changing tuple values, packing and un-packing tuples, join tuples.
6. Exercises on Boolean data type.
7. Creating sets- accessing elements of sets, adding and removal of elements in the sets.
8. Creating a dictionary- accessing,adding, removing, and looping through the elements in the dictionary.
9. Exercises on arrays – accessing, adding, slicing, changing and adding elements.
10. Exercises on if and if –else conditional statements
11. Exercises on if-elif-else and nested if-else conditional statements.
12. Exercises on break, continue and pass transfer statements
13. Exercises on for loop and range function.
14. Exercises on while loop. Looping through the string.
15. Exercises on creating different types of functions.
16. Creating the functions- Calculating the circumference of circle with return value.
17. Creating the functions - Calculating the circumference of circle with no return value
18. Examples on built in python functions
19. Examples on lambda function
20. Importing the math module to IDE and exercises on sin, cos, tan, exp, log, log10, factorial, sqrt, floor.
21. Reading and writing a csv, excel data file to carry out the statistical calculations.

22. Exercises on data clearing and preprocessing from the excel file.
23. Exercises on creating an arrays and concatenation
24. Exercises on random libraries
25. Exercises on sys module and line arguments
26. Examples on attributes and constructors
27. Practice on drawing various plots to data using matplotlib
28. Practice on drawing various plots to data using matplotlib
29. Practice on object oriented programming
30. Obtaining the weather/experimental data and development of linear models
31. Obtaining the data of multi linear regression models and plotting the data using matplotlib
32. Development of multi linear regression models and plotting the data using matplotlib

References

1. Rakesh. K. Yadav, Srinivas Arukonda, Monu Singh, Tapasya Dinakar, DileepKumar Yadav. "*Zero to mastery in Python programming*". 2nd Edition. Vayu Education of India, New Delhi.
2. R. Nageswara Rao, "*Core Python Programming*", DreamtechVamsiKurama.*Python Programming: A Modern Approach*, Pearson Publications.
3. Brian Heinold.*A Practical Introduction to Python Programming*. Department of Mathematics and Computer Science Mount St. Mary's University
4. Udayan Das, Aubrey lawson, Wiley Chris Mayfield, NargesNorouzi. *Introduction toPython Programming*. OpenStax Rice University 6100 Main Street MS-375 Houston, Texas.
5. Allen B. Downey. *Think Python: How to Think Like a Computer Scientist*. 2nd edition, Updated for Python 3, Shroff/O 'Reilly Publishers, 2016.

AEBE 466 Artificial Intelligence (2+1)

Course outlines

Objective

To enable the students to know the details of problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning, communicating, perceiving, and acting in artificial intelligence.

Theory

Foundation and history of artificial intelligence; Intelligent agents, structure of agents;AI programming languages, introduction to LISP and PROLOG; Solving problems by searching, problem solving agents, infrastructure for search algorithms, measuring problem solving performance, blind search strategies, breadth first search, depth first search, heuristic search techniques, best first- A* algorithm, AO* algorithm; Hill climbing search, Genetic algorithms; Games, game tree, game playing, min-max algorithms, alpha beta pruning; Logical agents, knowledge representation issues, predicate logic, logic programming; Constraint satisfaction problems, backtracking search; Knowledge representation- representing knowledge using rules, rules based deduction systems, semantic nets, frames, inheritance, temporal reasoning; Quantifying uncertainty, reasoning under uncertainty; Probabilistic reasoning- review of probability, Baye's probabilistic interferences, Dempster Shafer theory, fuzzy reasoning; Classical planning- planning, representation for planning, partial order planning algorithm; Planning and acting in the real world- planning in situational calculus, high-level actions; Supervised learning, artificial neural networks, neural network structures, single-layer feed-forward neural networks (perceptron), multilayer feed forward neural networks, learning in multilayer networks; Knowledge in learning- a logical formulation of learning, explanation-based learning; Natural language processing- principles of natural language processing; Expert systems, knowledge acquisition concepts; Robotics, AI application to robotics; Current trends in intelligent systems

Practical

Hands on exercise on problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning in artificial intelligence, communicating, perceiving, and acting in artificial intelligence and verifying engineering concepts in artificial intelligence.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Foundation and history of artificial intelligence
2. Introduction to Intelligent agents, structure of agents
3. Introduction to Artificial Intelligence programming languages
4. introduction to LISP and PROLOG

Unit II

5. Solving problems by searching techniques
6. Introduction to problem solving agents
7. Familiarization with infrastructure for search algorithms
8. Familiarization with measuring problem solving performance

Unit III

9. Introduction to blind search strategies
10. Familiarization with breadth first search

11. Familiarization with depth first search
12. Familiarization with heuristic search techniques

Unit IV

13. Introduction to best first- A* algorithm, AO* algorithm
14. Familiarization with Hill climbing search
15. Introduction to genetic algorithms
16. Familiarization with Games, game tree, game playing

Unit V

17. alpha beta pruning
18. Logical agents- knowledge representation issues
19. Predicate logic, logic programming
20. Familiarization with Constraint satisfaction problems, backtracking search

Unit VI

21. Knowledge representation- representing knowledge using rules, rules based deduction systems
22. Knowledge representation -semantic nets, frames, inheritance, temporal reasoning
23. Introduction to quantifying uncertainty, reasoning under uncertainty
24. Probabilistic reasoning- review of probability, Baye's probabilistic interferences, Dempster Shafer theory, fuzzy reasoning

Unit VII

25. Classical planning- planning, representation for planning, partial order planning algorithm
26. Classical planning- Planning and acting in the real world planning in situational calculus, high-level actions
27. Supervised learning, artificial neural networks, neural network structures,
28. single-layer feed-forward neural networks (perceptron), multilayer feed-forward neural networks, learning in multilayer networks

Unit VIII

29. Knowledge in learning- a logical formulation of learning, explanation-based learning
30. Natural language processing- principles of natural language processing
31. Expert systems, knowledge acquisition concepts
32. Robotics, AI application to robotics; Current trends in intelligent systems

Practical

No. Practical outline

1. Hands on exercise on problem solving in artificial intelligence
2. Hands on exercise on problem solving in artificial intelligence
3. details of knowledge, reasoning, and planning in artificial intelligence

4. details of knowledge, reasoning, and planning in artificial intelligence
5. learning in artificial intelligence
6. learning in artificial intelligence
7. communicating, perceiving, and acting in artificial intelligence
8. communicating, perceiving, and acting in artificial intelligence
9. communicating, perceiving, and acting in artificial intelligence
10. Verifying engineering concepts in artificial intelligence.
11. Verifying engineering concepts in artificial intelligence.
12. Verifying engineering concepts in artificial intelligence.
13. Advanced tree representations, basic problem-solving strategies, depth first search strategy, breadth-first search strategy.
14. Advanced tree representations, basic problem-solving strategies, depth first search strategy, breadth-first search strategy.
15. Advanced tree representations, basic problem-solving strategies, depth first search strategy, breadth-first search strategy.
16. Practical Examination

References

1. Russell S and Norvig P. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.
2. Rich E and Knight K. 1991. Artificial Intelligence. Times McGraw-Hill.
3. Winston P H. 1992. Artificial intelligence. Addition Wesley 3rd Ed.
4. Nilson N J. 2002. Principles of Artificial Intelligence. Narosa Publishing House.

AEBE 467 Advances in Automation and Robotics in Agriculture 3(2+1)

Course outlines

Objective

To enable the students to gain advanced knowledge and skill for application of automation and robotics in agriculture, know about the modeling of robot mechanisms, robot control architectures and robot design and considerations for agricultural operations.

Theory

Sensors and sensor-driven robot Control, Robot Sensors, Proximity sensors- Infrared sensors, Ultrasonic sensor, Laser range finder, Robot Vision sensors- RGB camera, Thermal Camera, Multispectral sensor, Hyper spectral sensor, Stereo vision system, Optical flow sensor, GPS sensor-RTK, PPK. Sensor noise and uncertainty- Sensor uncertainty, Non-observability, Action uncertainty.

Introduction to Robotics and its importance in Agriculture, classification of robots (Anatomy),Automation and Robotics in Intelligent Environments, History of Robotics, Robot manipulators, Mobile robots, Walking Robot, Humanoid Robots, Autonomous Robots, Traditional Industrial Robots, Requirements for Robots in Intelligent Environments, Status and scope in Agriculture; Modeling of robot mechanisms, Kinematics, Dynamics, Robot sensor selection, Active and passive proximity sensors, Low-level control of actuators, Closed-loop control, Control architectures, Traditional planning architectures, Behavior based control architectures, and Hybrid architectures. Modeling the Robot Mechanism, Forward kinematics, Inverse kinematics, Jacobian calculation, and Mobile Robot Odometry.

Robot Actuator Control system, Mass, inertia, friction and force, frequent actuators, control approach Proportional, PI, and PID control, Actuators- DC motor, BLDC motor, Linear actuator, Servomotor, Stepper motor, Drivers and control algorithms. Ground Control station system, Transmitters, and receivers, PWM, PPM signal, telemetry system, band, and frequency. Transmitter, receiver, PWM, PPM, Telemetry system, band and frequency; Robot Navigation, Path planning addresses and computing a trajectory, Algorithms, and control navigation, mission planning and control, Geo-fencing, Triggering, Software for robot control and navigation, Probabilistic Robot Localization- Localization, Mapping, and Model Building; Robot Control Architectures, Deliberative Control Architecture-Perception, modeling, planning, task execution and motor control, Advantages, and disadvantages; Behavior-Based Robot Control Architectures, Reactive, Behavior-Based Control Architectures, Hybrid Control Architectures, Intuitive Robot Interfaces-Graphical programming interfaces, Deictic (pointing) interfaces, Voice recognition and reaction.

AI adaptation and Learning for Robots-Supervised learning, Learning Sensory Patterns-Neural networks, Decision trees, Reinforcement Learning, AI programming techniques. Classical AI, the concept of expert system, conflict resolution, multiple rules, forward chaining, and backward chaining. Advantages and disadvantages of expert system. Robot design and considerations for agricultural operations, Robots for Seedbed preparation, sowing and transplanting, weeding operation-mechanical and chemical, fruit harvesting, robots for greenhouse application, moisture management, post-harvest losses management, dairy and food packaging, humanoid robots, cattle and poultry farm management, VRT robots, Driverless Autonomous tractor.

Practical

Demonstration of different types of robots and their use in agricultural operations; Robot mechanisms, forward kinematics, inverse kinematics calculations and modeling; PID control of actuators and their calibration for precise control; Practical on robot actuator control systems for determination of mass, inertia, friction, and forces; Calibration of PID controllers for close-loop controls of the system; Mission planning and computation of trajectory for a robot through Python coding and other software; Sensor-driven robot control for obstacle avoidance using different sensors;

Calibration of GPS sensors and 3-D fixing for precise control; Robot control architecture design, control, and behavior study; Robot-supervised learning for sensory patterns to detect leaves, flowers, fruit, animal, human body, etc; Robot design consideration for sowing and transplanting operation; Robot design for weeding operation; Robotic arm design for fruit detection and harvesting; Robotic prime mover design for greenhouse operations for selected crops; Automation of machines for food packaging; Robots for food control and cleaning in cattle and poultry farms; Robots for variable rate application of agricultural inputs; Driverless and autonomous tractor for straight control calibration of movement; Control of humanoid robots for selected agricultural operations and active voice command control.

Lecture outlines

Theory

No. Lecture outline

Unit I Introduction to Robotics in Agriculture

1. Introduction to Robotics and its Importance in Agriculture – Classification of Robots (Anatomy) – Automation and Robotics in Intelligent Environments
2. History of Robotics – Traditional Industrial Robots – Status and Scope of Robotics in Agriculture
3. Requirements for Robots in Intelligent Environments – Types of Robots: Mobile Robots, Walking Robots, Humanoid Robots, Autonomous Robots.
4. Robot Manipulators and Their Applications – Overview of Robot Applications in Agricultural Operations.

Unit II Robot Sensors and Sensor Uncertainty

5. Introduction to Robot Sensors – Types of Sensors and Their Applications in Robots.
6. Proximity Sensors: Infrared Sensors, Ultrasonic Sensors, Laser Range Finder – Applications in Agriculture.
7. Vision Sensors: RGB Camera, Thermal Camera, Multispectral and Hyper spectral Sensors, Stereo Vision System, Optical Flow Sensor
8. GPS Sensors: RTK and PPK – Sensor Noise and Uncertainty – Concepts of Sensor Uncertainty, Non-observability, and Action Uncertainty.

Unit III Robot Mechanism and Modeling

9. Basics of Robot Mechanism – Forward and Inverse Kinematics – Introduction to Jacobian Calculation
10. Dynamics of Robot Mechanisms – Mass, Inertia, Friction, and Force – Applications in Agricultural Robots.
11. Mobile Robot Odometry and Path Estimation – Introduction to Robot Navigation Systems.
12. Robot Sensor Selection and Active/Passive Proximity Sensors – Key considerations for Agricultural Robots

Unit IV Robot Control Systems and Actuators

13. Introduction to Robot Actuator Control – Common Actuators: DC Motor, BLDC Motor, Linear Actuator, Servomotor, Stepper Motor.

14. Control Approaches: Proportional, PI, and PID Control – Drivers and Control Algorithms for Actuators.
15. Ground Control Station Systems – Transmitters, Receivers, PWM, PPM Signals, Telemetry Systems, Bands, and Frequencies.
16. Software for Robot Control – Mission Planning and Control – Geofencing and Triggering Applications.

Unit V Robot Navigation and Path Planning

17. Fundamentals of Robot Navigation – Path Planning and Computing Trajectories – Navigation Algorithms.
18. Probabilistic Robot Localization: Localization, Mapping, and Model Building – Role of AI in Navigation.
19. Control Architectures: Traditional Planning Architectures – Deliberative, Reactive, and Behavior-Based Architectures.
20. Hybrid Architectures – Advantages and Limitations of Various Control Approaches in Agricultural Robots.

Unit VI AI and Learning in Robotics

21. AI Adaptation and Learning in Robots – Supervised Learning and Neural Networks.
22. Learning Sensory Patterns – Decision Trees and Reinforcement Learning – AI Programming Techniques.
23. Classical AI: Expert Systems, Conflict Resolution, Forward and Backward Chaining – Advantages and Disadvantages
24. Applications of AI in Agricultural Robots: Seedbed Preparation, Sowing, Transplanting, and Weeding.

Unit VII Design and Applications of Robots in Agriculture

25. Robot Design Considerations for Agricultural Operations – Factors Affecting Design Choices.
26. Robots for Greenhouse Applications, Moisture Management, and Post-Harvest Loss Management.
27. Specialized Robots for Fruit Harvesting, Dairy and Food Packaging, and Poultry Farm Management.
28. Driverless Autonomous Tractors and Variable Rate Technology (VRT) Robots – Precision Agriculture Applications.

Unit VIII Advanced Topics and Interfaces in Robotics

29. Robot Interfaces: Graphical Programming, Deictic (Pointing) Interfaces, Voice Recognition, and Reaction Systems.
30. Robot Control Architectures: Deliberative, Behavior-Based, and Hybrid Architectures – Practical Examples.
31. Humanoid Robots in Agriculture – Future Applications and Challenges.
32. Integration of AI, Robotics, and Automation for Sustainable Agricultural Practices.

Practicals

No.	Practical Outline
1.	Demonstration of Robot Types and Their Applications in Agricultural Operations
2.	Calculation of Forward and Inverse Kinematics for Robot Mechanisms
3.	Study the PID Control of Actuators and Calibration for Precise Movement Control
4.	Practical Assessment of Robot Actuator Control Systems for Mass, Inertia, Friction, and Forces
5.	Calibration of PID Controllers for Closed-Loop Control Systems in Agricultural Robots
6.	Mission Planning and Trajectory Computation for Agricultural Robots using Python
7.	Sensor-Driven Robot Control for Obstacle Avoidance using Infrared, Ultrasonic, and Laser Sensors
8.	Calibration of GPS Sensors for 3D Position Fixing and Precise Control in Agricultural Robots
9.	Study of Robot Control Architecture for Efficient Task Execution in Agriculture
10.	Supervised Learning for Sensory Pattern Recognition in Agricultural Robots (Leaf, Flower, Fruit, etc.)
11.	Study the working of Robots for Efficient Sowing and Transplanting Operations
12.	Study the Robots for Weeding Operations (Mechanical and Chemical)
13.	Study the working and construction of Robotic Arm for Fruit Detection and Harvesting Applications
14.	Study the working and construction of Robotic Prime Movers for Greenhouse Operations
15.	Study the Automation of Food Packaging Processes using Agricultural Robots
16.	Practical Examination

Suggested Readings

1. Ben-Ari, Mordechai and Mondada, Francesco. Elements of Robotics. Springer Nature, 2017.
2. Braunl, T. Embedded Robotics Mobile Robot Design and Applications with Embedded Systems.Springer Berlin Heidelberg, 2013.
3. Craig, John J. Introduction to Robotics Mechanics and Control. 5 Pearson Education, Inc.Pearson Prentice Hall Pearson Education, Inc. Upper Saddle River, NJ, 2005.
4. Miller, Mark R. and Miller, Rex. Robots and Robotics, Principles, Systems, and Industrial Applications. McGraw-Hill Education, 2017.
5. Schilling, Robert. J. Fundamentals of Robotics – Analysis and Control. Prentice Hall of India,1990.
6. Siegwart, Roland, Nourbakhsh, Illah Reza and Scaramuzza, Davide. Introduction to autonomous Mobile Robots. MIT press, 2011.

AEBE 468 **Machine Learning** **3(2+1)**

Course outlines

Objective

To enable the students about the basics of machine learning and to know the applications of machine learning in different fields.

Theory

Introduction to Machine Learning, Preliminaries, what is machine learning; varieties of machine learning, learning input/output functions, bias, sample application. Boolean functions and their classes, CNF, DNF, decision lists. Version spaces for learning, version graphs, learning search of a version pace, candidate elimination methods; Neural Networks, threshold logic units, linear machines, networks of threshold learning units, Training of feed forward networks by back propagations, neural networks vs. knowledge-based systems; Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation;

Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction; Computational learning theory, fundamental theorem, VapnikChernonenkis dimension, linear dichotomies and capacity. Unsupervised learning, clustering methods based on Euclidian distance and probabilities, hierarchical clustering methods. Introduction to reinforcement and explanation based learning

Practical

Hands on experience with Machine Learning functionalities and its use in Agricultural Engineering and allied fields.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Preliminaries, definition of machine learning
2. Wellsprings of machine Learning, varieties of machine learning
3. Learning input/output functions
4. Bias, sample application

Unit II

5. Representation-Boolean Algebra, Diagrammatic Representations
6. Classes of Boolean Functions- CNF

7. DNF, decision lists
8. Version spaces and Mistake bounds

Unit III

9. Version graphs
10. Learning search of a version pace
11. Candidate elimination methods
12. Definition, types Neural networks

Unit IV

13. Threshold logic units
14. Linear machines,
15. Networks of threshold learning units
16. Training of feed forward networks by back propagations,

Unit V

17. Neural networks vs. knowledge-based systems
18. Background and general method
19. Learning belief networks
20. Nearest neighbour method

Unit VI

21. Definitions, supervised learning of uni-variance decision trees
22. Network equivalent of decision trees,
23. Over fitting and evaluation
24. Inductive Logic Programming, notation and definitions

Unit VII

25. Introducing recursive programs,
26. Inductive logic programming vs decision tree induction
27. Notation, PAC Learning Theory, fundamental theorem
28. VapnikChernonenkis dimension-linear dichotomies and capacity.

Unit VIII

29. Clusteringmethods based on -Euclidian distance, Probabilities
30. Hierarchical clustering methods
31. Introduction to reinforcement
32. Explanation-based learning

Practical

No.	Practical outline
1	Installing applications and creating environment

2 Basic coding for loops
3 Basic coding for functions
4 Basic coding for if/else statements
5 Reading csv into memory
6 Loading data from seaborne
7 Implement classification based on the K-nearest neighbor's method, using the scikit-learn library.
8 Implementation of linear regression(least-squares)
9 Implementation of logistic regression
10 Implement methods for classification using support vector machines and investigate the use of cross-validation for model evaluation
11 Implementation of classification using decision trees and investigate the use of cross-validation for model evaluation
12 Implementation of ensembles of trees (random forests, gradient boosted trees)
13 Implementation of neural networks-based classifiers
14 Implementation of dimensionality reduction
15 Implementation of unsupervised clustering
16 Practical Examination

References

1. Andreas, C. Muller. 2009. Introduction to Machine Learning with Python- A guide for dataScientists, Sarah Guido, and O'Reilly.
2. Alpaydin Ethem. 2009. Introduction to Machine learning, Third Edition, MIT Press.
3. Muller J P. and Massaron L. 2021. Machine learning for dummies, 2nd Edition, Weily.

AEBE 469 Operations Research 3(3+0)

Course outlines

Objective

To enable the students to

1. Understand the importance of operations research for solving field problems
2. Understand and apply linear programming, transportation problem, etc. for agricultural engineering applications
3. Understand the project planning and network analysis

Theory

Introduction to operations research: elementary concepts and objectives, applications of operations research in decision making; Linear programming problem- mathematical formulation of the linear programming problem and its graphical solution, simplex method, simplex method for maximizing and minimizing, mixed constraints, duality theory, the Primal-vs- Dual solutions; Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution; Assignment problem, introduction and mathematical formulation, solution of Assignment problem; Inventory control, introduction and general notations, economic lot size models with known demand; Replacement theory, introduction and elementary concepts, replacement of items deteriorating with time; Sequencing problem: introduction and general notations, solution of a sequencing problem; Queuing theory: introduction and classification of queues, solution of queuing models; Project planning and network analysis: introduction and basic definitions in Network Analysis, rules for drawing Network Analysis, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT).

Lecture outlines

Theory

No.	Lecture outlines
Unit I	
1	Introduction to operations research: Definition, history and characteristics of operations research
2	Objectives of operations research, steps in OR process
3	Applications of operations research in decision making;
4	Linear programming problem-Definition of LPP, Assumptions of linear programming, Components: Decision variables, objective function, and constraints.
5	Real-life applications of linear programming
6	mathematical formulation of the linear programming problem
Unit II	
7	Graphical Solution of LPP
8	Introduction to the Simplex Method: simplex method algorithm
9	The simplex method for maximization
10	Problems on simplex method for maximization
11	The Simplex Method for Minimization
12	Problems on simplex method for Minimization
Unit III	
13	Mixed Constraints in the Simplex Method
14	Introduction to Duality Theory
15	Solving Dual Problems
16	The Primal vs. Dual Solutions and comparisons
17	Introduction to the Transportation Problem: definition, assumptions and objectives
18	Mathematical Formulation of the Transportation Problem

Unit IV

19 Balance and Degeneracy in Transportation Problems

20 Initial Basic Feasible Solution (IBFS)

21 Optimality in Transportation Problems

22 Optimal Solution Using the MODI Method

23 Optimal Solution Using the Stepping Stone Method

24 Applications and Extensions of the Transportation Problem

Unit V

25 Introduction to the Assignment Problem

26 Mathematical Formulation of the Assignment Problem

27 Hungarian Method for Solving Assignment Problems

28 Special Cases in Assignment Problems

29 Variants and Extensions of the Assignment Problem

30 Problems on assignment problems

Unit VI

31 Introduction to Inventory Control and General Notations

32 Economic Order Quantity (EOQ) Models with Known Demand

33 Variants of the EOQ Model

34 Introduction to Replacement Theory

35 Replacement of Items Deteriorating Over Time

36 Problems on replacement

Unit VII

37 Sequencing problem: introduction and general notations, Key components of a queue

38 Performance Metrics in Queuing Systems solution of a sequencing problem;

39 Queuing theory: introduction and classification of queues, (Kendall's Notation)

40 Solution of queuing models:The M/M/1M/M/1M/M/1 Queue Model

41 Multi-Server Queues (M/M/cM/M/cM/M/c)

42 Generalized Models (M/G/1M/G/1M/G/1 and M/D/1M/D/1M/D/1)

Unit VIII

43 Project planning and network analysis: Introduction and basic definitions in Network Analysis

44 Rules for drawing Network Analysis,

45 Critical Path Method (CPM)

46 Problems on Critical Path Method (CPM)

47 Project Evaluation and Review Technique (PERT)

48 Problems on Project Evaluation and Review Technique (PERT

References

1. Introduction to Operations Research" by Frederick S. Hillier and Gerald J. Lieberman, McGraw Hill Education
2. "Linear Programming and Network Flows" by Mokhtar S. Bazaraa, John J. Jarvis, and Hanif D. Sherali, Wileypublishing company, USA
3. Taha, H. 2003. Operations Research. Macmillan Publishing Company.
4. Winston, W. L. 2004. Operations Research: Applications and Algorithms. Indian University.
5. "Optimization in Operations Research" by Ronald L. Rardin, Pearson Education 6."Stochastic Models in Operations Research" by Daniel P. Heyman and Matthew J. Sobel, Dover Publications
7. "Fundamentals of Queuing Theory" by Donald Gross, John F. Shortle, James M. Thompson, and Carl M. Harris, Wiley publishing company, USA

AEBE 470 MECHATRONICS 3(2+1)

Course outlines

Objective

To enable the students to

1. Know the measurement system, control systems, microprocessor-based controllers of A.C. & D.C. motor.
2. Understand the principles behind the working of different data acquisition, digital signal processing 3. Know the different application of microcontrollers, PLC. robotics, robot components, robot classification and specification

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 and mechanical actuation systems- hydraulic and pneumatic actuation systems, measurement system, electrical actuation systems, A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, 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 classification and specification, robot components, 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

Study of different types transducers; Selection of sensor for a particular application from catalogue and internet; Design of a mechatronics product/ system; Application of mechatronics for enhancing product values; Study of electrical actuation systems with A.C. Motor and with D.C. Motor; Study of electrical actuation systems with Stepper Motor; Study of the PID Controller; Study of the hardware and software of mechatronics kit; Study of the pulse modulation, data presentation systems; Moving a table in X-direction within the range of proximity sensors using Control-X software; Running a motor with PLC; Running a conveyor with computer; Study of the movement of actuating cylinders and sensors.

Lecture outlines

Theory

No. Lecture outline

Unit I

1. Definition of Mechatronics, measurement system, control systems, microprocessor-based controllers, Mechatronics approach
2. Brief overview of measurement systems, classification, characteristics and calibration of different sensors
3. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors & Proximity sensor
4. Transducer: Definition, classification (active, passive, primary, secondary, mechanical, electrical, analog, digital, Photo-electrical, flow & optical transducers)

Unit II

5. Transducer selection criteria, sources of error for parameter under measurement, transducer specifications, test condition & operating conditions
6. Actuators, definition, example, types, selection. Pneumatic actuator, Electro pneumatic actuator
7. Types of Steppers– Construction – Working Principle – Advantages and Disadvantages
8. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems

Unit III

9. Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps. Design of hydraulic circuits
10. Hydraulic actuator, control valves, valve sizing valve selection
11. Drives: servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems

12. Electrical actuating systems: solid-state switches, solenoids, electric motors: DC motors, AC motors, single phase motor, 3-phase induction motor, synchronous motor

Unit IV

13. Piezoelectric actuator: characterization, operation, and fabrication; shape memory alloys
14. Basic elements of Digital signal processing- concept of frequency in Analog and Digital signals- measurement systems-pulse modulations-data presentation system
15. System modelling & control, Mathematical Models, Modelling Dynamic Systems, Transfer Functions, Control Models
16. Electro-mechanical & hydraulic-mechanical systems, modeling dynamic systems

Unit V

17. Control modes of PID controllers, Micro-processor & computer- computer and interfacing, micro-computer structure
18. Evolution of microprocessors and microcontrollers, memory devices, number system, architecture, interrupts instruction set and computer interfacing
19. Micro-controllers and application of microcontrollers
20. History and developments in industrial automation. Vertical integration of industrial automation, Control elements in industrial automation, PLC introduction

Unit VI

21. Basics of PLC, Advantages, Capabilities of PLC, Architecture of PLC, Scan cycle, Types of PLC, Types of I/O modules, configuring a PLC, PLC wiring
22. Applications of PLC: Case studies of Machine automation, Process automation, Selection parameters for PLC. Introduction to Programmable Automation Controller
23. Installation and maintenance procedures for PLC - Troubleshooting of PLC, PLC Networking
24. Robotics: Introduction — brief history, types, classification and usage, Science and Technology of robots

Unit: VII

25. Positions, Orientations and frames, Mappings: Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations - Transformation Arithmetic
26. DH Representation - Forward and inverse Kinematics Of Six Degree of Freedom Robot Arm – Robot Arm dynamics
27. Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-toLinear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws
28. Trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion – straight line motion

Unit VIII

29. Robot applications in manufacturing, Material transfer and machine loading/unloading
30. Robotics applications in Processing operations like Welding & painting, Assembly operations
31. Robotics applications in Inspection automation
32. Robotics applications in farm operations and Future applications of robotics in agriculture

Practical

No. Practical outline

1. To study the different types transducers
2. To study Selection of sensor for a particular application from catalogue and internet
3. To design of a mechatronics product/ system
4. To study electrical actuation systems with A.C. Motor
5. Application of mechatronics for enhancing product values
6. To study electrical actuation systems with D.C. Motor
7. To study electrical actuation systems with Stepper Motor
8. To study the characteristics of PID Controller
9. Study of the hardware and software of mechatronics kit
10. Study of the pulse modulation, data presentation
11. To Move a table in X-direction within the range of proximity sensors using Control-X software
12. To Run a motor by using PLC
13. To Run a conveyor with computer software
14. To study the movement of actuating cylinders and sensors
15. Robot programming exercises
16. Practical Examination

Reference

1. Bolton W. 2015. Mechatronics. Pearson Education Asia
2. Stadler W. 1995. Analytical Robotics and Mechatronics. McGraw-Hill Inc.
3. Doeblin E O. 1966. Measurement Systems. McGraw-Hill Inc
4. Malvino A P. 1983. Digital Computer Electronics. McGraw-Hill Inc.
5. Niku S Y. 2001. Introduction to Robotics: Analysis, systems and Applications.Pearson Education International
6. Craig J J. 1986. Introduction to Robotics. Pearson Education International

PFEN 429 Natural Fibres: Extraction and Properties 3 (2+1)

Course outlines

Objective

To enable the students to understand the importance of natural fibres and the principles of quality management of natural textile fibres, and learn the properties of different types of natural fibresand their respective extraction methods and gain knowledge of the equipment and machinery used in natural fibre extraction processes.

Theory

Introduction to Natural fibres: Natural fibres definition, Detailed Classification; Naturalfibres–physical and chemical properties, Advantages and disadvantages of Natural fibres; Plant fibres; Animal fibres; Applications of Natural fibres. Identification, characterization and quality management of natural textile fibres. Cotton: Types, Morphology, Physical and Chemical properties, grading and marketing, Organic and Bt cotton, processing and utilization; Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application; Jute: Cultivation- Extraction and Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. diversified application of jute; Other (Natural) Textile fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp; Physical and Chemical Properties, grading and marketing, processing and end use application. Silk: Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting. Physical Properties of Natural fibres: fibre Morphology; fibre length, diameter, l/b ratio and its significance; concept of denier and tex; colour and lustre, fibre defects and root content; cross sectional study of fibres; yarn count, moisture regain, thermal behavior; Mechanical Properties: Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.

Practical

Identification of natural fibres; Extractions of jute, cotton, flax, banana, sisal and ramie; Retting of Jute and Flax; Quality evaluation of jute and other fibres; Determination of mechanical and insulation properties.

Lecture outlines

Theory

No Lecture outline

Unit I

1 Introduction to Natural Fibres – Definition and importance

2 Classification of Natural Fibres – Plant, Animal, Mineral, etc.

3 Physical and Chemical Properties of Natural Fibres

4 Advantages and Disadvantages of Natural Fibres

Unit II

5 Overview of Plant Fibres – Characteristics and examples

6 Overview of Animal Fibres – Characteristics and examples

7 Applications of Natural Fibres in Textiles and Industry

8 Identification and Characterization of Natural Fibres

Unit III

9 Quality Management and Testing of Natural Fibres

10 Cotton – Types and Morphology

11 Cotton – Physical and Chemical Properties

12 Cotton – Grading, Marketing, and Utilization

Unit IV

13 Organic and Bt Cotton – Features and Processing

14 Wool – Types and Morphology

15 Wool – Physical and Chemical Properties

16 Wool – Grading, Marketing, and Applications

Unit V

17 Jute – Cultivation, Extraction, and Retting Methods

18 Jute – Physical and Mechanical Properties

19 Jute – Grading, Marketing, and Role in Packaging

20 Diversified Applications of Jute

Unit VI

21 Other Natural Fibres – Overview of Long Vegetable Fibres

22 Flax Fibre – Cultivation, Extraction, and Properties

23 Sisal, Pineapple Leaf, and Banana Fibres – Processing and Use

24 Maize and Hemp Fibres – Properties and Applications

Unit VII

25 Silk – Types of Silk and Mulberry Cultivation

26 Silk Production – Cocoon Formation and Processing

27 Silk Reeling – Methods and Machines

28 Silk – Morphology, Physical and Chemical Properties

Unit VIII

29 Silk – Grading, Marketing, Degumming, and Weighting

30 Physical Properties of Natural Fibres – Morphology, Length, Diameter

31 Mechanical Properties – Stress-Strain, Tenacity, Elongation
32 Fibre Defects, Moisture Regain, and Thermal Behaviour

Practical

No	Practical outline
1	Introduction to Natural Fibre Identification
2	Identification of Cotton Fibre
3	Identification of Wool Fibre
4	Identification of Silk Fibre
5	Identification of Jute Fibre
6	Extraction of Cotton Fibre
7	Extraction of Jute Fibre
8	Extraction of Flax Fibre
9	Extraction of Banana and Sisal Fibres
10	Extraction of Ramie Fibre
11	Quality Evaluation of Jute Fibre
12	Quality Evaluation of Cotton and Wool Fibres
13	Study of Fibre Morphology (Microscopic Analysis)
14	Determination of Mechanical Properties of Fibres
15	Determination of Thermal and Insulation Properties
16	Practical Test / Project Presentation

Suggested Readings

1. Cook, J. G. 2005. Hand Book of Textile Fibers. Wood Head Publishers, London, Vol 1 & 2
2. Corbmann, P. B. 2001. Textile Fiber to Fabric. Mc Graw-Hill International Education, 6th edn.
3. Gohl and Vilensky. 2003. Textile Science. 2nd Edn. Mahajan Book Publishers.
4. Mishra, S.P. 1998. Fibre Science and Technology. New Age India International Ltd. New Delhi.
5. Shenai, V. A. 2004. Technology of Textile Processing- Textile Fibers. Sevak Publications.
6. Sreenivasa Murthy, H.V. 1994. Introduction Textile Fibres. Textile Association of India, Bombay.
7. Tammanna and Sonwalkar, N. 2002. Handbook of Silk Technology. Wiley Eastern Limited, New Delhi.

PFEN 430 Natural Fibre Applications in Agriculture 3(2+1)

Course outlines

Objective

To enable the students to**understand the diverse applications of natural fibres** in areas such as soil and water conservation, packaging, energy production, and soilless farming and **analyze the economic feasibility of using natural fibres** for various agricultural, industrial, and environmental applications.

Theory

Natural Fibre based Agrotextiles, Characterization and their application: Overview of Agrotextile, Technical Textile, Non-woven technology, Design principles for Natural Fibre based Agrotextiles, Tensile and Hydro-physical properties, Estimation techniques, Application as crop mulch, Effect on soil properties, Measurement of soil hydrothermal regime, Effects on crop yield, Effects on soil moisture retention and weed population, Application as shade net, Biodegradability, Life cycle and environmental impact, Economic evaluation. Natural Fibre based Geotextiles, Characterization and their application: Overview of Geotextile in soil and water conservation, Woven technology, Design principles for Natural Fibre based Geotextiles (Coir, jute, bamboo etc), Blended Geotextiles its application and case studies, Tensile and Hydro-physical properties, Estimation techniques, Application as soil saver, Effect on soil degradation properties, Factors affecting soil erosion, Rainfall erosivity and indices, Wischmeir's equation for its prediction, isoerodent map of India, Soil erodibility and its measurement, Method of soil loss estimation and measurement (USLE and RUSLE), Water erosion prediction programme (WEPP), sediment transport equations, runoff measurement, sediment measurement (multislot divisor),Concept of integrated watershed management and role of RS and GIS, Bioengineering, Role of jute, coir and bamboo based geotextile in soil conservation, Reinforcement, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based sustainable packaging for Agricultural/Horticultural produce: Overview of the packaging industry and current packaging materials, Principle behind packaging of perishable crop produce, Characteristics and properties of natural fibers suitable for packaging, Natural fibre based Green composite and their role in packaging, Design principles for natural fiber-based packaging, natural fibre-based reaper binder, Advantages and limitations of natural fiber-based packaging compared to synthetic alternatives, Biodegradable plastics for packaging agricultural produce. Life cycle assessment and environmental impact analysis, Government policies and regulations related to sustainable packaging. Potential of natural fibers as a source of renewable energy: Characteristics of natural fibers and their suitability as a source of renewable energy, Methods of converting natural fibers into energy, such as combustion and gasification, Economic and environmental analysis of natural fiber-based renewable energy systems, Comparison of natural fiber-based energy systems with other renewable energy sources, Government policies and incentives related to renewable energy (Bioethanol). Role of Natural Fibre in Organic and Soilless Farming: Overview of organic and natural farming, soilless farming, natural fibre waste, characterization of waste, different methods of compost preparation, role of fibre waste as compost, Characteristics of natural fibers and their suitability as a source of soilless media, Effect on crop yield, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Practical

Preparation of woven and nonwoven fabrics; Estimation of different mechanical and hydro physical properties; Agro-textile field trial/experiment; Natural fibre-based Packaging; Production of energy from natural fibres.

Lecture outlines

Theory

No	Lecture outline
Unit I	
1	Introduction to Natural Fibre-Based Applications – Scope and Objectives
2	Overview of Agrotextiles, Technical Textiles, and Non-woven Technology
3	Design Principles for Natural Fibre-Based Agrotextiles
4	Tensile and Hydro-physical Properties of Agrotextiles
Unit II	
5	Estimation Techniques for Fibre and Fabric Properties
6	Application of Agrotextiles as Crop Mulch
7	Effects of Mulching on Soil Properties and Crop Yield
8	Measurement of Soil Hydrothermal Regime and Moisture Retention
Unit III	
9	Application of Natural Fibre-Based Shade Nets
10	Biodegradability, Life Cycle, and Environmental Impact of Agrotextiles
11	Economic Evaluation of Natural Fibre-Based Agrotextiles
12	Introduction to Geotextiles and Their Role in Soil & Water Conservation
Unit IV	
13	Woven Technology for Natural Fibre-Based Geotextiles
14	Design Principles for Coir, Jute, and Bamboo Geotextiles
15	Blended Geotextiles – Case Studies and Applications
16	Tensile and Hydro-physical Properties of Geotextiles
Unit V	
17	Estimation Techniques and Application as Soil Saver

18 Soil Erosion – Factors, Measurement, and Control Methods
19 Rainfall Erosivity and Prediction (Wischmeier's Equation, Isoerodent Map)
20 Soil Erodibility and Soil Loss Estimation (USLE, RUSLE)

Unit VI

21 Water Erosion Prediction Programme (WEPP) and Sediment Transport
22 Runoff and Sediment Measurement (Multislot Divisor Method)
23 Integrated Watershed Management – Role of RS and GIS
24 Bioengineering and Role of Jute, Coir, Bamboo in Soil Conservation

Unit VII

25 Biodegradability, Life Cycle, and Economic Evaluation of Geotextiles
26 Overview of Sustainable Packaging Industry and Current Materials
27 Principles and Properties of Natural Fibres for Packaging Applications
28 Natural Fibre-Based Green Composites and Design Principles

Unit VIII

29 Biodegradable Plastics and Government Regulations on Packaging
30 Renewable Energy from Natural Fibres – Methods and Analysis
31 Role of Natural Fibres in Organic and Soilless Farming
32 Life Cycle Assessment, Environmental Impact, and Economic Evaluation

Practical

No	Practical outline
1	Introduction to Agrotextiles and Geotextiles
2	Preparation of Woven Fabrics Using Natural Fibres
3	Preparation of Nonwoven Fabrics Using Natural Fibres
4	Determination of Tensile Strength of Fibre-Based Fabrics
5	Estimation of Hydro-physical Properties (Permeability, Water Holding)
6	Field Trial on Natural Fibre-Based Crop Mulch
7	Measurement of Soil Moisture and Temperature under Mulch
8	Evaluation of Crop Growth and Yield in Mulched Plots
9	Study of Natural Fibre-Based Shade Nets – Light and Temperature Effects
10	Preparation and Testing of Natural Fibre-Based Packaging Materials
11	Comparison of Natural Fibre and Synthetic Packaging
12	Design and Fabrication of Fibre-Based Reaper Binder
13	Energy Production from Natural Fibres – Combustion Method
14	Energy Production from Natural Fibres – Gasification Method
15	Compost Preparation Using Natural Fibre Waste for Soilless Media

Suggested Readings

1. Blackburn, R. S. (Ed). 2009. Sustainable Textiles: Life Cycle and Environmental Impact. Woodhead Publishing. ISBN 978-1-84569-453-1.
2. Cheng, H. N., Byron, A. E. and Okos, M. R. (Eds). 2017. Sustainable Fiber-Based Packaging. John Wiley & Sons. ISBN: 978-1-119-17306-4.
3. Fangueiro, R. and Rana, S. (Eds). 2016. Natural Fibre Composites in Geotextiles: Design and Applications. Woodhead Publishing. ISBN: 978-0-08-100215-7
4. Hakeem, K. R., Jawaid, M., and Alothman, O. Y. (Eds). 2019. Biomass and Bioenergy: Processing and Properties. Springer. ISBN: 978-981-13-8562-2.
5. Hardin, M. R. (Ed.). 2007. Natural and Artificial Fiber Nonwoven Textiles. CRC Press. ISBN: 978-0-8493-6454-9.
6. Koz³owski, Ryszard M. (Ed). 2012. Handbook of natural fibres. Volume 2: Processing and applications. Woodhead Publishing Limited. ISBN 978-1-84569-698-6.
7. Tripathy, R.P. and Singh, H.P. (Eds). 1993. Soil Erosion and Conservation. New Age International (P) Limited, Publishers. ISBN: 81-224-0305-0.

PFEN 431 Processing of Natural Fibres 3(2+1)

Course outlines

Objective

To enable the students to understand the chemical composition of natural fibres and their conversion processes and learn the mechanical and chemical processing methods used for natural fibres and gain knowledge of the value addition techniques for natural fibres.

Theory

Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and blending.

Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, roving machine, Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for-one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity.

Preparatory weaving: Winding, Warping, Sizing, beaming, drawing and denting; Weaving: Concept of weaving, Handloom, Primary and secondary motions of loom; shedding, picking, beat up, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs; Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation.

Basic Yarn testing: Count, Twist, tensile strength, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission.

Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities – Desizing; Scouring; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool.

Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application; Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent; Dyeing machine; Dyeing of different textile forms-Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.

Practical

Basic concepts of spinning; Manufacture of yarn from natural fibres; Practical on weaving and knitting; Yarn and fabric testing; Pre-treatments of natural fibres; Bleaching and dyeing of natural f ibres; Finishing of natural fibres.

Lecture outlines

Theory

No	Lecture outline
Unit I	
1	Concept of Spinning – Definition, Objectives, and Historical Development
2	Hand Spinning System – Principles and Operations
3	Charkha Spinning System – Mechanism and Process
4	Ginning – Concepts and Working Principles
Unit II	
5	Opening, Cleaning, and Blending of Fibres – Methods and Equipment
6	Concept of Yarn Manufacture – Overview of Fibre-to-Yarn Process
7	Cotton Spinning System – Flow Chart and Operations
8	Woollen and Worsted Spinning Systems – Comparison and Processes

Unit III

9 Jute and Flax (Wet) Spinning Systems – Features and Process Steps

10 Blow Room and Carding – Functions and Working of Flat and Roller-Clearer Types

11 Drawing, Roving, and Ring Spinning Machines – Working Principles

12 Rotor Spinning – Concept, Mechanism, and Advantages

Unit IV

13 Modern Developments in Spinning – Compact, Airjet, Friction Spinning

14 Ring Doubler and Two-for-One Twister – Principles and Applications

15 Fibre Packing Density of Yarn and Yarn Twist Relationship

16 Stress-Strain Relation and Mass Irregularity of Yarn

Unit V

17 Preparatory Weaving Processes – Winding, Warping, Sizing, Beaming

18 Drawing-in and Denting Operations – Purpose and Methods

19 Concept of Weaving and Handloom Mechanism

20 Primary and Secondary Motions of Loom – Shedding, Picking, Beat-up

Unit VI

21 Loom Timing, Take-up, and Let-off Motions

22 Types of Sheds – Tappet, Dobby, Jacquard Mechanisms

23 Stop Motions and Warp Protector Motion in Looms

24 Shuttle and Shuttle-less Looms – Comparison and Applications

Unit VII

25 Basic Woven Fabric Structures and Simple Weave Designs

26 Knitting – Concept, Warp Knitting, and Weft Knitting Systems

27 Nonwoven Fabric – Concepts, Classification, and Recent Advances

28 Basic Yarn Testing – Count, Twist, Tensile Strength, CSP, Hairiness

Unit VIII

29 Fabric Testing – GSM, EPI, PPI, Tensile, Tear, Burst, Crease, Stiffness

30 Air Permeability, Thermal Conductivity, Wetting, Wicking, and Comfort Properties

31 Chemical Composition and Pre-treatment of Natural Fibres – Desizing, Scouring, Bleaching, Mercerization, Carbonization

32 Value Addition by Colouration and Finishing – Dyes, Dyeing Methods, Colour Fastness, and Finishes

Practical

No Practical outline

1 Introduction to Spinning Equipment and Processes

2 Demonstration of Hand and Charkha Spinning
3 Manufacture of Yarn from Natural Fibres (Cotton/Wool/Jute)
4 Study of Ginning, Opening, and Blending Equipment
5 Carding and Drawing Machine Operations
6 Operation of Roving and Ring Spinning Machines
7 Study of Modern Spinning Methods (Rotor, Airjet)
8 Preparatory Weaving Operations – Winding, Warping, Sizing
9 Weaving on Handloom and Power Loom – Fabric Formation
10 Demonstration of Knitting (Warp and Weft Systems)
11 Yarn Testing – Count, Twist, Tensile Strength, Hairiness
12 Fabric Testing – GSM, EPI, PPI, Tensile and Tearing Strength
13 Pre-treatment of Natural Fibres – Desizing, Scouring, Bleaching
14 Dyeing of Natural Fibres – Direct, Reactive, and Natural Dyes
15 Finishing of Natural Fibre Fabrics – Mechanical and Chemical Methods
16 Evaluation of Colour Fastness and Fabric Comfort Properties

Suggested reading

1. Booth J. E. 1996. Principles of Textile Testing: An Introduction to Physical Methods of Testing Textile Fibres, Yarns and Fabrics. 6th edn. London: Newnes Butterworths
2. Brown, R. 1978. Weaving, Spinning and Dyeing Book. London: Routledge and Kegan Paul.
3. Cegarra, J. P. and Valladperas, J. 1992. The Dyeing of Textile Manual, the Scientific Bases and the Techniques of Application. Italy: NecovaOflito.
4. Corbman, B. P. 1983. Fibre to Fabric step by Step Weaving. 6th edn. New York: McGraw Hill.
5. David G, Sinclair, Roy, S. 1989. Giles Laboratory Course in Dyeing. 4th edn. London: Society of Dyers and Colourist.
6. Eichhorn SJ, Hearle JWS, Jaffe M, and Kikutani T. 2009. Handbook of Textile Fibre Structure: Fundamentals and Manufactured Polymer Fibres, Volume 1 in Woodhead Publishing Series in Textiles.
7. Fannin and Allen, A. 1979. Handloom Weaving Technology. New York: Van Nostrand Reinhold.
8. Jarman, C. 1998. Plant Fibre Processing: A Handbook. eBook 9781780442990, pp.64
9. Ponting, K. G. 1981. A Dictionary of Dyes and Dyeing. London: Bell and Hymen Ltd.
10. Rouette, H. K. 2001. Encyclopaedia of Textile Finishes. Berlin: Springer Verlag.
11. Saville, B. P. 1999. Physical Testing of Textiles. Woodhead publication. CRC Press.

12. Shenai, V. A. 1985. Technology of Dyeing: Technology of Textile Processing. Vol. VI. Sevak Publication.

13. Shenai, V. A. 1985. Technology of Printing: Technology of Textile Processing. Vol. IV. Sevak Publication.

AEAS 472 Agricultural Marketing and Trade 3(2+1)

Course outlines

Objective

To enable the students to understand the **fundamentals of agricultural marketing and trade**, analyze the **key factors influencing supply and demand** in agricultural markets, explore the **various marketing channels and strategies** in agriculture and examine the **role of government policies and regulations** in agricultural marketing systems.

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; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and 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 labelling (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 and 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 innovations in 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; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

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.

Lecture outlines

Theory

No	Lecture outline
Unit I	
1	Introduction to Agricultural Marketing – Concepts and Definitions
2	Meaning and Types of Markets – Market, Marketing, and Agricultural Marketing
3	Market Structure – Components and Characteristics
4	Marketing Mix and Market Segmentation – Concepts and Importance
Unit II	
5	Classification and Characteristics of Agricultural Markets
6	Demand and Supply of Agricultural Commodities – Concepts and Determinants
7	Producer's Surplus – Meaning, Types, and Importance
8	Marketable and Marketed Surplus – Factors Affecting Them
Unit III	
9	Pricing Strategies – Cost-Based and Competition-Based Pricing
10	Market Promotion – Advertising and Personal Selling
11	Sales Promotion and Publicity – Merits and Demerits
12	Marketing Process – Concentration, Dispersion, and Equalization
Unit IV	
13	Exchange Functions – Buying and Selling in Agricultural Markets
14	Physical Functions – Storage, Transportation, and Processing
15	Facilitating Functions – Packaging, Branding, and Grading
16	Quality Control and Labelling – Agmark and Standards
Unit V	
17	Market Functionaries – Types and Roles of Agencies in Agri-Marketing
18	Marketing Channels – Concept, Levels, and Importance

19 Marketing Channels for Major Farm Commodities

20 Market Integration – Meaning, Definition, and Types

Unit VI

21 Marketing Efficiency – Concepts and Measures

22 Marketing Costs, Margins, and Price Spread

23 Factors Affecting Marketing Costs and Ways to Reduce Them

24 Role of Government in Agricultural Marketing – Overview

Unit VII

25 Public Sector Institutions – CWC, SWC, FCI, CACP, DMI – Functions

26 Cooperative Marketing in India – Structure and Significance

27 Risks in Marketing – Types, Speculation, and Hedging

28 Futures Trading – Concept and Importance in Agriculture

Unit VIII

29 Agricultural Prices and Policy – Administered Prices and Innovations

30 International Trade in Agriculture – Concept and Need

31 WTO, Agreement on Agriculture (AoA), and Implications for India

32 Role of APMC and Its Relevance in the Present Context

Practical

No	Practical outline
1	Plotting and Study of Demand and Supply Curves
2	Calculation of Price Elasticities of Demand and Supply
3	Study of Relationship Between Market Arrivals and Prices of Selected Commodities
4	Computation of Marketable and Marketed Surplus of Major Commodities
5	Study of Price Behaviour Over Time for Selected Agricultural Commodities
6	Construction and Interpretation of Index Numbers
7	Visit to a Local Market – Observation of Marketing Functions
8	Identification of Marketing Channels for Selected Commodities
9	Collection of Data on Marketing Costs, Margins, and Price Spread
10	Preparation and Presentation of Market Study Report
11	Visit to NAFED – Study of Organization and Functioning
12	Visit to State Warehousing Corporation (SWC) and Central Warehousing Corporation (CWC)
13	Visit to Cooperative Marketing Societies – Structure and Activities
14	Analysis of Market Efficiency and Integration Using Field Data
15	Application of Principles of Comparative Advantage in International Trade
16	Viva Voce / Final Report Presentation on Agricultural Marketing System

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L. 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S. S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore. Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N. 2002. Marketing of Agricultural Products. Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong. 2005. Principles of Marketing. Pearson Prentice-Hall.
6. Lekhi, R. K. and Singh, J. 2006. Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I. 2003. Principles and Practice of Marketing in India. Kitab Mahal, New Delhi.
8. Pandey, M. and Tewari, D. 2004. Rural and Agricultural Marketing. International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R. 2005. Export Management. Laxmi Narain Agarwal, Agra.

PFEN 432 Seed Drying, Processing and Storage 3(2+1)

Course outlines

Objective

To acquaint and equip the students with seed processing related aspects such as seeds, drying, primary processing, storage and design aspects of various related systems.

Theory

Processing of different seeds and their engineering properties, Principles and importance of seed processing. Differences between seed processing and normal grain processing.

Performance characteristics of different unit operations such as pre-cleaning, grading, conveying, elevating, drying, treating, blending, packaging and storage, seed processing machines like scalper, debearder, huller, velvet separator, spiral separator, cleaner-cumgrader, specific gravity separator, indent cylinder, disc separator and color sorter, seed treater, weighing and bagging machines, operation and maintenance, installation and determination of their capacity, seed quality maintenance during processing, plant design and layout, economy and safety consideration in plant design.

Seed drying principles and methods, theory of seed drying, introduction to different types of heated air dryers, significance of moisture equilibrium, method of maintaining safe seed moisture, thumb rule and its relevance, importance of scientific seed storage, types of storage structures to reduce temperature and humidity, management and operation, cleanliness of seed stores, packaging principles, practices, materials and hermetic packaging, seed treatment methods and machines used, method of stacking and their impact, design features of medium term seed storage buildings.

Practical

Study of various seed processing equipment such as pre-cleaners, scalper, air screen cleaner, graders, spiral and pneumatic separators, seed treating equipment, bag closures, scale etc. and their performance evaluation, design and layout of seed processing plant and its economics, analysis of cost of operation and unit cost of processed product, effect of drying temperature and duration of seed germination and storability.

Lecture outlines

Theory

No.	Lecture outline
Unit I	
1	Processing of different seeds and their engineering properties
2	Principles and importance of seed processing
3	Performance characteristics of different unit operation such as pre-cleaning and grading
4	Conveying and elevating – principles and equipment
Unit II	
5	Drying - principles and types of dryers
6	Treating and blending of seeds
7	Packaging and storage of seeds
8	Study of seed processing machine components scalper, degrades, huller
Unit III	
9	Velvet separator, spiral separator – principle and working
10	Cleaner – cum grader, specific gravity separator, indent cylindrical grader – principle and working
11	Disc separator and color sorter – principle and working
12	Seed treater, weighing and bagging machine
Unit IV	
13	Operation and maintenance of seed grader
14	Installation and determination of their capacity
15	Seed quality maintenance during processing
16	Seed plant design and layout

Unit V

17 Economy and safety consideration of plant design
18 Processing technology for different grains
19 Seed drying principles, method and theory
20 Introduction to different types of heated air dryers

Unit VI

21 Significance of moisture equilibrium, method of maintaining safe seed moisture – thumb rule and its relevance
22 Importance of scientific seed storage
23 Types of storage structures to reduce temperature and humidity for seed storage
24 Management and structure / cleanliness of seed stores

Unit VII

25 Packaging principle of seed storage
26 Materials of packaging and hermetic packaging
27 Seed treatment methods
28 Seed treatment machines used

Unit VIII

29 Methods of stacking and their impact
30 Design features of medium term seed storage building
31 Design features of seed storage building
32 Seed storage techniques

Practical

No.	Practical outline
1	Study of pre-cleaners
2	Study of scalper
3	Study of air screen cleaner
4	Study of graders
5	Study of spiral and pneumatic separators
6	Study of seed treating equipment
7	Study of bag closures, scale etc. and their performance evaluation
8	Performance evaluation of processing equipment, design and evaluation of seed processing plant and its economics
9	Analysis of cost of operation
10	Analysis of cost of operation
11	Evaluation of unit cost of processed product

12 Evaluation of unit cost of processed product

13 Experiment for determination of moisture content

14 Effect of drying temperature and duration of seed germination and storability

15 Effect of drying temperature and duration of seed germination and storability

16 Practical examination

Suggested Readings

1. Brooker, D. B., Bakker-Arkema, F. W., and Hall, C. W. 1992. Drying and storage of grains and oilseeds. Springer Science & Business Media.

2. Gregg *et al*. 1970. Seed Processing. NSC.

3. Henderson, S & Perry, SM. 1976. Agricultural Process Engineering. 5th Ed. AVI Publ.

4. Sahay, KM and Singh, KK. 1994. Unit Operations of Agricultural Processing. Vikas Publishing House.

Field based learning - Students mastering ferti cum seed drill technology

Hands on learning in programming and data analysis

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