CATALOGUE OF

UNDERGRADUATE COURSE

B. Tech. (Food Technology)

2024

ANGRAU

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY

Lam, Guntur - 522 034

Demonstration of juice processing line

Interactive session on curriculum structure

Dr. R. Sarada Jayalakshmi Devi
Vice - Chancellor

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
Administrative Office: Lam,
Guntur-522034. A.P. India
http://www.angrau.ac.in
Tel:91-0863-2347011(O)
Email:vicechancellor@angrau.ac.in

ANGRAU

FOREWORD

The food processing sector is a vital engine for India's economic progress, forging essential links between the two foundational pillars of our economy: agriculture and industry. In India it has become a vital contributor to the economy, supported by the Ministry of Food Processing Industries (MoFPI). The sector has grown at an average annual rate of 7.3% from 2015 to 2022, impacting GDP, employment, and investment. The food processing industry represents 32% of India's food market, contributing significantly to manufacturing (8.8%) and agriculture (8.39%).

In this era, as India sharpens its focus on value addition, food safety, export competitiveness, and sustainability, the role of Food Technology becomes paramount. This discipline is the science and art dedicated to transforming raw agricultural produce into safe, nutritious, and high-quality food products through innovative and efficient technologies. Modern processing interventions and technical advancements are indispensable for enhancing product value, guaranteeing food safety, and meeting the ever-evolving expectations of consumers, both domestically and globally.

The Government of India's consistent policy support and schemes underscore the continuous emphasis on agricultural education, research, and innovation. Acharya N.G. Ranga Agricultural University (ANGRAU), in active partnership with ICAR, remains at the forefront of providing quality education and developing skilled human resources in Food Technology. We take immense pride in producing approximately 214 Food Technology graduates every year, who form the backbone of India's food industry, driving significant contributions to entrepreneurship, research, and industrial growth.

The curriculum is meticulously designed to be dynamic, skill-oriented, and industry-relevant, ensuring that students are thoroughly prepared to tackle the current and emerging challenges of the food sector. It serves as a clear roadmap for effective learning, actively promoting innovation, entrepreneurship, and self-reliance among graduates. I am fully confident that this curriculum will equip students with the necessary technical competence, leadership qualities, and entrepreneurial abilities.

I would like to take this opportunity to sincerely appreciate the Faculty of Agricultural Engineering & Technology for their dedicated and comprehensive efforts in developing and updating the B.Tech. (Food Technology) curriculum. Their work successfully aligns program with global trends, sustainability goals, and industry needs. Their commitment reflects the University's resolve to produce graduates who are capable of transforming India's agricultural food landscape into a more sustainable, profitable, and innovative system.

R. Sarada Jayalakshmi Devi
Vice - Chancellor

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

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
Administrative Office: Lam,
Guntur-522034. A.P. India
Email: deanaet@angrau.ac.in
Phone:0863-2347006
Cell:7093403883

ANGRAU

PREFACE

The Bachelor of Technology (Food Technology) program is a thoughtfully designed applied science course that equips students with the essential principles and processes underpinning the modern food industry. This dynamic discipline spans the entire food value chain, encompassing production, processing, preservation, packaging, labeling, quality management, and distribution. By integrating the fundamentals of science and engineering, the program empowers students to transform raw materials into safe, nutritious, and value-added food products.

The growing demand for wholesome and safe food calls for continuous research, innovation, and skilled expertise. Food Technology, therefore, stands at the vital intersection of science and industry. The program is committed to nurturing professionals with strong technical knowledge and practical competence, qualities that are indispensable for success in this rapidly evolving field.

The curriculum has been comprehensively revised in accordance with the VI Dean's Committee recommendations, incorporating updates that ensure relevance and quality in meeting the changing needs of the food sector. In alignment with the National Education Policy (NEP-2020), the program offers multiple exit options: a UG Certificate after the first year and a UG Diploma after the second year, both contingent upon the successful completion of a mandatory 10-week internship.

A distinctive feature of this program is its emphasis on experiential learning. Through structured laboratory sessions, field training, and industry internships, students gain hands-on exposure to food processing, preservation, quality control, and product development. This practical approach ensures that graduates are not only conceptually sound but also industry-ready to address real-world challenges.

The vision for this program is to develop competent, innovative, and responsible food technologists who can contribute to national priorities such as reducing post-harvest losses, enhancing value addition, developing novel food products, ensuring quality and safety standards, and advancing sustainability in the food processing sector.

The Faculty of Agricultural Engineering and Technology gratefully acknowledges the vision, guidance, and encouragement of Dr. R. Sarada Jayalakshmi Devi, Hon'ble Vice-Chancellor, Acharya N.G. Ranga Agricultural University. Her leadership has been instrumental in shaping a curriculum that aspires to uphold excellence and foster innovation in Food Technology

A. Mani

A. Mani
Dean Faculty of Agril. Engg & Technology

DETAILED LECTURE OUTLINES

(as per VI Deans' Committee Recommendations)
B. Tech. (Food Technology)
2024

Chief Editor

Dr. A. Mani

Dean of Agricultural Engineering & Technology

Editors

Dr. K. N. Raja Kumar

Technical Officer

Dr. Ch. Someswara Rao
Assistant Professor
Dr N.T.R. CFST, Bapatla

Dr. K. Rajesh
Assistant Professor
CFST, Pulivendula

Dr. K. Niveditha
Assistant Professor
Dr N.T.R. CFST, Bapatla

Dr. M. Kirthy Reddy
Assistant Professor
CFST, Pulivendula

ANGRAU

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY

Lam, Guntur – 522 034

December, 2025

No. of copies: 700

Laser Typeset and Printed at

Ritunestham Press
Guntur.
Ritunestham Press,
Pulladigunta, Guntur. Ph.: 0863-2286288
ritunesthampress@gmail.com

CONTRIBUTORS

Dr. M. V. Ramana
Registrar
ANGRAU, Lam, Guntur

Dr. B. V. S. Prasad
Comptroller
ANGRAU, Lam,Guntur

Dr. S. Kaleemullah
Principal Scientist & Univ.Head
(Food Processing Technology),
RARS, Tirupati

Dr. P. V. K. Jagannadha Rao
Principal Scientist &Univ.Head
(Food Process Engineering),
AICRP on PHET, RARS, Anakapalle

Dr. M. Sardar Baig
Associate Dean &Univ.Head
(Processing and Food Engineering),
Dr N.T.R. College of Food Science and
Technology, Bapatla

Dr. M. Madhava
AssociateDean
College of Food Science and
Technology, Pulivendula

Dr. V. Srinivasa Rao
Senior Professor & University Head
(Statistics & Computer Applications)
Agricultural College, Naira

Dr. K. N. Ravi Kumar
Senior Professor & University Head
Dept. of Agricultural Economics,
Ag. College, Tirupati

Dr. T. Gopi Krishna
Professor & University Head,
Dept. of Agricultural Extension,
SriMekapati Goutham Reddy Agricultural
College, Udayagiri

Dr. T. Sreelatha
Principal Scientist (SSAC) &
University Head,
RARS, Anakapalle

Dr. R. Ravikanth Reddy
Professor&University Head
Dept. of Physical Education,
SV Ag. College, Tirupati.

Dr. N. Vinoda
Associate Professor
Dr. N.T.R.College of Food Science and
Technology, Bapatla

Ms. R. Aruna
Associate Professor
College of Food Science and Technology,
Pulivendula

Dr. Ch. Someswara Rao
Assistant Professor
Dr. N.T.R. College of Food Science
and Technology, Bapatla

Dr. P. Jayamma
Assistant Professor
College of Food Science & Technology,
Pulivendula

Dr. K. Rajesh
Assistant Professor
College of Food Science and Technology,
Pulivendula

Dr. K. N. Sreenivasulu
Assistant Professor,
Ag. College, Pulivendula

Dr. S. Blessy Sagar
Assistant Professor
Dr. N.T.R. College of Food Science and
Technology, Bapatla

Er. S. Nazma Hafeeza
Assistant Professor
College of Food Science and
Technology, Pulivendula

Dr. K. Niveditha
Assistant Professor
Dr. N.T.R.College of Food Science and
Technology, Bapatla

Dr. M. Kirthy Reddy
Assistant Professor
College of Food Science and
Technology, Pulivendula

Dr. E. Gowthami
Assistant Professor
Dr N.T.R. College of Food Science and
Technology, Bapatla

Dr. B. Aparna
Assistant Professor
Dept. of Agricultural Economics,
Ag. College, Bapatla

Er. K. Subba Reddy
Teaching Associate
College of Food Science and
Technology, Pulivendula

Er. G. Nookaratnam
Teaching Associate
Dr N.T.R. College of Food Science and
Technology, Bapatla

Dr. Y. Phaneendra Kumar
Teaching Associate
Dept of Physical Education
Dr N.T.R. College of Food Science
and Technology, Bapatla

Er. M.L. Lavanya
Teaching Associate
Dr. N.T.R. College of Food Science and
Technology, Bapatla

Dr. V. Jyothi
Associate Professor
Dept. of Agricultural Extension
Ag. College, Bapatla

Dr. M. Sandhya
Professor
Dept. of Biochemistry,
Ag. College, Bapatla

Er. K. Sowjanya
Assistant Professor
Dr. N.T.R. College of Food Science and
Technology, Bapatla

Dr. Y. Dileepsean
Teaching Associate
Dr N.T.R. College of Food Science and
Technology, Bapatla

Sri N. Seshagiri Rao
Teaching Associate
Dr. N.T.R. College of Agricultural
Engineering, Bapatla

Dr. K. Arjuna Rao
Teaching Associate
Ag. College, Bapatla

Dr. M. Sai Srinivas
Teaching Associate
College of Food Science and Technology,
Pulivendula

Dr. Sk. Jakeer Basha
Teaching Associate
College of Food Science
and Technology, Pulivendula

Dr. B. Sunitha V.S.
Teaching Associate (Part Time),
Dr N.T.R. College of Food Science and
Technology, Bapatla

***

INDEX

S.No.	Particulars	Page No.
1	Year-wise and Semester-wise distribution of credits among different departments	i-ii
2	Department-wise distribution of credit load	iii
3	Department-wise distribution of courses	iii - iv
4	Year-wise & Semester-wise distribution of courses	v -x
Course Content & Lecture Outlines		
5	Department of Food Processing Technology (30 credits)	1 - 37
6	Department of Food Process Engineering (37 credits)	38 - 85
7	Department of Food Safety and Quality Assurance (24 credits)	86 - 116
8	Department of Food Business Management (27 credits)	117 - 151
9	Department of Food Plant Operations - (including study tour) (27 + 2 NG Credits)	152 - 156
10	Deeksharambh & Physical Education (2 NG + 4)	157 - 162
11	Skill Enhancement (12 Credits)	163 - 192
12	Elective Courses (10 Credits) Non – Credit Courses (2 credits)	193 - 234
13	Online Courses (6 Credits)	----

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	Food Processing Technology	111 2+1				311 2+1 312 2+1 313 1+1 314 2+1 315 1+1	316 2+1 317 2+1 318 2+1 319 1+1	411 2+1		19	11	30
2	Food Process Engineering	121 1+2 122 2+1	123 2+1 124 2+1 125 2+1 126 1+2	221 2+1 222 2+1 223 1+1	224 2+1	321 1+1	322 2+1	421 2+1		22	15	37
3	Food Safety and Quality Assurance	131 2+1	132 2+1	231 2+1 232 2+1	233 2+1 234 2+0	331 2+1	332 1+1 333 1+1			16	8	24
4	Food Business Management	141 2+1 142 1+1	143 2+1	241 2+0 242 2+1	243 2+0 244 2+1 245 1+1	341 1+1	342 2+1	441 0+2		17	10	27
5	Food Plant Operations				251 2+1	351 0+2(NG)		451 0+1 452 0+3	453 0+20	2	25	27+2 NG
6	Deeksharambh &Physical Education	101 0+2(NG) 102 0+1	103 0+1	201 0+2						0	4	4+2 NG
7	Skill Enhancement	0+2 0+2	0+2 0+2	0+2	0+2					0	12	12
8	Elective Courses							10				10
9	Online Courses/ MOOCs											6
	Total	22 (10+12) +2NG	23 (11+12)	23 (13+10)	20 (13+7)	20 (12+8) +2NG	21 (13+8)	22 (4+8) +10EC	20 (0+20)	76	85	171+6+ 4NG

Credits Allocation Scheme of B. Tech (Food Technology)

Semester	Core Courses (Majors+ Minors)	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	Internship
I	12	$3^{(2)}$	-	$1^{(3)}+2^{(4)}$	4	-	22	$2^{(1)}$	-	
II	15	-	$3^{(6)}$	$1^{(3)}$	4	-	23	-	-	
Post-II semester	-	-	-	-	-	-	-	-	-	$(10)^{12}$
III	16	-	$3^{(10)}$	$2^{(8)}$	2	-	23	-	-	
IV	13	$3^{(5)}$	-	$2^{(7)}$	2	-	20	-	-	
Post-IV semester	-	-	-	-	-	-	-	-	-	$(10)^{13}$
V	20		-	-	-	-	20	$2^{(11)}$		
VI	18	$3^{(9)}$	-	-	-	-	21	-	6	
VII	19	-	-	-	-	3	22	-		
VIII	-	-	-	-	-	20	20	-		
Total	**113**	**9**	**6**	**8**	**12**	**23**	**171**	**4**	**6**	

Note: The credit hours mentioned in the table includes both theory and practical.

(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Meditation
(9) Agriculture Marketing and Trade
(10) Agriculture Informatics and artificial intelligence
(11) Study tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

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

Department-wise Distribution of Credit Load

S. No.	Name of Department	Credits
1	Food Processing Technology	30(19+11)
2	Food Process Engineering	37(22+15)
3	Food Safety and Quality Assurance	24(16+8)
4	Food Business Management	27(17+10)
5	Food Plant Operations	27+2NG (2+25)
6	Deeksharambh & Physical Education	4+2NG (0+4)
7	Skill Enhancement	12(0+12)
8	Elective Courses	10
9	Online Courses/ MOOC	06
	Total	**171+6+4NG**

Department-wise Distribution of Courses

S.No.	Course/No.	Title of the Course	Credits
		Food Processing Technology	
1	FDPT 111	Fundamentals of Food Processing	3 (2+1)
2	FDPT 311	Processing Technology of Cereals	3 (2+1)
3	FDPT 312	Processing Technology of Fruits and Vegetables	3 (2+1)
4	FDPT 313	Food Packaging Technology and Equipment	2 (1+1)
5	FDPT 314	Processing of Spices and Plantation Crops	3 (2+1)
6	FDPT 315	Processing Technology of Beverages	2 (1+1)
7	FDPT 316	Processing Technology of Legumes and Oilseeds	3 (2+1)
8	FDPT 317	Processing of Meat, Fish and Poultry Products	3 (2+1)
9	FDPT 318	Bakery, Confectionary and Snack Products	3 (2+ 1)
10	FDPT 319	Processing Technology of Liquid Milk	2 (1+1)
11	FDPT 411	Processing Technology of Dairy Products	3 (2+1)
		Total	**30(19+11)**
		Food Process Engineering	
1	FDPE 121	Workshop Technology	3 (1+2)
2	FDPE 122	Basic Electrical Engineering	3 (2+1)
3	FDPE 123	Post-Harvest Engineering	3 (2+1)
4	FDPE 124	Unit Operations in Food Processing	3 (2+1)
5	FDPE 125	Food Thermodynamics	3 (2+1)
6	FDPE 126	Engineering Drawing and Graphics	3 (1+2)
7	FDPE 221	Fluid Mechanics	3 (2+1)
8	FDPE 222	Heat and Mass Transfer in Food Processing	3 (2+1)
9	FDPE 223	Basic Electronics Engineering	2 (1+1)
10	FDPE 224	Fundamentals of Food Engineering	3 (2+1)
11	FDPE 321	Food Storage Engineering	2 (1+1)
12	FDPE 322	Food Refrigeration and Cold Chain	3 (2+1)
13	FDPE 421	Food Process Equipment Design	3 (2+1)
		Total	**37(22+15)**

		Food Safety and Quality Assurance	
1	FSQA 131	General Microbiology	3 (2+1)
2	FSQA 132	Food Chemistry I	3 (2+1)
3	FSQA 231	Food Chemistry II	3 (2+1)
4	FSQA 232	Food Microbiology	3 (2+1)
5	FSQA 233	Food Plant Sanitation	3 (2+1)
6	FSQA 234	Food Quality, Safety Standards and Certification	2 (2+0)
7	FSQA 331	Food Biochemistry and Nutrition	3 (2+1)
8	FSQA 332	Food Additives and Preservatives	2 (1+1)
9	FSQA 333	Sensory Evaluation of Food Products	2 (1+1)
		Total	**24(16+8)**
		Food Business Management	
1	FDBM 141	Farming Based Livelihood System	3 (2+1)
2	FDBM 142	Communication Skills	2 (1+1)
3	FDBM 143	Environmental Studies and Disaster Management	3 (2+1)
4	FDBM 241	Engineering Mathematics I	2(2+0)
5	FDBM 242	Agricultural Informatics and Artificial Intelligence	3 (2+1)
6	FDBM 243	Engineering Mathematics- II	2 (2+0)
7	FDBM 244	Entrepreneurship Development and Business Management	3 (2+1)
8	FDBM 245	Personality Development	2 (1+1)
9	FDBM 341	Project Preparation and Management	2 (1+1)
10	FDBM 342	Agricultural Marketing and Trade	3 (2+1)
11	FDBM 441	ICT Applications in Food Industry	2 (0+2)
		Total	**27(17+10)**
		Food Plant Operations	
1	FDPO 251	Food Plant Utilities and Services	3 (2+1)
2	FDPO 351	Study tour (10-12 days during the semester)	2 (0+2) NG
3	FDPO 451	Seminar	1 (0+1)
4	FDPO 452	Research Project	3 (0+3)
5	FDPO 453	Student READY/ Internship(at Industry/ Research Institutes, etc.) (20 weeks)	20 (0+20)
		Total	**27(2+25) +2NG**
		Deeksharambh & Physical Education	
1	COCA 101	Deeksharambh (Inductioncum-Foundation Course of 2 weeks)	2 (0+2) NG
2	COCA 102	NCC-I/ NSS-I	1 (0+1)
3	COCA 103	NCC-II/NSS-II	1 (0+1)
4	COCA 201	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)
		Total	**4(0+4) +2NG**

Skill Enhancement		
SECM		12(0+12)
	Total	**12(0+12)**
Elective Courses		
		10
	Total	**10**
Online Courses/ MOOC		
Online Courses/ MOOC		6
	Total	**6**
Grand Total: 171(76+85) +10EC+06OC/MOOC+4NG		

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 (Induction cum-Foundation Course of 2 weeks)	2 (0+2) NG	22 (10+12) + 2 NG
2.	FDPT 111	Fundamentals of Food Processing	3 (2+1)	
3.	FDPE 121	Workshop Technology	3 (1+2)	
4.	FDPE 122	Basic Electrical Engineering	3 (2+1)	
5.	FSQA 131	General Microbiology	3 (2+1)	
6.	FDBM 141	Farming Based Livelihood System	3 (2+1)	
7.	FDBM 142	Communication Skills	2 (1+1)	
8.	COCA 102	NCC-I/ NSS-I	1 (0+1)	
9.	SECM^{+}	Skill Enhancement Course	2 (0+2)	
10.	SECM^{+}	Skill Enhancement Course	2 (0+2)	
		I YEAR II SEMESTER		
1	FDPE 123	Post-Harvest Engineering	3 (2+1)	23 (11+12)
2	FSQA 132	Food Chemistry I	3 (2+1)	
3	FDPE 124	Unit Operations in Food Processing	3 (2+1)	
4	FDPE 125	Food Thermodynamics	3 (2+1)	
5	FDPE 126	Engineering Drawing and Graphics	3 (1+2)	
6	FDBM 143	Environmental Studies and Disaster Management	3 (2+1)	
7	COCA 103	NCC-II/NSS-II	1 (0+1)	
8	SECM^{+}	Skill Enhancement Course	2 (0+2)	
9	SECM^{+}	Skill Enhancement Course	2 (0+2)	
		Post – II Semester		
1	FDPO 151	Internship (for 10 weeks, only for exit option for award of UG Certificate)	10 (0+10)	

S. No	Course No	Course Title	Credit hours	Total credit hours
		II YEAR I SEMESTER		
1	FSQA 231	Food Chemistry II	3 (2+1)	23 (13+10)
2	FDPE 221	Fluid Mechanics	3 (2+1)	
3	FDPE 222	Heat and Mass Transfer in Food Processing	3 (2+1)	
4	FDPE 223	Basic Electronics Engineering	2 (1+1)	
5	FSQA 232	Food Microbiology	3 (2+1)	
6	FDBM 241	Engineering Mathematics I	2 (2+0)	
7	FDBM 242	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8	COCA 201	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
9	SECM^{+}	Skill Enhancement Course	2 (0+2)	
		II YEAR II SEMESTER		
1	FDPE 224	Fundamentals of Food Engineering	3 (2+1)	20 (13+7)
2	FSQA 233	Food Plant Sanitation	3 (2+1)	
3	FSQA 234	Food Quality, Safety Standards and Certification	2 (2+0)	
4	FDBM 243	Engineering Mathematics- II	2 (2+0)	
5	FDPO 251	Food Plant Utilities and Services	3 (2+1)	
6	FDBM 244	Entrepreneurship Development and Business Management	3 (2+1)	
7	FDBM 245	Personality Development	2 (1+1)	
8	SECM^{+}	Skill Enhancement Course	2 (0+2)	
		Post - II Semester		
1	FDPO 252	Internship (for 10 weeks, only for exit option for award of UG Diploma in Food Technology)	10 (0+10)	
		III YEAR I SEMESTER		
1	FSQA 331	Food Biochemistry and Nutrition	3 (2+1)	20 (12+8) +2 (Non-Gradial)
2	FDPT 311	Processing Technology of Cereals	3 (2+1)	
3	FDPT 312	Processing Technology of Fruits and Vegetables	3 (2+1)	
4	FDPT 313	Food Packaging Technology and Equipment	2 (1+1)	
5	FDPT 314	Processing of Spices and Plantation Crops	3 (2+1)	
6	FDPE 321	Food Storage Engineering	2 (1+1)	
7	FDBM 341	Project Preparation and Management	2 (1+1)	
8	FDPT 315	Processing Technology of Beverages	2 (1+1)	
9	FDPO 351	Study tour (10-12 days during the semester)	2 (0+2) NG	

S. No	Course No	Course Title	Credit hours	Total credit hours
		III YEAR II SEMESTER		
1	FSQA 332	Food Additives and Preservatives	2 (1+1)	21 (13+8)
2	FSQA 333	Sensory Evaluation of Food Products	2 (1+1)	
3	FDPT 316	Processing Technology of Legumes and Oilseeds	3 (2+1)	
4	FDPE 322	Food Refrigeration and Cold Chain	3 (2+1)	
5	FDPT 317	Processing of Meat, Fish and Poultry Products	3 (2+1)	
6	FDBM 342	Agricultural Marketing and Trade	3 (2+1)	
7	FDPT 318	Bakery, Confectionery and Snack Products	3 (2+ 1)	
8	FDPT 319	Processing Technology of Liquid Milk	2 (1+1)	
		IV YEAR I SEMESTER		
1	FDPE 421	Food Process Equipment Design	3 (2+1)	22 (4+8) +10EC
2	FDPT 411	Processing Technology of Dairy Products	3 (2+1)	
3	FDBM 441	ICT Applications in Food Industry	2 (0+2)	
4	FDPO 451	Seminar	1 (0+1)	
5	FDPO 452	Research Project	3 (0+3)	
6		Elective Courses	10	
		IV YEAR II SEMESTER		
1	FDPO 453	Student READY/ Internship (at Industry/ Research Institutes, etc.) (20 weeks)	20 (0+20)	20 (0+20)
			Total	171+4 (NG)
			Online courses/MOOCs	6
			Grand Total	181

Proposed Basket of Skill Enhancement Course Modules for Semester 1 to VI^{++}

Discipline/ Department	Course Title	Credit Hours	Course No
	Food Processing Technology		
1	Introduction to Drying Technology and Dryers	2 (0+2)	SECM 112
2	Introduction to Processing of Extruded Products	2 (0+2)	SECM 212
3	Introduction to Milling (Rice, Dal, Spices etc)	2 (0+2)	SECM 111
4	Milk and Milk Products Processing	2 (0+2)	SECM 211
	Food Safety and Quality Assurance		
1	Introduction to Food Safety and Sanitation	2 (0+2)	SECM 231
2	Introduction to Good Laboratory Practices	2 (0+2)	SECM 132
3	Basic Food Analysis and Laboratory Techniques	2 (0+2)	SECM 131

Discipline/ Department	Course Title	Credit Hours	Course No
	Food Process Engineering		
1	Introduction to Electrical and Control Systems in Food Industry	2 (0+2)	SECM 222
2	Introduction to Mechanical Systems in Food Industry	2 (0+2)	SECM 121
3	Introduction to Auto CAD	2 (0+2)	SECM 221
	Food Plant Operations		
1	Maintenance of Food Processing Equipment	2 (0+2)	SECM 251
2	Introduction to Bottling and Canning Line	2 (0+2)	SECM 252
3	Introduction to Manufacturing of Bakery Products	2 (0+2)	SECM 151

++ From Basket of Skill enhancement course modules, only one course from each discipline is to be selected per the semester as per the selected specialization of certificate. However, at least one course of other specialization viz., Food Technology, Food Engineering and Food Quality is to be taken for the Diploma Course.

Student taking various SKILL ENHANCEMENT COURSES will be eligible to get a certificate with nomenclature as follows provided the student has selected courses as mentioned against the nomenclature of the UG-Certificate

Nomenclature of Certificate	**Skill Enhancement Courses to be selected from the respective disciplines**	
	Semester-1	**Semester-II**
UG Certificate in Food Technology (Food Plant Operations)	Food Engineering	Food Plant Operations
UG Certificate in Food Technology (Food Manufacturing)	Food Technology	Food Plant Operations
UG Certificate in Food Technology (Food Quality Testing)	Food Quality Assurance	Food Plant Operations

ELECTIVE COURSES

S. No	Course No	Course Title	Credits
1	FDPT 412	Design and Formulation of Foods	3 (2+1)
2	FSQA 431	Industrial Microbiology	3 (2+1)
3	FSQA 432	Introduction to Food Biotechnology	3 (2+1)
4	FDBM 442	Business Management and Economics	2 (2+0)
5	FDBM 443	Statistical Methods and Numerical Analysis	2 (1+1)
6	FDPE 422	Instrumentation and Process Control in Food Industry	3 (1+2)
7	FSQA 433	Instrumental Techniques in Food Analysis	2 (1+1)
8	FDPT 413	Traditional Indian Dairy Products	2 (1+1)
9	FDPT 414	Ice-cream and Frozen Desserts	3 (2+1)
10	FDPE 423	Energy Conservation and Management	2 (1+1)
11	FDPE 424	Applications of Renewable Energy in Food Processing	2 (1+1)
12	FDPE 425	Food Plant Design and Layout	3 (2+1)
13	FDPT 415	Waste and By-Products Utilization	3 (2+1)

Online courses:

Six credits of online courses are at the discretion of students. Students have the choice of taking online courses to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these Non-credit elective courses of 6 credits any time during the 3rd and 4th years. These courses are to be completed with satisfactory grade.

Guidelines for taking the online courses

- 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. (Food Technology) 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 courses can be taken during the third year and 4th year of the UG program as per choice of students.
- The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course).
- The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

UG programme in Food Technology with Entry and Exit option

The entry and exit options for the UG programs in Food Technology are shown in the figure below.

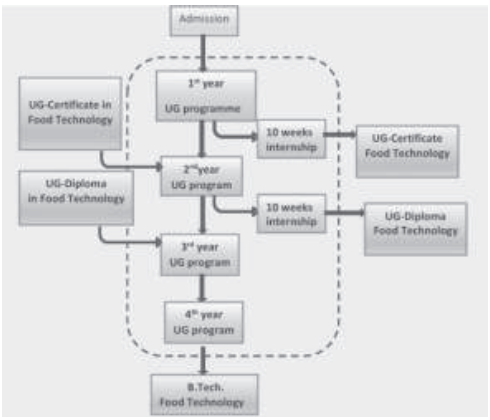


Fig. 1 UG programme in Food Technology with Entry and Exit option

1. Eligibility for Entry into 1st year UG program:

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

Exit options

UG-Certificate in Food Technology (exit after first year and completion of 10 weeks' internship) with following specialization e.g. UG certificate in Food technology (Food Plant Operations)

a. Food Plant Operations

b. Food Manufacturing

c. Food Quality Testing

2. UG-Diploma in Food Technology (exit after second year and completion of 10 weeks' internship)

3. B.Tech. (Food Technology) (on successful completion of four-year degree requirements)

DEPARTMENT OF FOOD PROCESSING TECHNOLOGY

FDPT 111 Fundamentals of Food Processing 3(2+1)

Objectives

1. To understand about perishability of food and causes for food spoilage.
2. To have an idea of the basic methods of preservation of food.
3. To gain knowledge about non thermal processing of food.

Course Outlines

Theory

Food: Definition and functions, Classification of foods, sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation. Food processing: Introduction, levels and techniques; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality. Preservation by heat treatment: Principle, process and equipment for blanching, canning, pasteurization, sterilization. Preservation by use of low temperature: Principle, methods, equipment. Preservation by drying, dehydration and concentration: Principle, methods, equipment. Preservation by irradiation: Principle, methods, equipment. Preservation by chemicals - antioxidants, mould inhibitors, antibodies, acidulants, hurdle technology etc. Preservation by fermentation: Principles, methods, equipment. Non thermal preservation processes: Principles, equipment - pulse electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology, etc. Quality tests and shelf-life of preserved foods.

Practical

Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment - pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives; Preservation of bread, cake using mold inhibitors; Drying of fruit slices - Pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze drying process; Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut; Study on effect of high pressure on microbes; Study on effect of pulse electric field on food.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Food: Food groups, functions and physico - chemical properties of food constituents
2	Perishability of foods: Perishables – Semi-perishables and Non-perishables foods
3	Food spoilage: Definition, causes, types - physical, chemical and microbiological spoilage during storage and transport
4	Food preservation - General principles, scope and benefits of food preservation
Unit II	
5	Food Processing: Different kinds of food industries, components of food industries. Scope of food processing and technology
6	Methods of food preservation: physical methods – chemical methods – biological methods – other methods
7	Preservation of food by salt: principle, methods and effect on food quality
8	Preservation of food by sugar: principle, methods - effect on food quality
Unit III	
9	Preservation by heat treatment: Blanching - Principle, process, types, advantages and disadvantages of blanching
10	Canning: principle and process of canning, type of equipment used for canning
11	Pasteurization: Principle, process and type of equipment for pasteurization, effect on food - advantages and disadvantages
12	Sterilization: Principle, type of equipment, effect on food - advantages and disadvantages
Unit IV	
13	Preservation by use of low temperature storage: principles, methods and equipment
14	Methods of food freezing – quick freezing and slow freezing- effect of freezing and thawing in food- advantages and disadvantages
15	Preservation by drying / dehydration, types of moisture - definition – bound moisture – unbound moisture – free moisture
16	Driers – Cabinet drier, tunnel drier drum drier, fluidized bed drier, spray drier, foam mat drying, and vacuum drying
Unit V	
17	Preservation of foods by heating: Moist heat methods, dry heat methods, extrusion cooking, baking
18	Preservation by concentration - principle, methods of concentration-open kettles, thin film evaporators - flash evaporator, vacuum evaporators
19	Preservation by irradiation - principle, methods of irradiation, equipment for irradiation
20	Applications of irradiation - effects of radiation - irradiation doses for treating various foods - advantages and disadvantages

Unit VI

21 Preservation by chemicals - types and their mechanism of preservation - class I preservatives – class II preservative - mould inhibitors - parabens - epoxides - benzoic acid - propionic acid

22 Preservation by antioxidants, mould inhibitors, antibiotics, acidulants, hurdle technology

23 Preservation by fermentation - principle, methods of fermentation and equipment

24 Preservation by fermentation: Application in food pickling and curing

Unit VII

25 Non-thermal preservation processes: Introduction, scope of different methods of non-thermal treatments applied in food industries and effect on food - advantages and disadvantages

26 Pulsed electric filed and pulsed intense light - principle, equipment, applications, effect on food - advantages and disadvantages

27 Ultrasound processing- principle, equipment, applications, effect on food - advantages and disadvantages

28 Dielectric and infrared heating - principle, equipment, applications and effect on food - advantages and disadvantages

Unit VIII

29 Ohmic heating- principle, equipment, applications and effect on food - advantages and disadvantages

30 High pressure processing - principle, equipment, applications and effect on food - advantages and disadvantages

31 Microwave heating- principle, method, equipment, applications and effect on food. Cold Plasma technology - principle, applications, advantages and disadvantages

32 Quality tests- different quality characteristics of foods - shelf life of preserved foods-methods

Practical

No.	Practical Outline
1	Demonstration of various perishable food items and degree of spoilage
2	Demonstration of effect of blanching on food quality characteristics
3	Preservation of food by heat treatment - pasteurization
4	Preservation of food by high concentration of sugar: Jam
5	Preservation of food by using salt: pickle
6	Preservation of food by using acidulants/acid: vinegar
7	Preservation of food by using chemical preservatives
8	Preservation of bread, cake using mold inhibitors
9	Drying of fruit slices: pineapple slices, apple slices using cabinet drier
10	Drying of mango pulp using foam mat drying method

11 Drying of semisolid food using roller drier
12 Drying of foods using freeze drier
13 Demonstration of preserving foods under cold vs freezing process
14 Processing of foods using fermentation - sauerkraut
15 Study on effect of high-pressure processing and pulsed electric field on food
16 Practical Examination

References

1. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
2. Desrosier N.W. and Desrosier, J.N. 1977. The Technology of Food Preservation. 4thedn. AVI Publishing Co., Connecticut, USA.
3. Fellows, P. 2000. Food Processing Technology: Principles and Practice. 2ndedn. CRC Press, Boca Raton, FL, USA.
4. Karel, M. and Lund, D.B. 2003. Physical Principles of Food Preservation. 2ndedn. Marcel Dekker, Inc., NY, USA.
5. Lal, G., Siddappa, G.S. and Tandon, G.L. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
6. Potter, N. N. and Hotchkiss, J.H. 1995. Food Science. 5th edn. Chapman and Hall, NY, USA.
7. Rahman, M.S. 2007. Handbook of Food Preservation. 2nd edn. CRC Press, Boca Raton, FL, USA.
8. Stavros Y. 2008. Solving Problems in Food Engineering. Springer, NY, USA.
9. Tewari, G. and Juneja, V.K. 2007. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.
10. Zeuthen, P. and Bugh-Sorensen, L. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.

FDPT 311 Processing Technology of Cereals 3(2+1)

Objectives

1. To learn milling technology of rice, wheat, corn and barley
2. To get knowledge about breakfast cereals and their processing technologies

Course Outlines

Theory

Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets, chemical composition and nutritive value; Paddy processing and rice milling: Conventional milling, modern milling; Milling

operations, milling machines, milling efficiency; Quality characteristics influencing final milled product; Parboiling; Rice bran stabilization and its methods; Ageing of rice; Enrichment of rice – methods of enrichment; Rice fortification; Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking; Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches; Barley: Malting and milling; Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, finger millets): Processing of millets for food uses; Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.

Practical

Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and milling of wheat; Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylograph; Processing of value added products from millets; Visit to Cereal processing unit.

Lecture outlines

Theory

No. Lecture Outline

Unit I

1 Present status and future prospects of cereals and millets-current trends in area, production and yield

2 Morphology: Morphology of cereals and millets-structure and composition of grains - wheat, corn, rice, barley, oat, rye, sorghum, finger millet and pearl millet

3 Physicochemical properties of cereals-physical properties - size, shape, sphericity, roundness, true density, bulk density, porosity, angle of repose, coefficient of friction

4 Major and minor millets; chemical composition and nutritive value of cereals and millets

Unit II

5 Paddy processing and rice milling: Conventional milling, modern milling; Milling operations: cleaning, shelling, polishing, grading and packaging

6 Milling machines: Traditional rice milling machinery-hand pounding, single huller, battery of hullers, sheller-cum-huller mill, sheller mill and Engleberg huller

7 Modern rice milling machinery: Paddy cleaner, destoner, paddy husker, husk aspirator, abrasive type and friction type polishers, indented cylinder grader and color sorter and determination of milling efficiency

8 Quality characteristics influencing final milled product- factors that affect rice out-turn during milling

Unit III

9 Parboiling – principle - steps involved in parboiling - physicochemical changes during parboiling

10 Advantages and disadvantages of parboiling and methods of parboiling

11 Rice bran stabilization; methods of rice bran stabilization

12 Ageing of rice; enrichment of rice–methods of enrichment; rice fortification

Unit IV

13 Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition

14 Soft wheat milling and Durum wheat milling

15 Quality characteristics of flour and their suitability for baking flour grades-treatment of wheat flour

16 Corn milling: Dry milling of corn- cleaning, tempering/conditioning, corn dehulling and de-germination and roller milling

Unit V

17 Wet milling of corn-cleaning, steeping, germ separation, fiber separation, starch refinement

18 Starch and gluten separation, milling fractions and modified starches

19 Barley Malting: steeping, germination, kilning and ageing-uses of malt

20 Barley milling-cleaning, conditioning, blocking, pearling and bleaching

Unit VI

21 Oat processing- milling-traditional and modern processing- grading, stabilization, kiln-drying, shelling and cut groats

22 Rye processing-cleaning, conditioning, break rolls, husk aspiration, reduction rolls and rye flour

23 Sorghum: malting, pearling-dry milling

24 Wet milling of sorghum - uses of sorghum malt

Unit VII

25 Millets (Pearl millet): Processing of pearl millet for food use

26 Millets (Finger millet): Processing of finger millet for food use

27 Secondary and tertiary products processing of cereals

28 Secondary and tertiary products processing of millets

Unit VIII

29 By-products processing of cereals and millets

30 Processing of infant foods from cereals and millets

31 Breakfast cereal foods: Flaked, puffed, expanded products flaked rice, oat flakes, corn flakes, sorghum flakes, puffed rice, puffed wheat, puffed corn, puffed sorghum

32 Breakfast cereal foods: Extruded and shredded products- extruded rice, directly expanded snacks, quick cooking pasta, instant noodles and shredded wheat

Practical

No.	Practical Outline
1	Study of morphological characteristics of cereals
2	Determination of physical properties of cereals
3	Determination of chemical properties of cereals
4	Experiment on production of parboiled paddy
5	Determination of cooking quality of rice
6	Determination of milling characteristics of rice
7	Experiment on conditioning and milling of wheat
8	Experiment on production of sorghum flakes
9	Experiment on production of popcorn
10	Experiment on production of flaked rice and puffed rice
11	Experiment on production of noodles
12	Experiment on production of sorghum malt
13	Determination of gelatinization temperature by amylograph
14	Processing of value added products from millets
15	Visit to cereal processing unit
16	Practical Examination

References

1. Araullo, E.V., De Padua, D.B. and Graham, M. 1976. Rice Post Harvest Technology. IDRC, Canada.
2. Chakraverty, A. and Singh, R.P. 2014. Post-Harvest Technology and Food Process Engineering.CRC Press, Boca Raton, FL, USA.
3. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc.,NY, USA.
4. Champagne, E.T. 2004. Rice: Chemistry and Technology, 3rd edn. AACC International, Inc., St.Paul, MN, USA.
5. David, A.V. Dendy and Dobraszczyk, B.J. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
6. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th edn. Elsevier Science Ltd., Oxford, UK.
7. Khan, K. and Shewry, P.R. 2009. Wheat: Chemistry and Technology, 4th edn. AACC International, Inc., St. Paul, MN, USA.
8. Matz, S.A. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd edn. Springer Science + Business Media, NY, USA.
9. Wrigley, C. 2004. Encyclopedia of Grain Science. Academic Press, London, UK.
10. White, P. J. and Johnson. L. Lawrence A. 2003. Corn: Chemistry and Technology, 2nd edn. AACC International, Inc., St. Paul,

FDPT 312 Processing Technology of Fruits and Vegetables 3(2+1)

Objectives

1. Understand methods of preservation of fruits and vegetables
2. Get knowledge of FSSAI specifications of fruits and vegetables products

Course Outlines

Theory

Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables; Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching- operations and equipment; Canning: - Definition, processing steps, and equipment.

Cans and containers, quality assurance and defects in canned products; FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.; Processing and equipment for above products; FSSAI specifications of crystallized fruits and preserves, jam, jelly and marmalades, candies; Preparation, preservation and machines for manufacture of above products; Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, leather, dehydrated, wafers and papads, soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products; By-products of fruit and vegetable processing industry.

Practical

Primary processing of selected fruits and vegetables; Canning of Mango/Guava/ Papaya; Preparation of jam from selected fruits; Preparation of jelly from selected fruits; Preparation of fruit marmalade; Preparation of RTS; Preparation of squash; Preparation of syrup; Preparation of raisins, dried fig and dried banana; Preparation of anardana; Preparation of papain; Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers; Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Production and processing scenario of fruits and vegetables in India and world; Future prospectus and scope of fruit and vegetable processing industry in India

2 Overview of principles and preservation methods of fruits and vegetables-Drying principle, methods, effect of drying on quality

3 Overview of principles and preservation methods of fruits and vegetables -Low temperature storage-principle, methods and changes during storage

4 Overview of principles and preservation methods of fruits and vegetables -Chemical preservation- preservation class-I and Class II preservatives

Unit II

5 Overview of principles and preservation methods of fruits and vegetables - Application of fermentation, Irradiation and Hurdle concept in fruit and vegetable processing

6 Overview of principles and preservation methods of fruits and vegetables –Intermediate moisture processing in fruit and vegetable processing

7 Supply chain of fresh fruits and vegetables- Introduction, objective and scope of supply chain- supply chain cluster and model- methodology- factors affecting fruit and vegetable supply chain

8 Primary processing and pack house handling of fruits and vegetables- operations of primary processing–need for pack house- dumping- presorting- washing and cleaning-sizing and grading

Unit III

9 Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables- equipment used for the above operations

10 Minimal processing of fruits and vegetables-concept of minimal processing, principle, methods of minimal processing and applications in food industry

11 Minimal processing of fruits and vegetables: Various technologies in minimal processing of fruits and vegetables

12 Blanching operations and equipment-Types of blanching and equipment used; pretreatments used in blanching

Unit IV

13 Canning: Definition, processing steps, equipment, cans and containers for fruits

14 Canning: processing steps involved in canning of vegetables

15 Canning: factors affecting canning process and defects in canned products

16 FSSAI specifications, preparation and preservation of juices

Unit V

17 FSSAI specifications, preparation and preservation of squashes and syrups

18 FSSAI specifications, preparation and preservation of sherbets, nectars, cordials etc.

19 Processing and equipment for squashes, syrups, sherbets, nectars and cordials

20 FSSAI specifications- FSSAI standards for various processed fruits and vegetables

Unit VI

21 Preparation, preservation and machines for manufacture of crystallized fruits and preserves

22 Preparation, preservation and machines for manufacture of jam

23 Preparation, preservation and machines for manufacture of jelly and marmalades

24 Preparation, preservation and machines for manufacture of candies

Unit VII

25 Preparation, preservation and machines for manufacture of chutney and pickles

26 Preparation, preservation and machines for manufacture of sauce, puree, paste and ketchup

27 Preparation, preservation and machines for manufacture of toffee, cheese and leather

28 Preparation, preservation and machines for manufacture of dehydrated wafers and papads

Unit VIII

29 Preparation, preservation and machines for manufacture of soup powders

30 Production of pectin- sources, types of pectins - low methoxy, high methoxy pectins and their role in fruit processing; method of extraction

31 Production of vinegar- Different methods of production of vinegar- Orleans slow method- Quick generator method - defects

32 Commercial processing technology of selected fruits and vegetables for production of various valueadded processed products

Practical

No.	Practical Outline
1	Primary processing of selected fruits and vegetables
2	Canning of Mango/Guava/ Papaya
3	Preparation of jam from selected fruits
4	Preparation of jelly from selected fruits
5	Preparation of fruit marmalade
6	Preparation of RTS
7	Preparation of squash
8	Preparation of syrup
9	Preparation of raisins, dried fig and dried banana
10	Preparation of Anardana
11	Preparation of Papain
12	Preparation of Pickles
13	Preparation of dried ginger, dried onion and garlic
14	Preparation of banana and potato wafers
15	Preparation of dehydrated leafy vegetables
16	Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant

References

1. Chavan, U.D. and Patil, J.V. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
2. Chakraverty, A. Mujumdar, A.S. Vijaya Raghavan, G.S. and Ramaswamy, Hosahalli S. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. Cruess, W.V. 2004. Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur.
4. Dauthy, M. E. 1995. Fruit and Vegetable Processing. FAO Agricultural Services Bulletin No.119. FAO of UN, Rome.
5. EIRI Board of Consultants and Engineers. Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.
6. Hui, Y.H. 2006. Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford, UK.
7. Hui, Y.H., Chazala, S., Graham, D.M., K.D. Murrell and Wai-Kit Nip. 2004. Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.
8. Lal, G., Siddappa, G.S. and Tandon, G.L. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
9. Pandey, P.H. 1997. Post-Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.
10. Srivastava, R.P. and Kumar, S. 2002. Fruit and Vegetable Preservation: Principles and Practices, 3rd edn. International Book Distribution Co., Delhi.

FDPT 313 Food Packaging Technology and Equipment 2(1+1)

Objectives

1. To understand concept of packaging, its type and properties of packaging materials
2. To gain knowledge about intelligent, smart and active packaging
3. To learn labelling requirement and regulations

Course Outlines

Theory

Packaging situations in World and India; Need of packaging; Package requirements, package functions; Properties of different packaging materials; Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.; Glass as package material, manufacture, advantages, disadvantages; Metal (Aluminium/tin/SS) as package material-manufacture, advantages, disadvantages, Plastic as package material, classification of polymers, properties of each plastics, uses of each plastics; Lamination: Moulding- Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic

packaging; Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods; Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP; Retort structure and packaging; Edible packaging- Types and sources; Microwavable packaging – Types and applications. Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package. Packaging practices followed for fruits and vegetables and their products, packaging machines, Filling machines, vacuum packaging machines. Bottle fillers, fillers for dry mixers, ice-cream fillers, Form fill and seal (FFS) machines, vacuum packaging machine, shrink wrap packaging machine, Aseptic tetra pack system; Labelling requirements, methods of coding and regulation and standards of labelling of food packages.

Practical

Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paperboards; Measurement of water absorption of paper, paper boards; Measurement of bursting strength of paper, paper boards; Measurement of tear resistance of papers; Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers; Determination of gas and water transmission rate of package films; Determination of laquer integrity test; Drop test, Box compression test; Identification of plastic films; Determination of seal integrity, ink adhesion; packaging practices followed for packing fruits and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machines, bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.

Lecture outlines

Theory

No.	Lecture Outline
Unit I	
1	Packaging situations in world and India; need of packaging; package requirements and package functions
2	Properties of different packaging materials; package materials: classification of packages
Unit II	
3	Paper as package material, manufacturing of paper-chemical pulp-mechanical pulp, alkali process, bleaching, beating and refining, converting, calendaring and sizing of paper
4	Types of paper and paper board grades; advantages of corrugated and paper board boxes

Unit III

5 Glass as package material, manufacture of glass containers-Blow and Blow method, Press and blow method; advantages and disadvantages of glass packaging material

6 Metal (Aluminium/tin/SS) as package material-manufacture of tin plate, manufacture of aluminum containers; advantages and disadvantages of metal packaging material

Unit IV

7 Plastic as package material, classification of polymers, properties of each plastic, uses of each plastic; Lamination: Moulding- Injection, blow, extrusion; coating on paper and films

8 Aseptic packaging: need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging

Unit V

9 Permeability: Theoretical considerations, permeability of gases and vapors; permeability of multilayer materials; permeability in relation to packaging requirement of foods

10 Intelligent/Smart/Active packaging systems and their food applications

Unit VI

11 Controlled atmospheric packaging and modified atmospheric packaging; Retort structure and packaging

12 Edible packaging-Types and sources; Microwavable packaging-Types and applications

Unit VII

13 Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods; mechanical and functional tests on package

14 Packaging practices followed for fruits and vegetables and their products

Unit VIII

15 Packaging machines: Filling machines, vacuum packaging machines. Bottle fillers, fillers for dry mixers, ice-cream fillers, Form Fill and Seal (FFS) machines, vacuum packaging machine, shrink wrap packaging machine, Aseptic tetra pack system

16 Labelling requirements, methods of coding and regulation and standards of labelling of food packages

Practical

No. Practical Outline

1 Classification of various packages based on material and rigidity

2 Measurement of thickness, basic weight and grammage of paper and paperboards

3 Measurement of water absorption of paper and paper boards (Cobb test)

4 Measurement of bursting strength of paper and paper boards

5 Measurement of tear resistance of papers

6 Measurement of puncture resistance of paper and paper board
7 Measurement of tensile strength of paper and paper boards
8 Measurement of grease resistance of paper
9 Determination of gas and water transmission rate of package films
10 Determination of lacquer integrity by lacquer integrity test
11 Drop test and box compression test for packed food items
12 Identification of plastic films and determination of seal integrity, ink adhesion
13 Packaging practices for packing fruits and vegetables; shelf life calculations for food products
14 Head space analysis of packaged food
15 Study of vacuum packaging machines, bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system
16 Practical Examination

References

1. Ahvennainen, R. 2003. Novel Food Packaging Techniques. CRCWoodhead Publishing Ltd., Cambridge, England.
2. Coles, R., McDowell, B. and Kirwan, M.J. 2003. Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK
3. Han, J. H. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.
4. Han, J.H. 2005. Innovations in Food Packaging. Elsevier Science and Technology Books, UK.
5. Lee, D. S. 2008. Food Packaging Science and Technology. CRC Press, Boca Raton FL, USA.
6. Robertson, G. L. 2014. Food Packaging: Principles and Practice, 3rd edn. CRC Press, Boca Raton, FL, USA.
7. Robertson, G. L. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.

FDPT 314 Processing of Spices and Plantation Crops 3 (2+1)

Objectives

1. Learn processing technology of different spices
2. Understand post-harvest technology of tea, coffee, cocoa etc.
3. To impart knowledge about spice and plantation crops processing, their marketable standards, their importance in Indian economy.
4. Learn about preparation of value added products
5. Study the Quality specifications of spices
6. Detect Adulteration of various spices

Course Outlines

Theory

Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: post-harvest technology, composition; Processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom. Equipment for cryogenic grinding; Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram; Rosemary, saffron, sage; Savory, thyme, ajowan; Asafoetida, curry leaves; Postharvest technology for Tea, coffee, cocoa, Vanilla and annatto processing; Post-harvest technology and processing of areca nut, cashew nut, oil palm, coconut. Flavours of minor spices; Flavour of major spices. Spice oil and oleoresins: Extraction techniques; Super critical fluid extraction of spices. Standard specification of spices; Standards like ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization. Functional packaging of spices and spice products; Byproducts of plantation crops and spices.

Practical

Identification and characterization of flavouring compounds of spices; Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli; Extraction of oleoresins: Turmeric, ginger, pepper, clove; Peperine estimation in pepper oleoresin; Steam distillation of spices; Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, valuable oil, specific gravity, refractive index, acid value; Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to spice industry.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Production and processing scenario of spice and its scope – Introduction, History of spice, condiments, production trends, scope of spice processing
2	Flavour and plantation crops and its scope – Flavouring compounds, definition of plantation crops, commercial value of plantation crops that are grown in India
3	Major spices: post-harvest technology, composition-classification of spices and condiments, post-harvest techniques
4	Processed product of spice: Ginger - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration
Unit II	
5	Chilli - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

6 Turmeric-Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

7 Onion-Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

8 Garlic - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

Unit III

9 Pepper-Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

10 Cardamom - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

11 Cryogenic grinding-Equipment for cryogenic grinding, cryogens, advantages and limitations

12 Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization

Unit IV

13 All spice, Annie seed, Sweet basil - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

14 Caraway seed, cassia and cinnamon-Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

15 Clove and coriander - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

16 Cumin and dill seed - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

Unit V

17 Nutmeg, mace and fennel seed - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

18 Mint marjoram and rosemary - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

19 Saffron, sage and savory - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

20 Thyme, ajawan and curry leaves - Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

Unit VI

21 Asafoetida-Introduction, harvesting, post-harvest technology and treatments, processing into marketed products, adulteration

22 Post-harvest technology for tea – Introduction, harvesting, Composition, types, fermentation, processing, adulteration

23 Post-harvest technology for coffee–Introduction, harvesting, Composition, types, processing, roasting, adulteration

24 Cocoa-Introduction, harvesting, post-harvest technology, fermentation and processing marketable products, adulteration

Unit VII

25 Vanilla and annatto processing- Introduction, harvesting, post-harvest technology, processing into marketable products, adulteration

26 Post-harvest technology and processing of areca nut - Introduction, harvesting, post-harvest technology, marketable products, adulteration

27 Cashew nut- Introduction, harvesting, post-harvest technology, marketable products, adulteration

28 Oil palm and coconut- Introduction, harvesting, post-harvest technology, marketable products, adulteration

Unit VIII

29 Spice oil and oleoresins: extraction techniques; super critical fluid extraction of spices

30 Standard specification of spices; ESA, ASTA, FSSAI

31 Maintenance of quality by fumigation, CAS and ETO sterilization

32 Functional packaging of spices and spice products, By-products of plantation crops and spices

Practical

No.	Practical Outline
1	Identification and characterization of flavouring compounds of spices; Valuable oil determination
2	Extraction of oil from clove and pepper
3	Extraction of oil from cardamom
4	Extraction of oil from chilli
5	Extraction of oleoresins: Turmeric
6	Extraction of oleoresins: Ginger
7	Extraction of oleoresins: Pepper and clove
8	Piperine estimation in pepper oleoresin
9	Steam distillation of spices
10	Determination of curcumin content in turmeric
11	Chemical analysis of spices: moisture, valuable oil
12	Chemical analysis of spices: specific gravity, refractive index, acid value
13	Study of standard specification of spices
14	Packaging study of spices
15	Preparation of curry powder
16	Visit to spice industry

References

1. Gupta, S. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
2. Hirasa, K. and Takemasa, M. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
3. Panda, H. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
4. Pruthi, J.S. 2001. Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.
5. Pruthi, J.S. 2001. Spices and Condiments – Minor Spices of India. National Book Trust, New Delhi.
6. Purseglave, J.W., Brown, E.G., Green, C.L. and Robins. Spices, Vol. I and II. SRJ Academic Press, New Delhi.
7. Shanmugavelu, K.G. Spices and Plantation Crops. Oxford and IBH Publishing Co., New Delhi.

FDPT 315 Processing Technology of Beverages 2 (1+1)

Objectives

1. To learn about different types of beverages
2. To know various technologies involved in beverage processing
3. To gain knowledge about FSSAI specifications of beverages
4. To understand ingredients, manufacturing and packaging processes for beverages

Course outlines

Theory

History and importance of beverages and status of beverage industry; Processing of beverages: Packaged drinking water, juice-based beverages, synthetic beverages, still, carbonated; Low-calorie and dry beverages, isotonic and sports drinks. Dairy based beverages, Alcoholic beverages, fruit beverages, specialty beverages, Tea, coffee, cocoa, spices, plant extracts, etc. FSSAI specifications for beverages. Ingredients, manufacturing and packaging processes and equipment for different beverages; Water treatment and quality of process water; Sweeteners, colorants, acidulants, Clouding and clarifying and flavouring agents for beverages, Carbon dioxide and carbonation. Quality tests and control in beverages, miscellaneous beverages: Coconut water, sweet toddy, Sugar cane juice, coconut milk, flavoured syrups

Practical

Quality analysis of raw water; Determination of density and viscosity of caramel; Determination of colours in soft drinks by wool technique; Preparation of iced and flavoured

tea; Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages; Determination of brix value, gas content, pH and acidity of beverages; Quality analysis of tea and coffee; Preparation of miscellaneous beverages; Visit to carbonation unit; Visit to mineral water plant

Lecture outlines

Theory:

No. Lecture Outline

Unit I

1 History and importance of beverages and status of beverage industry

2 Processing of beverages: Packaged drinking water, juice-based beverages

Unit II

3 Processing of beverages: synthetic beverages, still, carbonated; Low-calorie and dry beverages, isotonic and sports drinks.

4 Processing of beverages: Dairy based beverages (milk drinks, buttermilk, drinkable yogurts, shakes and flavored milk drinks)

Unit III

5 Processing of beverages: Alcoholic beverages, fruit beverages

6 Processing of beverages: Specialty beverages, Tea, coffee

Unit IV

7 Processing of Beverages: cocoa, spices and plant extracts

8 FSSAI specifications for different Beverages

Unit V

9 Miscellaneous/Traditional beverages: Coconut water, sweet toddy and Sugar cane juice

10 Manufacturing and packagingprocesses and equipment for different beverages

Unit VI

11 Water treatment and quality of process water

12 Ingredients used in beverage making

Unit VII

13 Additives: Sweeteners, colorants, acidulants, Clouding and clarifying agents

14 Flavouring agents for beverages, Carbon dioxide and carbonation

Unit VIII

15 Quality tests and control in beverages

16 Processing of flavoured syrups

Practical

No.	Practical outline
1	Quality analysis of raw water-Physical, Chemical & Microbiological
2	Determination of density and viscosity of beverages
3	Determination of coloursin soft drinks by Wool technique/Paper chromatography
4	Preparation of iced tea
5	Preparation of low calorie beverages
6	Preparation of carbonated beverages
7	Preparation of non-carbonated beverages
8	Determination of caffeine in beverages
9	Determination of brix value and gas content of beverages
10	Determination of pH and acidity of beverages
11	Quality analysis of tea
12	Quality analysis of coffee
13	Preparation of traditional beverages-coconut milk
14	Visit to packaged water plant
15	Visit to carbonation unit
16	Practical examination

References

1. Ashurst, P.R. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd edn. Blackwell Publishing Ltd., Oxford, UK.
2. Woodroof JG and Phillips GF.1974. Beverages: Carbonated and Non Carbonated. AVI Publishing Co., Westport, Conn.
3. Eblinger, H.M. 2009. Handbook of Brewing: Processes, Technology, Markets. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim. Germany.
4. Wilson, T., & Temple, N. J. (Eds.). (2016). Beverage impacts on health and nutrition. New York, NY, USA,Humana Press.
5. Joshi, V.K. and Pandey, A. 1999. Biotechnology: Food Fermentation – Microbiology, Biochemistry and Technology, Vol. II. Educational Publishers and Distributors, New Delhi.
6. Varnam, A.H. and Sutherland, J.P. 1994. Beverages: Technology, Chemistry and Microbiology. Chapman, London, UK
7. Steen, D., and Ashurst, P. R. (Eds.). (2008). Carbonated soft drinks: formulation and manufacture. John Wiley & Sons.

FDPT 316 Processing Technology of Legumes and Oilseeds 3(2+1)

Objectives

1. Understand the nutritional value and composition of legumes and oil seeds
2. Gain knowledge about milling of pulse and oil seeds

Course Outlines

Theory

Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti- nutritional compounds; Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency; Factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes; Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines. Milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; Desolventization; Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, winterization and their principles and process controls; Hydrogenation of oils; New technologies in oilseed processing; Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.

Practical

Determination of physical properties of legumes and oil seeds; Determination of proximate composition of selected pulses and oilseeds; Determination of nutritional quality of selected pulses and oilseeds; Study of mini dhal mill; Study of mini oil mill; Preconditioning of pulses before of mini oil mill; Preconditioning of pulses before milling; Preconditioning of oilseeds before milling; Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation; Laboratory milling of selected oilseeds and its quality evaluation; Laboratory refining of selected oils; Laboratory hydrogenation of selected oils; Study of cooking quality of dhal; Processing of composite legume mix and preparation of value added products; Visit to commercial dhal mills and oil mills.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Present status and future prospects of legumes and oilseeds – Current trends, productivity, imports and exports, TMOP and other schemes
2	Morphology of legumes and oilseeds – anatomy of grain legume and oilseed
3	Classification and types of legumes and oilseeds- taxonomic details
4	Chemical composition and nutritional value of legumes and oilseeds

Unit II

5 Anti-nutritional compounds in legumes – Enzyme inhibitors, lectins, phenol compounds, flatulence factors, glycosides

6 Anti-nutritional compounds in oilseeds – Aflatoxins, ochratoxins, allergens, inhibitors

7 Methods of removal of anti- nutritional compounds – Soaking, moist heat cooking, dry heat cooking, fermentation, hydrothermal treatments

8 Pulse milling – Post harvest, Pretreatments (Dry, wet, chemical and enzymatic), dehulling and splitting

Unit III

9 Pulse milling: Home scale – Saddle quern. Mortar pestle, chakki (hand driven and animal harnessed)

10 Pulse milling: Cottage scale – Plate mills, hullers, under runner disc shellers

11 Pulse milling: Commercial scale – Emery rollers, Composite units (CFTRI- Modern, mini dhal dhal and hand operated), Tangential abrasive disc dehuller

12 Determination of Milling quality and milling efficiency

Unit IV

13 Factors affecting milling quality and quantity – seed characteristics, pretreatments and milling equipment

14 Problems in dhal milling industry – processing constraints and others

15 Nutritional changes during soaking and sprouting of pulses

16 Cooking quality of dhal – factors effecting – cell wall orientation, cooking methods, addition of salts and alkalies

Unit V

17 Quick cooking dhal, instant dhal

18 Soybean milk processing and value addition – Soy milk, tofu, sauce, tempeh, natto and miso

19 Texturized Vegetable Protein (TVP) - Extrusion

20 Fermented products of legumes – idli, dosa, dhokla, khaman, dawadawa, iru, ugba, badies

Unit VI

21 Oil seed milling: Sources, characteristics of oils (physical and chemical) and utilization

22 Oil seed milling: Post harvest – drying, grading, cleaning, dehulling, size reduction, flaking etc.

23 Oil seed milling: Ghanis, hydraulic presses and expellers

24 Oil seed milling: Mechanical screw press and extrusion

Unit VII

25 Solvent extraction principle and extractor – batch, continuous type

26 Extraction of oils from groundnuts, rapeseed/mustard, safflower, sunflower and sesame

27 Extraction of oils from rice bran, palm fruit, coconut and cotton seed

28 Milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry

Unit VIII

29 Desolventization: Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, winterization and their principles and process controls

30 Hydrogenation of oils; New technologies in oilseed processing (Super critical Fluid Extraction and Membrane processing)

31 Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates

32 By-products of pulse and oil milling and their value addition- hulls, cotyledon fibres, bioactive compounds extraction

Practical

No.	Practical Outline
1	Determination of physical properties of legumes and oil seeds
2	Determination of proximate composition and nutritional quality of selected pulses and oilseeds
3	Study of mini dhal mill
4	Study of mini oil mill
5	Study on preconditioning of pulses/oilseeds before milling
6	Removal of anti-nutritional compounds from selected pulses and oilseeds
7	Laboratory milling of selected pulses and its quality evaluation
8	Laboratory milling of selected pulses and determining efficiency
9	Laboratory milling of selected oilseeds (oil extraction) and its quality evaluation
10	Laboratory refining of selected oils
11	Laboratory hydrogenation of selected oils
12	Study of cooking quality of dhal
13	Processing of composite legume mix and preparation of value added products
14	Visit to commercial dhal mills
15	Visit to commercial oil mills
16	Practical examination

References

1. Chakraverty, A. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA

3. Gunstone, F.D. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.
4. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
5. Shahidi, F. 2005. Bailey's Industrial Oil and Fat Products, 6th edn., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA

FDPT 317 Processing of Meat, Fish and Poultry Products 3(2+1)

Objectives

1. Understand types of meat and the unit operations in meat, fish and poultry processing
2. Gain knowledge about various methods of preservation of meat, fish, poultry and their products.

Course Outlines

Theory

Status of meat poultry and fish industry in India; Sources and importance of meat, poultry and fish. Structure and composition of muscle, types, classification and composition of fish, Pre- slaughter operations and slaughtering operations for animals and poultry. Dressing and evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat. Preservation of meat, poultry and fish by chilling, freezing, pickling, curing, cooking and smoking, canning, dehydration, radiation, chemical and biological preservatives. Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for- meat, poultry and fish, Meat tenderization; Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH); Meat quality parameters - color water holding capacity, palatability, marbling quantum of connective tissue, firmness and storage conditions; Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation; Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation; Surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products; Problems on mass balancing of ingredients in formulation of value added meat products; Abattoir design and layout; Preservation of fresh fish, characteristic of fresh fish and fermented and value added products of fish; Spoilage indices of fish and factors affecting the spoilage of fish; Eggs: Structure, composition, quality characteristics, defects and grading of egg processing, preservation of eggs; Processing and preservation of poultry meat and chicken patties, Preparation protocols of indigenous products: Fish sauce and paste; By-products of meat, poultry, fish and eggs and their utilization; Safety standards in meat/ fish industry: HACCP/ISO/MFPO/ FSSAI/ Kosher/Halal, EU hygienic regulations and ISO 9000 standards.

Practical

Pre-slaughter operations of meat animals and poultry birds; Slaughtering and dressing of meat animals; Study of post-mortem changes; Meat cutting and handling; Preservation of meat by freezing; Preservation of meat by curing and pickling; Preservation of meat by dehydration; Evaluation of quality and grading of eggs; Preservation of shell eggs; Preparation of value added poultry meat products; Value added egg products; Visit to abattoir. Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products; Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process; Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA; Determination of iodine value; Visit to fish and prawn processing industry.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Status of meat poultry and fish industry in India; Sources and importance of meat, poultry and fish.
2	Structure and composition of muscle, types, classification and composition of fish
3	Pre- slaughter operations and slaughtering operations for animals and poultry.
4	Dressing and evaluation of animal carcasses.
Unit II	
5	Factors affecting post-mortem changes, properties and shelf life of meat.
6	Mechanical deboning, grading and aging.
7	Eating and cooking quality of meat.
8	Preservation of meat, poultry and fish by chilling, freezing, pickling, curing, cooking.
Unit III	
9	Preservation of meat, poultry and fish by smoking, canning, dehydration, radiation, chemical and biological preservatives.
10	Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for- meat, poultry and fish.
11	Meat tenderization; Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH).
12	Meat quality parameters – color water holding capacity, palatability, marbling quantum of connective tissue, firmness and storage conditions.

Unit IV

13 Meat cutting and handling.

14 Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation.

15 Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation.

16 Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation.

Unit V

17 Surimi process, traditional and modern surimi production lines.

18 Quality of surimi products, comparison of surimi and fish mince products.

19 Problems on mass balancing of ingredients in formulation of value added meat products.

20 Abattoir design and layout.

Unit VI

21 Preservation of fresh fish.

22 Characteristic of fresh fish and fermented and value added products of fish.

23 Spoilage indices of fish and factors affecting the spoilage of fish.

24 Eggs: Structure, composition.

Unit VII

25 Eggs: quality characteristics.

26 Defects and grading of egg processing,

27 Preservation of eggs.

28 Processing and preservation of poultry meat and chicken patties.

Unit VIII

29 Preparation protocols of indigenous products: Fish sauce and paste.

30 By-products of meat, poultry, fish and eggs and their utilization.

31 Safety standards in meat/ fish industry: HACCP/ISO/MFPO/ FSSAI/ Kosher/Halal.

32 EU hygienic regulations and ISO 9000 standards.

Practical

No.	Practical Outline
1	Pre-slaughter operations of meat animals and poultry birds.
2	Slaughtering and dressing of meat animals.
3	Study of post-mortem changes. Meat cutting and handling.
4	Preservation of meat by freezing; Preservation of meat by curing and pickling; Preservation of meat by dehydration.
5	Evaluation of quality and grading of eggs. Preservation of shell eggs.
6	Preparation of value added poultry meat products; Value added egg products.

7 Visit to abattoir.

8 Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products.

9 Identification of different types of fish - Selection and grading.

10 Identification of different types of prawn and other marine products.

11 Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish.

12 Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products.

13 Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process.

14 Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products.

15 Estimation of TVB and TMA; Determination of iodine value.

16 Visit to fish and prawn processing industry.

References

1. Berkel, B. M.V., Boogaard, B.V.D and Heijnen, C. 2004. Preservation of Fish and Meat. Agromisa Foundation, Wageningen.
2. Borstorm, G. 1961. Fish as Food - Vol. I, II, III and IV. Academic Press, New York
3. FAO. 2003. Code of Practices of Canned Fishery products. FAO, UN, Rome.
4. Hall, G.M. 1997. Fish Processing Technology, 2nd edn. Chapman and Hall, London, UK.
5. Kerry, J., Kerry, J. and Ledward, D. 2005. Meat Processing-Improvin Quality. Woodhead Publishing Ltd., Cambridge, England.
6. Lawrie, R.A. 1985. Meat Science, 4th edn. Pergamon Press, Oxford, UK.
7. Nanda, Vikas 2014. Meat, Egg and Poultry Science and Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.
8. Rautenstrauss, B.W. and Liehr, T. 2002. Fish Technology. Springer- Verlag, US.
9. Sen, D.P. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.
10. Sharma, B.D. and Sharma, K. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
11. Sharma, B.D. 2003. Modern Abattoir Practices and Animal ByproductsTechnology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
12. Stadelman, W.J. and Cotterill, O.J. 1995. Egg Science and Technology, 4th edn. Food Products Press, NY, USA.
13. Swatland, H.J. 2004. Meat Cuts and Muscle Foods, 2nd edn. Nottingham Univ. Press, Nottingham.

14. Toldrá, F., Hui, Y. H., Astiasarán, I., Nip, W.-K., Sebranek, J.G, Silveira,E.T.F., Stahnke, L.H., and Talon, R. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.
15. Varnam, A.H. and Sutherland, J.P. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman and Hall, London.

FDPT 318 Bakery, Confectionery and Snack Products 3 (2+1)

Objectives

1. To learn the processing, packaging, storage of bakery and confectionary products.
2. To understand extrusion technology and its application in production of breakfast cereals and snacks

Course Outlines

Theory

Bakery products-Types (leavened and unleavened), specifications, compositions and ingredients (flour, sugar, fat, shortening, leavening agent etc.); Formulations, processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depinning etc.), equipment, packaging, storage and quality testing of bakery products. Processing technology of bread, biscuits and cakes. Classification of biscuits and manufacturing process of crackers; Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations; Hard boiled candies, pan coating, toffees and caramels, chewing gum and sugar free confections; Processing of chocolate – types cocoa beans and processing, other ingredients, mixing refining, conching, storage and packaging. Processing, equipment, packaging, storage and quality testing of confectionery and chocolate products. Product quality characteristics; Defects, causes and corrective measures.

Extrusion technology and applications in food processing; Snack foods: Types, specifications, compositions, ingredients, Formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings. Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients; Formulations, processing, equipment for breakfast cereals, macaroni and malts; Packaging, storage and quality testing for breakfast cereals, macaroni and malts. Cooked corn products – tortilla chips; Modified starches for snack foods; Oils and industrial frying. Preservatives used in Bakery, Confectionery and snack products preservation; Quality testing of Bakery, Confectionery and snack products.

Practical

Identifications and composition of various ingredients for snacks, bakery and confectionery products; Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items; preparation, packaging and quality evaluation of selected bakery items; preparation, packaging and quality evaluation of selected confectionery items; preparation, packaging and quality evaluation of selected chocolates;

Preparation of traditional Indian confection. Visit to bakery, confectionary and snack units (industry).

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Bakery products – History, present trends, nutritional facts
2	Bakery products: Types (leavened and unleavened) biscuits, crackers, breads, cakes, pastries
3	Bakery products specifications– Indian and International specifications
4	Bakery product compositions and ingredients – flour, sugar, yeast and milk
Unit II	
5	Bakery product compositions and ingredients – leavening agents, colors, setting material and flavors
6	Formulations and processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), of bakery product: biscuits – crackers, soda crackers cookies and equipment and its packaging
7	Formulations and processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), of bakery product: cakes – methods in cake making, types of cakes and equipment and its packaging
8	Formulations and processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), of bakery product: breads – methods of bread making and equipment and its packaging
Unit III	
9	Packaging and storage of bakery products – materials used for packaging and storage conditions
10	Quality testing of bakery product: physical, chemical and microbial qualities of bakery products
11	Confectionery and chocolate products – history, types and present trends
12	Confectionery and chocolate products specifications – Indian and International specifications
Unit IV	
13	Confectionery and chocolate products: compositions and ingredients used in confectionery– sugars, syrups and aerating agents
14	Confectionery and chocolate products: compositions and ingredients used in confectionery– confectionery fats, gelatinizing agents, starches, flavors and colors
15	Formulations and processing of traditional confectionery and hard-boiled candies

16 Formulations and processing of pan coating, toffees and caramels, chewing gum and sugar free confections

Unit V

17 Compositions, ingredients, formulations; Hard boiled candies, pan coating, toffees and caramels, chewing gum

18 Processing of chocolate – types of cocoa beans and processing and other ingredients used

19 Formulations and processing of chocolates – dark and white chocolate processing mixing, refining, conching, storage and packaging

20 Equipment used in chocolate and confectionery manufacturing

Unit VI

21 Packaging and storage of confectionery products – materials used for packaging, storage conditions

22 Quality testing of confectionery and chocolate products – physical, chemical and microbial qualities of confectionery products

23 Product quality characteristics, defects, causes and corrective measures of confectionery products

24 Extrusion technology and applications in food processing

Unit VII

25 Snack foods: Types, specifications, compositions, ingredients, Formulations a snack food seasoning

26 Snack foods: Equipment, packaging, storage and quality testing

27 Breakfast cereals: macaroni products and malts: Specifications, compositions and ingredients

28 Breakfast cereals: Formulations, processing, equipment for breakfast cereals, macaroni and malts

Unit VIII

29 Breakfast cereals: Packaging, storage and quality testing for breakfast cereals, macaroni and malts.

30 Cooked corn products – tortilla chips; Modified starches for snack foods; Oils used and industrial frying.

31 Packaging and storage of breakfast cereals, quality testing of breakfast cereals – product quality, physical, chemical and microbial

32 Preservatives used in Bakery, Confectionery and snack products for preservation

Practical

No.	Practical Outline
1	Identification and composition of various ingredients for snacks
2	Identification and composition of various ingredients for bakery

3 Identification and composition of various ingredients for confectionery
4 Flours, classifications and characterization I
5 Flours, classifications and characterization II
6 Processing technology and packaging of selected snack items
7 Quality evaluation of selected snack items
8 Processing technology and packaging of selected bakery items
9 Quality evaluation of selected bakery items
10 Processing technology and packaging of selected confectionery items
11 Quality evaluation of selected confectionery items
12 Processing technology and packaging of selected chocolate items
13 Quality evaluation of selected chocolate items
14 Processing technology of traditional Indian confectionery
15 Visit to bakery/confectionery/snack units (Industry)
16 Practical Examination

References

1. Amendola, J. and Rees, N. 2003. Understanding Baking: The Art and Science of Baking. 3rdedn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
2. Corke, H., Leyn, I.D., Cross, N.A. Nip, W.K., and Hui, Y.H. 2006. Bakery Products: Science and Technology. Blackwell Publishing Ltd., Oxford, UK.
3. Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd edn. Woodhead Publishing Limited, Cambridge, England.
4. Grewling, P.P. 2013. Chocolates and Confections, 2nd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Hui, Y.H. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
6. Jackson, E.B. 1995. Sugar Confectionery Manufacture, 2nd edn. Springer-Verlag, US.
7. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4thedn. Elsevier Science Ltd., Oxford, UK.
8. Kingslee, J. J. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.
9. Matz, S.A. 1976. Snack Food Technology, 2ndedn. AVI Publishing Co., Inc., Westport, Connecticut, USA.
10. Minife, B.W. 1989. Chocolate, Cocoa, and Confectionary – Science and Technology, 3rdedn. Chapman and Hall, Inc., New York, USA.
11. Pyler, E.J. and Gorton, L.A. 2009. Baking Science and Technology, Vol. II: Formulation and Production, 4th edn. Sosland Publishing Company, Kans City, MO, USA
12. Pyler, E.J. and Gorton, L.A. 2008. Baking Science and Technology, Vol. I: Fundamentals and Ingredients, 4thedn. Sosland Publishing Company, Kansas, City, MO, USA.

FDPT 319 Processing Technology of Liquid Milk 2 (1+1)

Objectives

1. Understand different steps of milk processing
2. Gain knowledge about different types of milk and their process

Course Outlines

Theory

Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavored milk. Effect of thermal treatment on milk constituents. Fermented milk, acidophilous milk, etc.; Effect of thermal treatment on milk constituents; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio chemical changes occurring during manufacture of fermented milks; Factors affecting classification, manufacture of different types of cream, processing of cream; Adulterations in milk and its detection; Quality defects in milk - causes and prevention. Liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk chilling units, milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.; Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.

Practical

Platform tests of raw milk (clot on boiling (COB) test, alcohol test); Determination of physical properties of milk; Determination of proximate composition and biochemical properties of milk; Determination of microbiological properties of milk; Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings; Preparing standardized milk as per requirement; Separation of fat from milk; Pasteurization and homogenization of milk; Packaging of liquid milk; Preparation of curd and yogurt, Visit to chilling centre and dairy plant.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Historical development of dairy in India, Production and utilization of milk and statistics of Indian milk production

2 Composition of different cattle milk and properties of milk and colustrum. Physical, Chemical and Thermal

Unit II

3 Liquid milk collection, preservation, processing, packaging and storage

4 Types of Milk-standardized milk, skim milk, sterilized milk, reconstituted milk, recombined milk, flavoured milk, fermented milk, acidophilous milk and other kinds prevailing in market

Unit III

5 Effect of thermal treatment on milk constituents

6 Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk

Unit IV

7 Biochemical changes occurring during manufacture of fermented milks

8 Cream: manufacture of different types of cream, processing of cream

Unit V

9 Adulterations in milk and its detection

10 Quality defects in milk - causes and prevention

Unit VI

11 Liquid milk collection, processing, packaging and storage systems

12 Bulk milk coolers, milk chilling units,

Unit VII

13 Milk reception equipment, pasteurizers and sterilizers

14 Centrifuges, clarifiers and filtration units

Unit VIII

15 Homogenizers, packaging and filling machines and CIP units

16 Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control

Practical

No.	Practical Outline
1	Platform tests of raw milk: Clot on boiling (COB) test, alcohol test of raw milk
2	Determination of physical properties of milk-specific gravity and viscosity
3	Determination of proximate composition and biochemical properties of milk
4	Determination of proximate composition and biochemical properties of milk
5	Determination of microbiological properties of milk
6	Determination of microbiological properties of milk
7	Visit to milk chilling centre
8	Detection of adulterants in milk
9	Demonstration of liquid milk processing equipment, pipes and fittings
10	Preparation of standardized milk as per requirement

11 Separation of fat from milk
12 Pasteurization and homogenization of milk
13 Packaging techniques of liquid milk
14 Preparation of curd and yogurt
15 Visit to dairy plant
16 Practical Examination

References

1. De, S. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
2. Hui, Y.H. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
3. Kanekanian, A. 2014. Milk and Dairy Products as Functional Foods. John Wiley and Sons, Ltd., UK.
4. Kessler, H.G. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R.Germany).
5. Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
6. Tamime, A. Y. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
7. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology, 2nd edn. CRC Press, Boca Raton, FL, USA.

FDPT 411 Processing Technology of Dairy Products 3 (2+1)

Objectives

1. To learn the processing of dairy products viz. cream, butter, ghee, ice-cream etc.
2. To gain knowledge of traditional dairy products and their processing.
3. To understand the defects and causes of different dairy products.
4. To acquire the knowledge related quality parameters in dairy products.

Course Outlines

Theory

Cream: Basic aspect, Classification, manufacture of different types of cream, processing of cream; Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter defects, causes and their prevention, packaging and storage; Butter oil and ghee: Definition, composition, processing, equipment, quality tests; Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage. Ice cream and frozen desserts: Definition, composition, types, Processing steps and flow diagram, equipment, quality testing,

defects cause and prevention, packaging and storage. Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk. Manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage. Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.

Practical

Preparation of Butter/ Table butter, Preparation of ghee, Preparation of paneer; Preparation of selected type of cheese; Preparation of ice-cream and selected frozen desserts; Preparation of condensed milk; Preparation of spray dried milk powder; Preparation of selected Indian dairy products; Shrikhand, mawa/khoa based products halwa/ kheer etc., Determination of selected quality parameters of selected dairy products; Visit to dairy plant

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Introduction to Dairy Products-Classification-Cream-Definition- Basic aspects - classification- manufacture of different types of cream and processing of cream
2	Butter: Definition, composition; processing and production steps.
3	Overrun, Butter making process and Equipment
4	Quality testing of Table butter- its defects- causes and their prevention- packaging and storage
Unit II	
5	Butter oil-Definition- composition-processing-equipment-quality tests
6	Ghee - Definition- composition-processing-equipment-quality tests
7	Paneer-Definition, composition, types, processing steps, process flow diagram, equipment, quality defects- causes and prevention, packaging and storage
8	Cheese- Definition, composition, types, processing steps, process flow diagram, equipment
Unit III	
9	Cottage cheese- composition-, processing steps, process flow diagram, equipment, quality defects- causes and prevention, packaging and storage
10	Cheddar cheese- composition- processing steps, process flow diagram, equipment, quality defects- causes and prevention, packaging and storage
11	Ice cream and frozen desserts: Definition, composition, types, Processing steps and flow diagram,
12	Ice cream processing equipment-Continuous freezer & hardening tunnels

Unit IV

13 Over run, quality testing, defects causes and prevention, packaging and storage.

14 Condensed milk- Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk,

15 Dried milk- - Definition, composition, role of milk constituents and manufacture of dried milk,

16 Types of standards for dried milk, manufacture of SMP and WMP using roller drying processing, packaging, storage, equipment and quality testing

Unit V

17 Spray drying-principle-Operational parameters

18 Spray drying of SMP, WHP and instantization

19 Recent developments in drying, quality testing, defects, causes and prevention, packaging and storage

20 Traditional Indian Dairy Products: Definition, History and developments in traditional dairy products

Unit VI

21 Classification of Traditional Indian dairy Products

22 Manufacture of Chhana- Processing, Packaging, storage, equipment and quality testing

23 Manufacture of Khoa- Processing, Packaging, storage, equipment and quality testing

24 Manufacture of Shrikhand- Processing, Packaging, storage, equipment and quality testing

Unit VII

25 Manufacture of Indian dairy sweets-Kheer, Malai laddu and Rabri,

26 Manufacture of Frozen dairy products-Kulfi and Milk ice

27 Manufacture of Chhana based sweets-Sandesh, Rasogolla and Rasmalai

28 Manufacture of Khoa based sweets-Kalakhand, Kaju katli and Gulab jamun

Unit VIII

29 By-products of dairy industry and their utilization-definition-classification composition-principle and methods of utilization

30 Manufacturing of by-products such as Industrial and edible casein-defects and use

31 Utilization of whey and its products, manufacture of whey protein concentrates and whey powder

32 Manufacturing of lactose, flow diagram and uses

Practical

No.	Practical Outline
1	Preparation of Butter/ Table butter
2	Preparation of Ghee

3 Preparation of Paneer
4 Preparation of Cottage/Soft cheese
5 Ice-cream mix calculations
6 Preparation of ice-cream
7 Preparation of condensed milk
8 Preparation of spray dried milk powder
9 Preparation of Rasogolla and Gulab jamun
10 Preparation of Sandesh
11 Preparation of Khoa
12 Preparation of Kalakhand
13 Preparation of Spray dried milk powder
14 Determination of selected quality parameters of selected dairy products
15 Visit to Dairy plant and enumeration of selected dairy products and specifications
16 Practical Examination

References

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. 2002. Technology of Indian Milk Products: Handbook of Process Technology Modernization for Professionals, Entrepreneurs and Scientists, Dairy India Yearbook.
2. De, S. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
3. Kanekanian, A. 2014. Milk and Dairy Products as Functional Foods. John Wiley and Sons, Ltd., UK.
4. Kessler, H.G. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising, F.R. Germany.
5. Hui, Y.H. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. WileyVCH, USA.
6. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology, 2nd edn. CRC Press, Boca Raton, FL, USA.
7. Tamime, A. Y. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.

DEPARTMENT OF FOOD PROCESS ENGINEERING

FDPE 121 Workshop Technology 3(1+2)

Objectives

1. The subject aims at imparting knowledge and skill components in the field of basic workshop technology.
2. It deals with different hand and machine tools required for manufacturing simple metal components and article.

Course Outlines

Theory

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications. Safety measures in workshop; Indian Factory Acts on safety; Measuring and Gauging: Basic measuring instruments and gauges. Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc. Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipment; Gas welding and cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost. Smithy and forging: Introduction to different tools and their uses, different forging operations. Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc. Machinery: Introduction to various workshop machines (1) Lathe, (2) Power hacksaw, (3) Shaper and planner, (4) Drilling, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for shaping, slotting and planning operations, work holding and tool holding devices. Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

Practical

Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipment, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration

of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

Lecture outlines

Theory

No. Lecture Outline

Unit I

1 Introduction to workshop, safety measures in workshop; Indian Factory Acts on1923, 1948 and 1858 safety

2 Introduction to basic materials; ferrous and non-ferrous materials; timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials; their properties and applications

Unit II

3 Heat treatment processes-hardening, tempering, annealing, normalizing and case hardening

4 Introduction to carpentry tools; type of woods and their characteristics; classification of saws, chisels, gauging tools and planes

Unit III

5 Introduction and classification of simple tools used in fitting shop; swage block, anvil, Surface Plate, Tongs

6 Welding-types of welding, types of electrodes, flux and usage, arc welding- types of welding joints, edge preparation, welding techniques and equipment

Unit IV

7 Gas welding and gas cutting, types of flame, introduction to soldering and brazing and application

8 Estimation of welding and soldering cost on prevailing market price with suitable examples

Unit V

9 Smithing and forging- Introduction to different tools of smithy and forging and their uses and Introduction to mechanized tools

10 Introduction to different forging operations, defects of forging. Introduction to power hacksaw

Unit VI

11 Introduction to lathe machine. Its components and different operations performed in lathe machine

12 Introduction to threading; tapping; sequence in tapping and dieing and measurements of threads

Unit VII

13 Introduction to drilling machine; components; adjustment in measurements. Introduction to milling and grinding machine; components; adjustment and measurements

14 Introduction to planer and shaper- length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances and usage of CNC in workshop machines

Unit VIII

15 Estimation of machining time for casting, shaping, slotting and planning operations on prevailing market price. Introduction to work holding and tool holding devices

16 Introduction to metal sheets of different operations, sheet metal joints; allowances for sheet metal, operations and joints, estimation of cost

Practical

No.	**Practical Outline**
1	Identification of different materials of manufacture
2	Demonstration of different measuring instruments and measuring technique
3	Demonstration of various hand tools; Demonstration of various power tools and machine tools
4	Demonstration of different tools of carpentry and study of specifications
5	Practice on carpentry -T- joints
6	Practice on carpentry- Mortise and Tenon joints
7	Demonstration of different tools of fitting shop and study of specifications
8	Practice on metal-Square Filling
9	Practice on metal-V-Fitting
10	Demonstration of different tools of metal sheet work and study of specifications
11	Practice on metal sheet work -Square Tin
12	Practice on metal sheet work -Circular Tin
13	Demonstration of casting various casting processes and equipment, tolls and their applications
14	Exercises on mould making using one-piece pattern
15	Exercises on mould making using two-piece pattern
16	Demonstration of arc welding, precaution and study of specifications
17	Practice on arc welding -Single V-Butt Joint
18	Practice on arc welding- Single Corner Joint
19	Demonstration of gas welding, precaution and study of specifications
20	Practice on gas welding of metal joint
21	Practice on gas welding of metal joint
22	Demonstration of drilling machine and operational setup for predefined measurement

23 Demonstration of planer and operational setup for predefined measurement
24 Demonstration of shaper and operational setup for predefined measurement
25 Demonstration of slotter and operational setup for predefined measurement
26 Introduction to smithy and forging tools and simple piece works on metal job
27 Demonstration of lathe machine and introduction to parts of lathe machine
28 Simple exercise on cutting and threading
29 Simple exercise on cutting and threading
30 Simple exercise on Step turning and taper turning
31 Introduction to CNC machine and operational demonstration
32 Practical Examination

References

1. Chapman, W. A. J. 1989. Workshop Technology, Parts I and II. Arnold Publishers (India) Pvt. Ltd., New Delhi
2. Hazra Choudhary, S. K. and Bose, S. K. 1982. Elements of Workshop Technology, Vols. I and II. Media Promoters and Publishers Pvt. Ltd., Mumbai.
3. Raghuwamsi, B. S. 1996. A Course in Workshop Technology, Vols. I and II. Dhanpet Rai & Sons, New Delhi.

FDPE 122 Basic Electrical Engineering 3(2+1)

Objectives

1. Differentiate between single and three phase connection.
2. Have an idea of the basic measuring electrical current and its quality.
3. Knowledge about application of wiring and connections.

Course outlines

Theory

AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, Magnetic circuits, composite magnetic circuits, magnetic leakage, hysteresis and eddy currents, phase relations and vector representation, AC through resistance, inductance and capacitance, AC series and parallel circuits, Simple R-L, R-C and R-L-C circuits; Engineering Circuit Analysis: Current, Voltage, Power, Circuit elements, Ohm's law. 3 Phase Systems: Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement. Transformer: Principle of working, construction of single-phase transformer, core type, shell type transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under

load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test. Single phase induction motor: Double field revolving theory, characteristics, phase split, shaded pole motors. Poly phase induction motor: Construction, operation, equivalent circuit, production of rotating field, effect of rotor resistance, torque equation, starting and speed control methods. Alternators: Principle of operation, types of rotors, EMF equation. D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics. D.C. Motors, their starting, speed controls and characteristics. Electric Power Economics: Maximum demand charge, Load factor, Power factor and power factor improvement. Measuring Equipment's: Classification, Characteristics of different electrical measuring systems and equipment's. Electrical Wiring: system of wiring, domestic wiring installation, industrial electrification. Protection devices: Earthing, Circuit protection devices, fuses, ELCB and relays.

Practical

Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Problems on Industrial Electrification. Study of various circuit protection devices. Study of various measuring instruments.

Lecture outlines

Theory

No. Lecture Outline

Unit I

1 A.C Fundamentals: - Definition of cycle, frequency, time period, amplitude, average value, RMS value, peak value

2 A.C. through resistance, inductance, capacitance, series R-L circuit and R-C circuit

3 Series RLC circuit and parallel circuit with phasor method

4 Electro motive force, magneto motive force, reluctance, magnetic circuit, composite magnetic circuit, magnetic hysteresis, area of hysteresis loop, eddy currents.

Unit II

5 Phase relation and vector representations: - Introduction, phasor diagram for AC currents, phasor diagram for similar AC quantities, different AC quantities, concept of

leading and lagging, addition and subtraction of alternating quantities, parallelogram method.

6 Engineering circuit analysis: - Measurement of voltage, current, power, in a circuit, resistance inductance, capacitance as circuit elements ohms law applied to a circuit.

7 3 Phase systems: - Relation between line voltage and phase voltage, line current and phase current in star and delta connected systems with phasor diagram.

8 Measurement of single- phase power using induction watt meter, measurement of three phase power using single watt meter.

Unit III

9 Measurement of three phase power using three-watt meter method and two-watt meter method.

10 Transformer: - working principle and construction of single-phase transformer, EMF Equation of transformer.

11 Ideal transformer characteristics and phasor diagram, transformer on no load and transformer under load.

12 Transformer losses, efficiency, regulation, open circuit test, short circuit test.

Unit IV

13 Magnetic leakage, core type, shell type transformer and difference between core and shell type transformer.

14 DC generator: - working principle, construction, field system, armature, commutator, other accessories.

15 DC armature winding, lap winding, wave winding, terms used in armature winding.

16 EMF equation of DC generator, armature reaction, demagnetizing and cross magnetizing ampere turn.

Unit V

17 Methods of compensating armature reactions, commutation, resistance commutation, emf commutation.

18 Characteristics of DC generator: - Separately exited, shunt, series, compound generator

19 DC motor: - working principle, value of back emf, voltage equation, torque equation of DC motor, armature torque, shaft torque.

20 Types of DC motor: - separately exited, shunt, series, compound motor, starting of DC motor.

Unit VI

21 Speed control of DC motor: - voltage control, armature control, field control of series motor, armature control, field control of shunt motor.

22 Single phase induction motor, double field revolving theory.

23 Phase split, shaded pole motors.

24 Poly phase induction motor: - Principle of operation, production of rotating magnetic field.

Unit VII

25 Torque equation, equivalent circuit, squirrel cage rotor, phase wound rotor.

26 Effect of rotor resistance, slip, speed control of induction motors.

27 Starting of induction motors: - DOL starter, auto transformer starter, star delta starter.

28 AC generator: - principle of operation, construction, salient pole type rotor.

UnitVIII

29 Smooth cylindrical type rotor, emf equation

30 Electric power economics: - Maximum demand charge, load factor, power factor and power factor improvement.

31 Electrical wiring: system of wiring, domestic wiring installation, industrial electrification.

32 Protection devices: - Earthing, circuit protection devices: - fuses, ELCB and relays.

Practical

No.	Practical Outline
1	Study of voltage resonance in L.C.R circuits at constant frequency
2	Study of voltage and current relation of Star and Delta connections
3	Measurement of power in 3-phase circuits for balance loads and unbalanced loads by wattmeter and energy meter.
4	Polarity test, No load test, efficiency and regulation test of single phase
5	To study the construction details of the DC machine and to draw sketches of different components
6	Starting of induction motor by D.O.L starters
7	Starting of induction motor by Manual star-delta.
8	Starting of induction motor by Manual auto-transformer.
9	Starting of induction motor by Automatic star-delta starter
10	Starting of slip-ring induction motor by normal and automatic rotor starters.
11	Test if 3-phase induction motor, determination of efficiency, speed.
12	Determination of power factor, slip, line current at various outputs of 3-phase induction motor
13	To determine the relation between the induced armature voltage and speed of separately exited DC generator
14	Magnetization characteristics of DC generator.
15	Study the starter connection and starting, reversing and adjusting speed of a DC motor
16	Study of various measuring instruments.

References

1. Theraja, B.L. and Theraja, A.K. 2005. A Textbook of Electrical Technology. Vol. II. S. Chand and Company Ltd., New Delhi.

2. Toro, V.D. 2000. Electrical Engineering Fundamentals. Prentice-Hall India Private Ltd., New Delhi.

FDPE 123 Post-Harvest Engineering 3 (2+1)

Objectives

1. To understand the basic post-harvest operations.
2. Gain an understanding of various engineering properties.
3. To differentiate between different types of material handling systems.

Course Outlines

Theory

Overview of Post-Harvest Technology, Concept and science, Introduction to different agricultural crops, their cropping pattern, production, harvesting and post-harvest losses, reasons for losses, importance of loss reduction; Post-Harvest Handling operations; Water Activity; Water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture; Engineering Properties of Food Materials; physical, thermal, aerodynamic, optical, mechanical, rheological and electromagnetic properties and their measurement; Cleaning; Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling, Sorting, grading, methods of grading; Grading Size grading, color grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance; Magnetic separator, destoners, electrostatic separators, pneumatic separator; Decorticating and Shelling; Principles of working, design and constructional details, operating parameters, maintenance, of various decorticators/ dehullers/shellers, description of groundnut decorticators, maize shellers etc; Milling, polishing, grinding, milling equipment, de-huskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement; Materials Handling; Introduction to different conveying equipment used for handling of grains; Scope and importance of material handling devices; Study of different Material Handling systems; Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement; Pneumatic conveying system: types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Practical

Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/ sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Overview of Post-Harvest Technology, Concept and science, Introduction to different agricultural crops, their cropping pattern, production
2	Harvesting and post-harvest losses, reasons for losses, importance of engineering approach in reduction of post-harvest losses
3	Water Activity; Water binding and its effect on enzymatic and non-enzymatic reactions, food texture. Control of water activity and moisture by various processing principles.
4	Engineering Properties of Food Materials - physical, thermal, mechanical, aerodynamic, optical, rheological and electromagnetic properties and their measurement.
Unit II	
5	Post-Harvest Handling operations; Cleaning, Cleaning of grains, types of cleaners
6	Washing of fruits and vegetables, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance
7	Peeling, Sorting, grading, methods of grading; Grading Size grading, color grading, specific gravity grading
8	Screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance
Unit III	
9	Types of screens, rotary screens, vibrating screens working principles, design parameters, cleaning efficiency, care and maintenance
10	Separation - Magnetic separator, destoners, electrostatic separators, pneumatic separator, color separator
11	Decorticating and Shelling; Principles of working, design and constructional details, operating parameters, care and maintenance

12 Description of groundnut decorticators, maize shellers, sunflower shellers, castor decorticator, Principles of working, constructional details, operating parameters

Unit IV

13 Grain drying theory, grain dryers, principle of drying, drying curve, constant rate and falling rate drying period, EMC

14 Liquid dryers: drum dryer, spray dryer and foam-mat dryer

15 Milling, polishing, grinding, milling equipment, de-huskers, polishers (abrasion, friction, water jet)

16 Flour milling machines, grinders, cutting machines – principles of working, constructional details, operating parameters, machine efficiency and power requirement.

Unit V

17 Parboiling: Process, changes during parboiling, parboiling methods, advantages and disadvantages of parboiling

18 Parboiling with respect to milling, nutritional and cooking quality of grain, significance of glass transition temperature

19 Pulse milling machines, principles of working, constructional details, operating parameters, machine efficiency and power requirement.

20 Oil expellers, principles of working, constructional details, operating parameters, machine efficiency and power requirement.

Unit VI

21 Materials handling; Introduction to different conveying equipment used for handling of grains; Scope and importance of material handling devices

22 Study of different Material Handling systems; Classification, principles of operation, conveyor system selection/design

23 Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity

24 Inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper

Unit VII

25 Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain

26 Trolley conveyor, Scraper conveyor and Apron conveyor

27 Screw conveyor: Principle of operation, capacity, power, troughs, advantages and disadvantages

28 Loading and discharge, inclined and vertical screw conveyors

Unit VIII

29 Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity

30 Bucket elevator speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement

31 Pneumatic conveying system: types, air/product separators, Advantages and Disadvantages

32 Gravity conveyor design considerations, capacity and power requirement

Practical

No.	Practical Outline
1	Study of cleaners and graders for grains
2	Study of washers and graders for fruits and vegetables
3	Study of groundnut and castor decorticators
4	Study of a maize and sunflower shellers
5	Study of crop dryers
6	Study of a RF/MW/tray dryer
7	Study of hot air dryer and modelling drying kinetics
8	Study of vacuum dryer and modelling drying kinetics
9	Study of working principle of spray dryer and spray drying process
10	Study of drum dryer and liquid food dehydration using drum drying
11	Study of fluidized bed dryer, freeze dryer and drying processes
12	Study of rice milling machines and different components of flour mill
13	Study of pulse milling machines
14	Study of oil milling machines
15	Study of different materials handling equipment
16	Practical Examination

References

1. Boumans, G. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
3. Chakraverty, A. and Singh, R.P. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
4. Chakraverty, A., Majumdar, A.S., Vijaya Raghavan, G.S and Ramaswamy, H.S. 2003. Handbook of Post-Harvest Technology. Markel Dekker Inc., New York.
5. Dash, S K, Bebartta, J P and Kar, A. 2012. Rice Processing and Allied Activities. Kalyani Publishers
6. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
7. Green, D.W. and Perry, R.H. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.

8. Hall, C. W. and Davis, D. C. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
9. Henderson, S.M. and Perry, R.L. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.
10. Mohsenin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
11. Mohsenin, N.N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.
12. Mohsenin, N.N. 1986. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties, 2nd edn. Gordon and Breach Science Publishers, NY.
13. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
14. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
15. Zeki Berk. 2009. Food Process Engineering and Technology. Academic Press. USA.

FDPE 124 Unit Operations in Food Processing 3(2+1)

Objectives

1. To learn insights of unit operations in food processing
2. Learn about thermal treatment techniques and applications
3. Understand working of equipment in unit operations and solving numerical

Course Outlines

Theory

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation. Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapor recompression systems; Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices. Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, Freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen

food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat and mass transfer during freeze drying, equipment and practice. Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations. Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization. Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, fractional distillation, steam distillation, distillation of wines and spirits. Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment. Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment. Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger. Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package. Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Thermal processing and microbial death curves; Homogenization, Emulsification.

Practical

Study of working principle of open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar. Study of freezers/ Design problems on freezers; To study freezing of foods by different methods IQF freezing; Determination of freezing time of a food material; To study simple distillation process and determine the rate of distillation; To study the process of roasting/ To study the effect of time- temperature combination on roasting; Determination of oil uptake by the food product during frying. To determine the efficacy of a blanching process; time-temperature combination for a blanching process; efficacy of a sterilization process; Determination of F value for a product in can/ retortable pouch; Study of sterilizer / blancher / pasteurizers / fryers / homogenizers / irradiators

Lecture Outlines

Theory

No.	Lecture Outline

Unit I

1 Principles of mass and energy transfer; Material and heat balance; Numerical on material and heat balance

2 Evaporation: Principle, heat and mass balance; pan evaporator, natural circulation, raising film evaporator, falling film evaporator, forced circulation evaporator-principle and working

3 Design of evaporator system; heat and mass transfer in evaporator; feed liquor properties on evaporation; Methods of operation-Single effect and multiple effect evaporator

4 Boiling-Point rise of solution; Use of Duhring plot in estimation of Boiling-Point rise; Effect of processing variables on evaporator operation

Unit II

5 Feeding methods of multiple effect evaporation systems, evaporator ancillary plant, feed preheating, factors influencing the overall heat transfer coefficient

6 Condenser in evaporator-surface condenser and direct contact condenser; Evaporation using vapour recompression-mechanical and thermal, fouling in evaporators

7 Food freezing: Introduction, freezing point curve for food and water, principle of food freezing, Direct and indirect contact food freezing systems

8 Freezing time: Derivation of Plank's equation for freezing time, Pham's method to predict freezing system, freezing time calculation for finite shaped objects

Unit III

9 Direct contact freezers: air blast, immersion freezers, fluidized bed freezer-principle of working and design of equipment, applications, merits and limitations

10 Indirect contact freezers: Plate Freezer-Horizontal and vertical plate freezer, spiral freezer-principle of working and design of equipment, applications, merits and limitations

11 Properties of frozen foods-Enthalpy, Density, Thermal conductivity, Specific heat; factors influencing freezing time and thawing time

12 Freeze concentration-principle of operation, equipment, special features, merits and limitations, application in food industry

Unit IV

13 Quality changes in frozen foods during processing and storage, comparison between freeze concentration and other freezing techniques

14 Freeze drying-principle of sublimation, concept of triple point for water and foods; working of freeze dryer, design and equipment, merits, limitations and applications

15 Expression-mechanical expellers-screw press, hydraulic press, hot pressing and cold pressing, factors affecting mechanical expression, merits, limitations and applications

16 Extraction: solvent extraction, liquid-liquid extraction-principle of working, design, applications

Unit V

17 Design of continuous multistage counter current extraction, derivation of equations, mass balance and numerical

18 Leaching: process, rate of leaching, solids preparation for leaching, types of equipment and equilibrium relation

19 Crystallization and dissolution: theory and principle of working, kinetics of crystallization, application in food industry

20 Equipment for crystallization, working principle and design; heat and mass balance in crystallizer, numerical

Unit VI

21 Distillation: principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, application

22 Fractional distillation, steam distillation, application in food industry, distillation of wines and spirits

23 Baking: principles of heat and mass transfer, baking equipment, baked foods, special features of baked foods

24 Roasting-principles of roasting, equipment for roasting, heat and mass transfer during roasting

Unit VII

25 Frying: Theory of frying, principle of frying, shallow/contact frying and deep fat frying, oil uptake studies, heat and mass transfer during frying

26 Puffing: Methods of puffing, heat and mass transfer, physicochemical changes during puffing, equipment for puffing

27 Blanching: Principles, pre-treatment and equipment, objectives of blanching, types of balancing

28 Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger

Unit VIII

29 Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package

30 Aseptic processing: principle, analysis of thermal resilience, special features, flow line for aseptic processing

31 Thermal death time, D, Z and F values, definition, range of values for different microorganisms, numerical

32 Homogenization-principle, design and equipment, merits and limitations Emulsification-principle, design and equipment, merits and limitations

Practical

No.	Practical Outline
1	Study of working principle of open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods
2	Study of heat and mass balance in single effect evaporator
3	Tutorials on single effect evaporator
4	Tutorials on multiple effect evaporator
5	Study on crystallization equipment and tutorial
6	Design problems on freezer
7	Study of freeze dryer
8	Study of freezing process by different freezing techniques
9	Study of freezing systems-air blast, plate and immersion freezer
10	Numerical on freezing time for Plank's and Pham's equation
11	Determination of oil uptake during frying
12	Study on solvent extraction from oilseeds
13	Numerical on thermal study (D, Z and F value)
14	Experiment on deep and shallow frying
15	Study on time and temperature combination on roasting quality
16	Practical examination

References

1. Earle, R.L. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science and Technology, New Zealand.
2. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd edn. CRC Press, Boca Raton, FL, USA.
3. Geankoplis, C.G. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
4. McCabe, W.L., Smith, J. and Harriott, P. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
5. Richardson, J F., Harker, J.H. and Backhurst, J.R. 2002. Coulson and Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th edn. Butterworth Heinemann, Oxford, UK.
6. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.

FDPE 125 Food Thermodynamics 3(2+1)

Objectives

1. Have an idea about basic concepts of energy and laws of thermodynamics.
2. Knowledge about thermodynamic cycles and their application.
3. Knowledge about psychrometric properties of air and its application in drying and other food applications

Course Outlines

Theory

Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat. First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis. Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, entropy, availability and irreversibility. Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, PV-T behavior of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, air standard Otto cycle, air standard Diesel cycle, vapor-compression refrigeration cycle. Psychrometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms. Three stages of water, phase diagram for water, vapour pressure temperature curve for water, heat requirement for vaporization, measurement of humidity. Boilers and steam generation: fuels for boilers and steam generation, boiler types, boiler mountings and accessories, Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, draught analysis; Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

Practical

Demonstration and application of zeroth law of thermodynamics; first law of thermodynamics; and second law of thermodynamics. Study of different types of boilers; boiler mounting and accessories; various types of burners and fuels; Determination of calorific values of different fuels. Study of vapour compression refrigeration test rig; heat pump; properties of wet, dry, saturated and superheated steam; Use of steam tables and Moiler charts; dryness fraction of steam; use of psychrometric chart for humidification, dehumidification, heating and drying; Determination of thermodynamic properties on

psychrometric charts; study of steam trap and steam line layouts; Visit to food plant with steam utilization.

Lecture outlines

Theory

No.	Lecture Outline
Unit I	
1	Basic concepts: definitions, approaches, thermodynamic systems
2	Thermodynamic properties and equilibrium, state diagram, Homogeneous and heterogeneous systems
3	Path and process, different modes of work, Quasi-static process, pure substance and thermostatics
4	Zeroth law of thermodynamics, concept of temperature and heat
Unit II	
5	First law of thermodynamics: energy, enthalpy and specific heats
6	First law of thermodynamics: specific heats
7	Applications of first law, steady and unsteady flow analysis
8	Applications of first law, unsteady flow analysis
Unit III	
9	Second law of thermodynamics: Kelvin-Planck statement
10	Clausius statements, reversible and irreversible processes
11	Thermodynamic temperature scale, entropy,
12	Availability and irreversibility of energy
Unit IV	
13	Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases
14	P-V diagram for pure substances
15	P-T diagram for pure substances
16	P-V-T behavior of simple compressible substances, phase rule
Unit V	
17	Thermodynamic cycles: Carnot vapor power cycle: Ideal Rankine cycle, Rankine reheat cycle
18	Air standard Otto cycle, air standard Diesel cycle
19	Air-standard Brayton cycle
20	Vapor-compression refrigeration cycle

Unit VI

20 Psychrometry: thermodynamic properties of moist air
21 Perfect gas relationship, absolute humidity
22 Relative humidity, percentage humidity
23 Humid volume, total heat, enthalpy, dry bulb temperature

Unit VII

24 Wet bulb temperature, dew point temperature
25 Adiabatic processes, wet bulb depression, humid heat
26 Specific volume, heating, cooling, dehumidifying
27 Sorption isotherms, three stages of water, phase diagram for water
28 Vapour pressure temperature curve for water, Heat requirement for vaporization, measurement of humidity

Unit VIII

29 Boilers and steam generation-Fuels for boilers and steam generation
30 Boiler types, boiler mountings and accessories
31 Properties of steam: Wet, dry saturated and superheated steam
32 Use of steam tables

Practical

No.	Practical Outline
1	Demonstration and application of zeroth law of thermodynamics
2	Demonstration and application of first law of thermodynamics
3	Demonstration and application of second law of thermodynamics
4	Study of different types of boilers; boiler mounting and accessories;
5	Study on various types of burners and fuels;
6	Determination of calorific values of different fuels.
7	Study of vapour compression refrigeration test rig; heat pump;
8	Properties of wet, dry, saturated and superheated steam
9	Use of steam tables and Moiler charts; dryness fraction of steam
10	Determination of dryness fraction of steam
11	Use of psychrometric chart for humidification, dehumidification
12	Use of psychrometric chart for heating and drying
13	Determination of thermodynamic properties on psychrometric charts
14	Study of steam trap and steam line layouts
15	Visit to food plant with steam utilization.
16	Practical Examination

References

1. Brooker, D.B., Bakker-Arkema, F.W. and Hall, C.W. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.
2. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
3. McCabe, W.L., Julian Smith and Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
4. Nag, P.K. 2005. Engineering Thermodynamics, 3rd edn. Tata-McGraw-Hill Education, New Delhi.
5. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
6. Rajput, R.K. 2007. Engineering Thermodynamics, 3rd edn. Laxmi Publications (P) Ltd., Bangalore.
7. Smith, J.M., Van Ness, H.C. and Abbott, M.M. 2005. Introduction to Chemical Engineering Thermodynamics, 7th edn. McGraw-Hill, Inc., NY, USA.

FDPE 126 Engineering Drawing and Graphics 3(1+2)

Objectives

1. The curriculum aim is to develop the skill to draw and read several drawings.
2. Main goal of this subject to develop thoughts and explain concepts.

Course Outlines

Theory

Definition of projection, Principle of projection, Methods of projections, Orthographic projection, plane of projection, First and third angle of projection. Different methods of dimensioning; Isometric scale, Isometric axes, Isometric projection, Preparation of working drawing from models and isometric views. Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts; Types of rivet heads and riveted joints, Symbols for different types of welded joints; Processes for producing leak proof joints. Nomenclature, thread profiles, multi-start threads, left and right-hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Drawing of missing views. Application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

Practical

Introduction of drawing scales; Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true

shapes of oblique plain surface; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications; Interpretation of sectional views of food equipment and components; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Definition of projection, Importance of projections, Principle of projection
2	Methods of projections- Orthographic projection, plane of projection
Unit II	
3	Methods of projections- First and third angle of projection.
4	Isometric projection – Explanation and difference between the orthographic and isometric
Unit III	
5	Isometric projection - Preparation of working drawing from models and isometric views
6	Different methods of dimensioning; Isometric scale, Isometric axes
Unit IV	
7	Concept of sectioning- Cutting plane and types of sectioning
8	Concept of sectioning- Revolved and oblique section- Sectional drawing of simple machine parts
Unit V	
9	Types of rivet heads and riveted joints
10	Symbols for different types of welded joints; Processes for producing leak proof joints
Unit VI	
11	Thread Nomenclature, thread profiles, multi-start threads, left and right-hand thread
12	Square headed and hexagonal nuts and bolts- Conventional representation of threads

Unit VII

13 Different types of lock nuts, studs, machine screws, cap screws and wood screws

14 Foundation bolts; drawing of missing views

Unit VIII

15 Application of computers for design, definition of CAD, benefits of CAD

16 CAD system components; Computer hardware for CAD

Practical

No.	Practical Outline
1	Introduction to drawing tools and practice on English alphabets drawings in different font style
2	Introduction to drawing scales-representation factor- reduced scale- enlarged scale-full scale and its usage in engineering drawing
3	Scales- plain scales, diagonal scales, isometric scales and their application in engineering drawing
4	Introduction to planes, views, plan, elevation and orthographic projections
5	Projection of points, description by using drawing lines and alphabets
6	Projection of lines inclined to simple planes and both the planes
7	Projection of planes and oblique planes
8	Introduction to solids, types of solids- drawings on solids
9	Section of solids and interpenetration of solid-surfaces
10	Projection of solids with reference to two planes
11	Introduction to developments- development of solids of flat faces
12	Development of solids- cylinders, pyramids, cones and frustum
13	Introduction to isometric scale- projection of simple geometric planes in isometric scale
14	Projection of solids in isometric scale-I
15	Projection of solids in isometric scale-II
16	Projection of solids in plane views from isometric scale-I
17	Projection of solids in plane views from isometric scale-II
18	Projections of solids (change of position method, alteration of ground lines)-I
19	Projections of solids (change of position method, alteration of ground lines)-II
20	Preparation of manual drawings with dimensions from models
21	Preparation of manual drawings with dimensions from isometric drawings of machine components
22	Preparation of sectional drawings of simple machine parts
23	Drawing of riveted joints and thread fasteners
24	Introduction to computer interface in engineering drawing and software

25 Demonstration on computer graphics and computer aided drafting
26 Exercise on sectional drawings of engineering machines using computer aided design
27 Exercise on drawing of food processing equipment using computer aided design
28 Interpretation of sectional views of food equipment and components
29 Practice on the use of basic drawing commands on AutoCAD
30 Generating simple 2-D drawings of machine surfaces with dimensioning using AutoCAD
31 Small projects of food processing equipment design and plant layout using CAD/CAM
32 Practical Examination

References

1. Bhat, N. D and Panchal, V. M. 1995. Machine Drawing. Charotar Publishing House, Anand.
2. Ibrahim Zeid. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.
3. Kunwoo Lee. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.

FDPE 221 Fluid Mechanics 3 (2+1)

Objectives

1. Get idea about types of fluids and their properties
2. Gain knowledge about the flow behaviour of the fluids
3. Principles of working at various types of pumps and their use in food processing

Course Outlines

Theory

Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces; Flow behavior of viscous foods; Compressible and non-compressible fluids; Surface tension, capillarity; Pressure measuring devices: Simple, differential, micro, inclined manometer, mechanical gauges, piezometer; Floating bodies: Archimedis principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height; Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Navier-Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries; Flow past through the immersed solids, packed and fluidized beds; Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturi

meters, pitot tube, rotameter; Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude; Turbines and pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, submersible pumps; Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps.

Practical

Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank; Determination of critical Reynold's number by Reynold's apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of rotameter; Study of different types of valves; Study of pumps for viscous fluid; Floating bodies, liquid flow, venturimeter, orifice, weir, flow through pipes; Study and operation of centrifugal and other pumps used in dairy and food processing plants.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Fluids - definitions, classification, units and dimensions
2	Properties of fluids, Surface tension and Capillarity
3	Static pressure of liquids: hydraulic pressure, absolute, gauge pressure and pressure head of a liquid
4	Pressure on vertical rectangular surfaces; Flow behavior of viscous foods; compressible and non-compressible fluids
Unit II	
5	Pressure measuring devices: simple, differential, micro, inclined manometer and piezometer
6	Mechanical gauges: Bourdon's tube pressure gauge; Bellows; Diaphragm pressure gauge
7	Floating bodies: Archimedes principle, stability of floating bodies; equilibrium of floating bodies and metacentric height
8	Fluid flow: classification, steady, uniform, non-uniform, laminar, turbulent flow

Unit III

9 Bernoulli's theorem and its applications; Navier-Stokes equations in cylindrical co-ordinates, boundary conditions

10 Simple application of Navier-Stokes equation, Laminar flow between two straight parallel boundaries

11 Flow through simple pipes; loss of head in pipes: Major losses friction

12 Minor losses-loss of head due to contraction, enlargement at entrance and exit of pipe

Unit IV

13 Determination of pipe diameter and discharge; friction factor and critical velocity

14 Flow through orifices (measurement of discharge); types of orifices; jet of water; vena contracta; discharge through rectangular orifice

15 Hydraulic coefficients, time of emptying a square tank through an orifice at its bottom

16 Time of emptying a rectangular and circular tank through an orifice at its bottom

Unit V

17 Flow through mouthpieces, types of mouthpieces, discharge through external and internal mouth piece

18 Flow over notches, types of notches, discharge over a rectangular notch and triangular notch

19 Time of emptying a tank over rectangular notch and triangular notch

20 Flow through weirs, types of weirs, discharge over a rectangular weir

Unit VI

21 Flow measurement: venturi meter, pitot tube and rotameter

22 Water level measurement: water level point gauge, hook gauge

23 Dimensional analysis; Buckingham's theorem application to fluid flow phenomena

24 Dimensionless numbers: Froude Number, Reynolds number, Weber number and hydraulic similitude

Unit VII

25 Pumps: classification, study of centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump

26 Centrifugal pumps: Pumps in series and parallel

27 Basic equations applied to centrifugal pump: Loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency

28 Operating characteristics of centrifugal pumps

Unit VIII

29 Working of reciprocating pump: Single acting and double acting reciprocating pumps

30 Instantaneous rate of discharge, acceleration of piston, water and gear pump

31 Pressure variation, work efficiency, pressure requirements for viscous foods to lift them to different heights

32 Selection and design of pumps

Practical

No.	Practical Outline
1	Study of different tools and fittings
2	Study on flow rate versus pressure drop with U-tube manometer
3	Verification of Bernoulli's theorem
4	Determination of discharge co-efficient for Venturi meter
5	Determination of discharge co-efficient for Orifice
6	Determination of discharge co-efficient for V-notch
7	Verification of emptying time formula for a tank
8	Determination of critical Reynold's number using Reynold's apparatus
9	Study of reciprocating, centrifugal and gear pump
10	Calibration of rotameter
11	Study of different types of valves
12	Study of pumps for viscous fluid
13	Floating bodies and liquid flow
14	Flow through pipes: venturi meter, orifice, weir
15	Study of centrifugal and other pumps used in dairy and food processing plants
16	Practical Examination

References

1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N. 2002. Transport Phenomena, 2nd edn. John Wiley and Sons, Inc., New York, USA.
2. Çengel, Y. A. and Cimbala, J.M. 2006. Fluid Mechanics: Fundamentals and Applications. McGraw-Hill, Inc., New York, USA.
3. Finnemore, E.J. and Franzini, J.B. 2002. Fluid Mechanics with Engineering Applications, 10thedn. McGraw-Hill, Inc., New York, USA.
4. Munson, B.R., Young, D.R. and Okiishi, T.H. 2002. Fundamentals of Fluid Mechanics, 4th edn. John Wiley and Sons, Inc., New York, USA.
5. Nevers, N.D. 1991. Fluid Mechanics for Chemical Engineers. McGrawHill, Inc., New York, USA.
6. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
7. Streeter, V.L. 1962. Fluid Mechanics, 3rd edn. McGraw-Hill Book Co., Inc., Boston, USA.
8. White, F.M. 2010. Fluid Mechanics, 7th edn. McGraw-Hill Book Co., Inc., Boston, USA.

FDPE 222 Heat and Mass Transfer in Food Processing 3 (2+1)

Objectives

1. Get a quant with the mechanism of heat and mass transfer
2. Details of dimensionless numbers involved in heat and mass transfer
3. Study of different types of heat exchangers

Course Outlines

Theory

Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer, food properties measurements and errors; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section, Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins; Introduction to unsteady state heat conduction: System with negligible internal resistance in various geometries;

Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer; Dimensionless numbers: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heisler charts and calculations; Heat transfer to flowing fluids; Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Introduction to condensing and boiling heat transfer: film and drop-wise condensation; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube, plate heat exchangers, Double pipe heat exchanger, cross flow heat exchanger, scraped surface heat exchanger; heat exchanger design; Efficiency and NTU analysis; Application of different types of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolar diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Practical

Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry; Preparation and calibration of thermocouples; Determination of thermal conductivity of different food products; Study of working principle

and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry; Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer; mass transfer coefficient in foods; glass transition temperature of food sample; mass transfer during leaching process.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Modes of heat transfer – conduction, convection and radiation
2	Heat transfer coefficient, properties related to heat transfer, measurement of food properties and errors
3	One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation
4	Concept of electrical analogy – It's application for thermal circuits
Unit II	
5	Heat transfer through composite walls and insulated pipelines – Derivation of critical thickness of insulation
6	One-dimensional steady state heat conduction with heat generation: Heat flow through slab
7	One-dimensional steady state heat conduction with heat generation: Heat flow through hollow sphere
8	One-dimensional steady state heat conduction with heat generation: Heat flow through hollow cylinder
Unit III	
9	Uniform / non-uniform heat generation in different solid
10	Development of equations for temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment
11	Introduction to extended surfaces (fins) of uniform area of cross-section; Equation of temperature distribution with different boundary conditions in fins
12	Effectiveness and efficiency of the fins: Theory and derivation and assumptions
Unit IV	
13	Introduction to unsteady state heat conduction: System with negligible internal resistance in various geometries
14	Convection: Forced and free convection derivation, theory and application
15	Use of dimensional analysis for correlating variables affecting convection heat transfer

16 Study of dimensionless numbers: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number

Unit V

17 Important empirical relations used for determination of heat transfer coefficient, Introduction to Heisler charts and calculations

18 Heat transfer in flowing fluids and empirical relations used for its determination

19 Radiation: Theory of radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors in radiation heat transfer

20 Introduction to condensing and boiling heat transfer: film and drop-wise condensation

Unit VI

21 Heat Exchangers: Principle of working, fouling factors, jacketed kettles

22 Concept of LMTD, parallel and counter flow heat exchangers

23 Shell and tube exchanger-Components, working principle, basic design procedure and theory, advantage and disadvantages

24 Plate heat exchanger-Components, working principle, basic design procedure and theory, advantages and disadvantages

Unit VII

25 Double pipe heat exchanger, cross flow heat exchanger, scraped surface heat exchanger - working principle, advantages and disadvantages

26 Fouling factors and typical overall heat transfer coefficient values

27 Study on heat exchanger design, effectiveness, efficiency and NTU analysis

28 Application of different types of heat exchangers in dairy and food industry

Unit VIII

29 Mass transfer: Fick's law of diffusion, theory and derivation

30 Steady state diffusion of gases and liquids through solids

31 Equimolar diffusion, isothermal evaporation of water into air

32 Mass transfer coefficient, application of mass transfer in dairy and food industry

Practical

No	Practical Outline
1	Tutorials on calculation of heat transfer on conduction heat transfer
2	Tutorials on calculation of heat transfer during convection heat transfer
3	Study on various types of heat exchangers in food industry
4	Tutorials on calculation of heat transfer in different conduction
5	Determination of thermal conductivity of different food products
6	Study of working principle and constructional details of plate heat exchanger
7	Determination of overall heat transfer coefficient of shell and tube heat exchanger used in food industry

8 Determination of overall heat transfer coefficient of plate heat exchanger used in food industry

9 Determination of overall heat transfer coefficient of jacketed kettle used in food industry

10 Study on heat transfer through extended surfaces

11 Study on temperature distribution in HTST pasteurizer

12 Ditermination of effectiveness of heat exchanger by NTU method

13 Study on mass transfer coefficient in foods

14 Study on glass transition temperature of food sample

15 Numerical on mass transfer under different conduction

16 Practical Examination

References

1. Cao, E. 2010. Heat Transfer in Process Engineering. The McGrawHill Companies, Inc., New York, USA.
2. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw Hill Co., Inc., NY, USA.
3. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4thedn. Prentice-Hall, NY, USA.
4. Holman, J.P. 2010. Heat Transfer, 10thedn. McGraw-Hill Book Co., Boston, USA.
5. Kumar, D.S. 2015. Heat & Mass Transfer. S.K Kataria & Sons Publishers
6. Lienhard IV, J.H. and Lienhard V, J.H. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
7. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7thedn. McGraw-Hill, Inc., NY, USA.
8. Ozisik, M.N. 1993. Heat Conduction, 2ndedn. John Wiley and Sons, NY, USA.
9. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
10. Paul Singh, R. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.
11. Rajput, R.K. 2008. Heat and Mass Transfer. S. Chand and Co., New Delhi.
12. Rao, Y.V.C. 2013. Heat Transfer. Universities Press (India) Private Limited, Hyderabad, India.
13. Richardson, J F., Harker, J.H. and Backhurst, J.R. 1999. Coulson and Richardson's Chemical Engineering, Vol. 1, Fluid Flow, Heat Transfer and Mass Transfer, 6thedn. Butterworth– Heinemann, Oxford, UK.
14. Treybal, R.E. 1980. Mass Transfer Operations, 3rdedn. McGraw-Hill Book Company, Auckland, USA.

FDPE 223 Basic Electronics Engineering 2(1+1)

Objectives

1. Study basic concept of electronics and their relevance in food industry
2. Get idea about various electronic components
3. Understand usage of various electronic units in instrumentation

Course Outlines

Theory

Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier; Diode circuits for OR and AND (both positive and negative logic); voltage multiplier, filter circuits; Bipolar junction transistor: Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider); Ideal OP-AMP characteristics, linear and nonlinear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiters, OP-AMP voltage regulators; Basic theorem of Boolean algebra;

Combinational logic circuits (basic gates, SOP rule and K-map) and sequential logic circuits binary ladder D/A converter and A/D converter; Transducers: Classification, selection criteria, characteristics, sensors and actuators construction, working principles, applications of following transducers- Potentiometers RTD, thermocouples, thermistors, LVDT, strain gauges, capacitive and inductive transducers, piezoelectric transducers, photoelectric transducers, self-generating transducers, variable parameter type, digital, actuating and controlling devices.

Practical

Study of diode characteristics; Study of triode characteristics; Study of Zener diode; Study of V-I characteristics of P-n junction diode; Study of RC coupled amplifier; Study of RC phase shift oscillator; Study of full wave rectifier; Verification of logic gates; Determination of energy gap in a junction diode; Study of transistor characteristics in CE configuration; Study of OP-Amp IC 741 as differential amplifier; Study of half wave rectifier; Study of OP-AMP IC 741 as an active rectifier; Study of transistor characteristics; Study of temperature characteristics of resistor; Study of diode as clipper and clamper.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Semiconductors - N Type and P Type semiconductor, P-n junction diode, formation of p-n junction, forward biased and reverse biased, V-I characteristics diode as circuit element

2 Rectifiers - half wave and full wave rectifier with circuit diagram, efficiency ripple factor, PIV, voltage regulation

Unit II

3 Diode circuit for OR and AND gates (both positive and negative logic)

4 Filter circuit Shunt capacitor filter, ripple factor, voltage regulation, series induction filter, ripple factor voltage regulation

Unit III

5 Bi - polar Junction transistor- PNP, NPN Transistor, operating point, AC load line analysis Transistor as an amplifier in (CB) node, CE mode, CC mode with circuit diagrams, input and output characteristics

6 Classification of amplifier – Class A, Class B, Class C amplifier

Unit IV

7 Transistor biasing – Stability factor, fixed bias, self-bias, potential divider bias methods,

8 Voltage regulators- Zener diode, Voltage regulator, Transistor series regulator

Unit V

9 Operational amplifier – characteristics of an ideal OP-AMP, operational amplifier stages, OP amp as integrator and differentiator

10 OP amp as active rectifier, differential, instrumentation amplifier, oscillator

Unit VI

11 Boolean algebra - OR laws, AND laws NOT laws, commutative law associative law distributive law, absorptive law, combination logic circuit, AND, OR, NOT, NOR, NAND gates, SOP rule, K-MAP, sequential gate

12 Binary ladder D/A converter and A/D converter

Unit VII

13 Transducers- Classification, characteristics, selection criteria, sensor and actuators construction and working principle

14 Application of transducers-Potentiometer, RTD, Thermocouple, Thermistors

Unit VIII

15 LVDT, strain gauges, capacitive and inductive transducer

16 Photo electric transducer, Pizo electric transducer, Self-generating transducer, Variable parameter type- Digital actuating and controlling devices

Practical

No	Practical Outline
1	Study of diode characteristics
2	Study of triode characteristics
3	Study of zener diode

4 Study of V-I characteristics of P-N Junction diode
5 Study of RC coupled amplifier
6 Study of RC phase shift oscillator
7 Study of full wave rectifier
8 Verification of logic gates
9 Determination of energy gap in a junction diode
10 Study of transistor characteristics in CE configuration
11 Study of OP-AMP IC 741 as differential amplifier
12 Study of half wave rectifier
13 Study of OP AMP IC 741as an active rectifier
14 Study of transistor characteristics and temperature characteristic of resistor
15 Study of diode as clipper and clamper
16 Practical Examination

References

1. Anand Kumar. 2014. Fundamental of Digital Circuits. PHI Pvt. Ltd., New Delhi
2. Gupta, S. 2002. Electronic Devices and Circuits. Dhanpat Rai Publications (P) limited, New Delhi.
3. Mehta, V.K. and Mehta, R. 2008. Principle of Electronics. S. Chand and Co., New Delhi
4. Roy, D.C .2003. Linear Integrated circuits. John Wiley International, NY.
5. Sawhney, A.K. 2010. Course in Electrical and Electronic Measurements and Instrumentation. Dhanpat Rai Publication (p) Limited, New Delhi.

FDPE 224 Fundamentals of Food Engineering 3(2+1)

Objectives

1. To learn basic concepts of food engineering principles
2. Imparting concept of drying, dehydration and types
3. To learn about size reduction, mixing, separation and study of equipment

Course Outlines

Theory

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying time, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foam mat dryers. Size reduction: Benefits, classification, determination and

designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mill, burr mill, tumbling mills, ultra-fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping) Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low and medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

Mechanical separation: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine. Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids. Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultrafiltration in food processing, reverse osmosis, mode of operation and applications; Membrane separation methods, demineralization by electrodialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

Practical

Determination of fineness modulus and uniformity index; Determination of mixing index of a feed mixer; Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law. Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of centrifugal separator; Study of freeze dryer and freeze-drying process; Study on osmosis in fruits; Determination of solid gain and moisture loss during osmosis; Study of reverse osmosis process; Study of ultrafiltration/membrane separation process.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Drying and dehydration-Theory, heat and mass transfer, in drying Process, Moisture content representation and its measurement, Equilibrium moisture content and its importance in drying
2	Drying – Drying rate curves, calculation of drying time, drying rate and dryer efficiency
3	Classification of dryers, factors influencing selection of dryers, design of dryers
4	Design and principles of dryers - tray, vacuum, osmotic, fluidized bed, pneumatic, rotary dryer; applications, merits and demerits

Unit II

5 Design and principle of dryers - tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; applications, merits and demerits

6 Liquid food dryers: Drum or roller dryer, spray dryer and foam-mat dryers; applications, merits and demerits

7 Size reduction: Theory, objectives, classification, calculation of the fineness of ground material

8 Sieve/screen analysis: Objective, types of sieves, national and international standards, design of sieves, calibration

Unit III

9 Principle and mechanism of comminution of food, calculation of work index and energy requirement

10 Laws of size reduction- Rittinger's, Kick's and Bond's equations, assumptions and calculations

11 Size reduction equipment: crushers- jaw crushers, gyratory, smooth roll; application, design and limitations

12 Size reduction equipment: Hammer mills, impactors, attrition mills, buhr mill, tumbling mills; application, design and limitations

Unit IV

13 Size reduction equipment: Ultra-fine grinders, fluid jet pulveriser, colloid mill and cutting machines; application, design and limitations

14 Mixing: theory of solids mixing, forces involved in mixing, factors affecting solids mixing, selection of mixers

15 Evaluation of mixer effectiveness and mixing indices; calculation of rate of mixing; solids mixing equipment

16 Mixing: theory of liquid mixing, forces involved in mixing, types of paddles, impellers and turbines

Unit V

17 Mixers for low and medium viscosity liquids - Design considerations of liquid mixers, baffles and types of vessel in mixers, calculation of power requirement for mixers

18 Mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids, design considerations and calculation of power requirement

19 Mechanical Separations: Theory, gravity separation, centrifugal separation, laws governing separation by mechanical means

20 Liquid-Liquid separation: Theory, design of equipment, mass balance, stripping, regeneration, packed beds

Unit VI

21 Solid-liquid separation: Centrifugation, design of centrifuge, factors influencing separation by centrifugation, solid-liquid and liquid-liquid centrifugation

22 Clarifiers: Theory of clarification, application, merits and limitations, types of clarifiers; Desludging and decanting machine

23 Filtration: Theory of filtration, rate of filtration, pressure drop during filtration and application

24 Filtration: Constant-rate filtration, constant-pressure filtration and derivation of equation

Unit VII

25 Filtration equipment- plate and frame filter press, rotary filters; principle of working, application, merits and demerits

26 Filtration equipment-centrifugal filters, air filters press, rotary filters- principle of working, application, merits and demerits, concept of filter aid

27 Membrane separation: Concept of membrane separation, design of membranes, types and material for membrane filtration

28 Construction of membrane separation unit, design features of membrane rigs, power and flux calculation

Unit VIII

29 Microfiltration, Ultrafiltration: design features, application, power requirement and numerical on calculation of flux and power

30 Concept of concentration and polarization in filtration, process variables during filtration and membrane fouling

31 Nano filtration and reverse osmosis-principle of operation, applications, merits and demerits; Membrane separation methods demineralization by electro-dialysis

32 Filtration methods: Gel filtration, ion exchange, per evaporation and osmotic dehydration

Practical

No	Practical Outline
1	Study on drying of grains using tray dryer
2	Sieve analysis and estimation of fineness modulus and uniformity index
3	Numerical on Rittinger's law, Kick's law and Bonds law
4	Principle of working and performance evaluation of hammer mill
5	Principle of working and performance evaluation of attrition mill
6	Numerical on mixing index
7	Study of centrifugal separator
8	Study of Freeze dryer
9	Determination of solid gain and moisture loss during osmosis
10	Study of planetary mixer
11	Practical on liquid mixing equipment
12	Study of filter press
13	Study of clarification process

14 Numerical on liquid-liquid extraction

15 Study of reverse osmosis unit

16 Practical Examination

References

1. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
2. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4thedn. Prentice-Hall, NY, USA.
3. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering,7th Ed. McGraw-Hill, Inc., NY, USA.
4. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in Food Process Engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
5. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.

FDPE 321 Food Storage Engineering 2(1+1)

Objectives

1. Understand storage structure design layout for storing of grains and perishables
2. Learn about design of grain and agricultural commodity storage structure
3. Pest Control measures, automation and specifications of storage structures

Course Outlines

Theory

Introduction: Importance of scientific storage systems, post-harvest physiology of semi perishables and perishables, climacteric and non-climacteric fruits; Respiration, ripening, changes during ripening, ethylene bio-synthesis. Deterioration mechanisms in stored agricultural commodities: Physical, chemical, biological, and microbiological factors and impacts of storage on quality and shelf life. Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control. Storage structures: Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos. Ripening chambers and cold storage, ethylene management in fruits blast freezing and frozen storage systems and design considerations for meat lockers and dairy cold storage. Storage of grains: Respiration of grains, moisture and temperature changes in stored grains;

conditioning of environment inside storage through ventilation. Aeration and stored grain management: Purposes of aeration, aeration theory, aeration system design, aeration system operation. Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control. Storage of perishables: Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage. Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores. Advanced technologies in food storage automation and smart storage solutions Role of AI and IoT in storage optimization, predictive maintenance and remote monitoring. Vacuum storage systems and applications of nanotechnology in storage.

Practical

Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity; Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage. Design of cold storage for particular capacity and commodity; Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity; Drawing and layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Introduction: Importance of scientific storage systems, postharvest physiology of semi - perishables and perishables, climacteric and non-climacteric fruits - respiration, ripening, changes during ripening, ethylene bio-synthesis
2	Deterioration of mechanisms in stored agricultural commodities: Physical, chemical, biological and microbiological factors and impacts of storage on quality and shelf life
Unit II	
3	Damages: Direct and indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control
4	Storage structures: Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design

Unit III

5 Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos

6 Ripening chambers and cold storage, ethylene management in fruits; blast freezing and frozen storage systems and design considerations for meat lockers and dairy cold storage

Unit IV

7 Storage of grains: Respiration of grains, moisture and temperature changes in stored grains

8 Conditioning of environment inside storage through ventilation, and aeration, Stored grain management: Purposes of aeration, aeration theory, aeration system design, aeration system operation

Unit V

9 Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc., damage caused by rodents and its control

10 Storage of perishables: Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage

Unit VI

11 Conditions for storage of perishable products, control of temperature and relative humidity inside storage

12 Design of storage structures: Functional and structural design of grain storage structures

Unit VII

13 Pressure theories, pressure distribution in bin, grain storage loads, pressure and capacities, warehouse and silos BIS specifications

14 Functional, structural and thermal design of cold stores

Unit VIII

15 Advanced technologies in food storage automation and smart storage Solutions; Role of AI and IoT in storage optimization, predictive maintenance and remote monitoring

16 Vacuum storage systems and applications of nanotechnology in storage

Practical

No.	Practical Outline
1	Visit to traditional storage structures
2	Layout design, sizing, capacity and drawing of traditional storage structures
3	Measurement of respiration of fruits/grains
4	Study on fumigation
5	Visits to FCI godowns

6 Design of grain godowns for particular capacity and commodity
7 Drawing and layout of grain godown for particular commodity and capacity
8 Visits to cold storage
9 Design of cold storage for particular capacity and commodity
10 Drawing and layout of cold storage for particular commodity and capacity
11 Visit to controlled atmosphere storage
12 Design of controlled atmosphere storage for particular capacity and commodity
13 Drawing and layout of controlled atmosphere storage for particular commodity and capacity
14 Visits to a storage unit and study of evaporative cooling system for storage
15 Storage study in the modified atmosphere package
16 Practical Examination

References

1. Boumans, G.1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brooker, D. B., Bakker- Arkema, F.W. and Hall, C.W.1976. Drying Cereal Grains. The AVI Publishing Company, Inc. Connecticut, MA, USA.
3. Hall,C.W.1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc, Westport, Connecticut, USA.
4. Jayas, D.S., WhiteN.D.G. and Muir, W.E.1994. Stored Grain Eco systems. Marcel Dekker, NewYork.
5. Kutz, M.2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY,USA.
6. Michael, A.M. and Ojha, T.P.2004. Principal of Food Technology, Vol.I. Jain Brothers, New Delhi.
7. New baver, L.W.andWalker,H.B.2003.Farm Buildings Design. Prentice- Hall Inc., New Jersey, USA.
8. Pandey,P.H.1997. Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.
9. Rahman, M. S. (Ed.). (2020). *Handbook of Food Preservation*. CRC Press.
10. Manual: Publications from the *Food and Agriculture Organization (FAO)* on meat and dairy cold storage guidelines.

FDPE 322 Food Refrigeration and Cold Chain 3(2+1)

Objectives

1. Understand the concept of refrigeration system, refrigerant and their properties
2. Design of cold storage and air conditioning systems for food storage application
3. Heat load calculations for various Food Processing Unit

Course Outlines

Theory

Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization. Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; plug and chill type refrigeration based on chemicals. Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with pV and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; effect of suction vapour, super heat and liquid sub cooling on actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine; water/lithium bromide and ammonia/water absorption cooling. Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants physical, chemical, safety, thermodynamic and economical; azeotrope refrigerants. Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture: principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost heave, interior finish and fitting, evaporators, automated cold stores, security of operations. Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display. Low temperature Refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food. Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/ summer/year-round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in airconditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling/Refrigeration load calculations: Load sources, product cooling, conduction heat load, convection heat load, internal heat sources, heat of respiration, peak load, miscellaneous loads; etc.

Practical

Study of vapour compression refrigeration system; Determination of COP of vapour compression refrigeration system; Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems; Study of refrigerants, their properties and charts; Study of direct and indirect contact freezing equipment for foods;

Study of spray freezing process for foods; Study of food cold storage; Estimation of refrigeration load for cold storage; Estimation of refrigeration load for meat and poultry products; Study of refrigeration system of dairy plant; Estimation of refrigeration load for ice-cream; Study of cooling system for bakery and estimation of refrigeration loads; Estimation of refrigeration load during chocolate enrobing process; Study of refrigerated van; Study of deep freezing and thawing of foods; Study of refrigerated display of foods and estimation of cooling load.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Introduction to Refrigeration and its principles, refrigeration and its applications in modern society, historical background of refrigeration and its importance in various industries

2 Introduction to basic thermodynamic principles and the second law of thermodynamics. Concept of refrigerating capacity, unit of refrigeration, and the Coefficient of Performance (COP) in refrigeration systems

3 Production of Low Temperatures - Expansion of Liquids process of flashing a liquid and its thermodynamic basis. Difference between reversible and irreversible adiabatic expansion of gases; Role of real gases in low-temperature refrigeration

4 Thermoelectric cooling and Adiabatic demagnetization, Principles of thermoelectric cooling and materials used in thermoelectric and adiabatic demagnetization and its application in low-temperature refrigeration

Unit II

5 Introduction to concept of the Carnot cycle and its application in refrigeration, reversed Carnot cycle, limitations and selection of operating temperatures for reverse Carnot air refrigerators

6 Reversed Brayton (Joule) or Bell-Coleman cycle, its relevance to refrigeration. Analysis of the gas cycle in Bell Coleman refrigeration and advantages over the Carnot cycle

7 Introduction plug and chill refrigeration systems based on chemicals, working principles, and industrial applications

8 Vapor Refrigeration Cycle - Introduction, basic principles of the vapor refrigeration cycle. Illustration on how vapor acts as a refrigerant in the reversed Carnot cycle using P-V and T-S diagrams

Unit III

9 Limitations and inefficiencies of the reversed Carnot cycle. Analysis how real systems deviate from the Carnot cycle and the practical implications on refrigeration performance

10 Introduction to vapor compression system and modification of the reversed Carnot cycle, dry vs. wet compression, throttling vs. isentropic expansion, their impacts on refrigeration systems

11 Illustration of vapor compression cycle on a pressure enthalpy diagram and importance of superheating and sub cooling in optimizing the vapor compression cycle

12 Impact of suction vapor on system performance, superheating and liquid subcooling influence the Efficiency and performance of a vapor compression cycle

Unit IV

13 Vapor absorption refrigeration system, working principles, Compare vapor compression and absorption refrigeration, key operational differences

14 Introduction to the concept of the Coefficient of Performance (COP) for heat-operated refrigerating systems. Calculations and analyzes the maximum COP of absorption refrigeration systems with different heat sources

15 Classification of refrigerants, introduction to their nomenclature, desirable physical, chemical, thermodynamic, and economical properties of refrigerants and their safety considerations

16 Azeotropic refrigerants and their formation, advantages and limitations of azeotropic refrigerants in modern refrigeration systems

Unit V

17 Introduction of main components of vapor compression systems: evaporator, compressor, condenser and expansion valve. Function and design considerations for each component, role in refrigeration efficiency

18 Basic principles and systems used in ice production types of ice production, types of components of ice-making systems

19 Water treatment methods used in ice production, the role of brines, freezing tanks, air agitation in improving ice quality and efficiency

20 Introduction to the role of cold storage in food preservation and industrial applications. Different types of cold storage and the factors influencing their design

Unit VI

21 Construction materials used in cold storage facilities, insulation methods, vapor barriers, and other design considerations, floors and frost-heave prevention

22 Introduction to automated cold storage systems, applications, security aspects and efficient management of automated cold storage

23 Refrigerated transport, its role in the cold chain, handling and distribution of refrigerated products and methods for maintaining temperature during transit

24 Design features of refrigerated vans used for transporting products and refrigerated display systems, importance in maintaining product temperature in retail environments

Unit VII

25 Introduction of cryogenic fluids, key properties, application in refrigeration, focus on liquefaction and low-temperature refrigeration techniques

26 Importance of cryogenic refrigeration in food preservation, usage of cryogenics in freezing and storage, advantages in the food industry

27 Air-conditioning and its role in maintaining comfort and the factors affecting comfort in air-conditioning, concept of the sensible heat factor

28 Classification of air-conditioning systems into unitary, central, and industrial types, features, advantages, and applications of each type of air-conditioning system

Unit VIII

29 Physiological principles that affect air-conditioning and comfort, air distribution and duct design methods for effective temperature control

30 Steps involved in designing of an air-conditioning system, methods for calculating cooling loads and selecting appropriate components for air-conditioning systems

31 Role of humidifiers and dehumidifiers in air-conditioning systems, methods and applications of humidification and dehumidification in maintaining air quality and comfort

32 Different load sources in refrigeration, cooling and internal heat sources. calculation of conduction and convection heat loads, peak loads, miscellaneous loads in refrigeration systems

Practical

No.	Practical Outline
1	Study of vapour compression refrigeration system
2	Determination of COP of vapour compression refrigeration system
3	Study of various types of compressors and condensers
4	Study of expansion valves and evaporative coils used in refrigeration systems
5	Study of refrigerants and properties
6	Study of direct and indirect contact freezing equipment for foods
7	Study of spray freezing process
8	Study of food cold storage, estimation of refrigeration load
9	Estimation of refrigeration load for meat and poultry products
10	Study of refrigeration system of dairy plant through industrial Visit
11	Estimation of refrigeration load for ice-cream
12	Study of cooling system for bakery
13	Estimation of refrigeration load during chocolate enrobing process
14	Study of refrigerated van
15	Study of deep freezing and thawing of foods
16	Practical Examination

Reference

1. Arora, C.P. 2009 Refrigeration and Air Conditioning. 3rd Ed. The McGraw Hill Education Pvt. Ltd., New York

2. Borgnakke,C. and Sonntag, R.E., 2020. Fundamentals of thermodynamics. 10th Ed. John Wiley & Sons
3. Silberstein, E., Obrzut, J., Tomczyk, J., Whitman, B. and Johnson, B., 2020. Refrigeration and Air Conditioning Technology. 9th Ed. Cengage Learning.
4. Dossat 2002. Principles of Refrigeration Pearson Education India; 4th Ed.
5. Althouse, A.D., Turnquist, C.H., Bracciano, A.F. and Bracciano, D.C., 2004. Modern refrigeration and air conditioning. 20th Ed. Tinley Park, IL, USA: Goodheart-Willcox.

FDPE 421 Food Process Equipment Design 3(2+1)

Objectives

1. To learn design aspects of various food processing equipment
2. To get acquaint with usage and maintenance of machine component
3. Hazard & safety aspects of food process machines

Course Outlines

Theory

Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes. Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations. Design of pressure and storage vessels: Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort. Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystallizer and entrainment separator. Design of agitators and separators: Design of agitators and baffles; Design of agitation system components and drive for agitation. Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems. Design of freezing equipment:

Design of ice-cream freezers and refrigerated display system. Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer. Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin screw extruder. Design of fermenters: Design of fermenter vessel, design problems. Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices

Practical

Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort; Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer; Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer; Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor; Design of twin screw extruder; Design of fermenter.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Materials and properties: Different materials for fabrication; mechanical properties-ductility and hardness

2 Corrosion, protective coatings, corrosion prevention linings in equipment

3 Choice of materials and material codes

4 Design considerations: stresses created due to static, dynamic loads and combined stresses

Unit II

5 Design stresses, theories of failure and safety factor

6 Temperature effects, radiation effects, effects of fabrication method and economic considerations

7 Design of pressure and storage vessels: operating conditions, design conditions and stress

8 Design of shell and its component, stresses from local load, thermal gradient, mountings and accessories

Unit III

9 Design of heat exchangers: Shell and tube heat exchanger

10 Design of plate heat exchanger

11 Design of scraped surface heat exchanger, sterilizer and retort

12 Design of evaporators and crystallizers: single effect, multiple effect evaporators and crystallizer

Unit IV

13 Design of rising film and falling film evaporators; feeding arrangements for evaporators

14 Design of crystallizer and entrainment separator

15 Design of agitators and separators

16 Design of agitation system components and drive for agitation

Unit V

17 Design of centrifugal separator; Equipment components-shafts, pulleys and bearings

18 Design of belts and springs

19 Design of drives and speed reduction systems

20 Design of freezing equipment - ice-cream freezers and refrigerated display system

Unit VI

21 Design of dryers: bed tray dryer and tunnel dryer

22 Design of fluidized dryer and spray dryer

23 Design of vacuum dryer

24 Design of freeze dryer

Unit VII

25 Design of microwave dryer

26 Design of extruders –cold and hot extruder

27 Design of screw and barrel of extruder

28 Design of twin screw extruder

Unit VIII

29 Design of fermenters: Design of fermenter vessel

30 Hazards and safety considerations: Hazards in process industries and analysis of hazards

31 Safety measures in equipment design

32 Pressure relief devices

Practical

No.	Practical Outline
1	Design of pressure vessel
2	Design of shell and tube heat exchangers
3	Design of plate heat exchanger
4	Design of sterilizers and retort
5	Design of single and multiple effect evaporators
6	Design of rising film and falling film evaporator
7	Design of crystallizer
8	Design of tray dryer
9	Design of fluidized bed dryer
10	Design of spray dryer
11	Design of vacuum dryer
12	Design of microwave dryer
13	Design of belt and chain conveyor; Design of screw conveyor

14 Design of bucket elevator and pneumatic conveyor

15 Design of twin screw extruder

16 Practical Examination

References

1. Albert Ibarz and Gustavo V. Barbosa-Canovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
2. Bhattacharyya, B. C. 2008. Introduction to Chemical Equipment Design- Mechanical Aspect. CBS Publishers and Distributors, New Delhi.
3. Couper, J.R., Penney, W.R., Fair, J.R. and Walas, S.M. 2012 Chemical Process Equipment: Selection and Design. Elsevier Inc.
4. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
5. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010.
6. Experiments in food process engineering. New Delhi: CBS. Publisher and Distributors Pvt Ltd.
7. Richardson, J F. and Peacock, D.G. 1994. Coulson and Richardsons's Chemical Engineering, Vol. 3, Chemical and Biochemical Reactors and Process Control, 3rd edn. Elsevier Butterworth-Heinemann, Amsterdam, The Netherlands.
8. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.
9. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.
10. Sinnott, R.K. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd edn. Butterworth-Heinemann, Oxford, UK.
11. Stanbury, P.F. Whitakar, A. and Hall, S.J. 1995. Principles of Fermentation Technology, 2nd edn. Elsevier Science Ltd., Burlington, MA, USA.

Department of Food Safety and Quality Assurance

FSQA 131 General Microbiology 3(2+1)

Objectives

1. Identify the microorganisms, their structure and growth characteristics
2. Techniques for cultivation and preservation and control

Course Outlines

Theory

Scope and history of microbiology: (notable contributions of Leeuwenhoek, Pasteur, Koch, etc.), Place of Microorganisms in living world; Groups of microorganism; Applied area of microbiology, Classification and identification of micro- organism; Major Characteristics of Microorganisms, Methods of classification of bacteria. Microscopy: Introduction to microscope; Component of microscope; Types of microscopes and microscopic techniques. Microbial Ultra Structure and Functions: Morphological features; Structures external to cell wall, Cell wall; Structures internal to cell wall. Cultivation and preservation of micro-organisms: Nutritional requirements; Types of media. Physical condition required for the growth; Enumeration methods for micro-organisms. Bacterial Metabolism and Growth: Reproduction of bacteria; Growth of bacteria: growth curve, continuous culture, synchronous culture; Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections. Control of microorganisms: Physical and Chemical agents. Bacterial genetics. Structure and functions of DNA and RNA; Overview of replication and regulation.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/ pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria**.**

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1. Scope and History of Microbiology: (Contributions of Leeuwenhoek, Pasteur, Koch, etc.), Spontaneous Generation theory- Contributions of Antony Van Leeuwenhoek- Francesco Redi- Lazzaro Spallanzani- Franz Schulze- Schroder and Von Dusch-Louis Pasteur- John Tyndall. Role of microbes in fermentation-Contributions of Cagniard Latour-Theodor Schwann, F. Kutzing- Louis Pasteur - Germ theory of disease - Contribution of Louis Pasteur- Robert Koch - Pure Culture Methods- Joseph Lister- Robert Koch- Beijerinck-Winogradsky- Francois Appert- Schroder and Von Dush- John Tyndall.
2. Protection against infection-Contributions of Edward Jenner-F. Loeffler-Behring-Kitasato- Louis Pasteur. Place of Microorganisms in living world: Haeckel 's Kingdom Protista, Prokaryotic and Eukaryotic protists, Whittaker 's Five kingdom concept. Groups of Microorganisms: Bacteria, Fungi, Algae and Protozoa.
3. Applied aspects of Microbiology-Agricultural Microbiology-Industrial Microbiology-Food Microbiology-Medical microbiology-Water Microbiology-Geochemical Microbiology- Pollution microbiology-Air microbiology-Exo-Microbiology - Microbial biotechnology.

Unit II

4. Microbial classification, Nomenclature and Identification of Microorganisms, Major characteristics of Microorganisms.
5. General methods of classifying bacteria.

Unit III

6. Introduction to Microscope, components of microscope: Resolving power, Numerical aperture, Limit of resolution, Magnification.
7. Types of microscopes- Simple microscope, compound, Phase contrast, dark field fluorescent microscope, electron microscope (SEM AND TEM).
8. Microscopic techniques: Smears and staining techniques.

Unit IV

9. Microbial Ultra Structure and Functions: Morphological and fine structure of bacteria-Size, shape, arrangement of bacterial cell structure.
10. Structures external to Cell wall
11. Structures internal to Cell wall
12. Differences between Prokaryotes and Eukaryotes
13. Introduction to Fungi and Yeast: Their distinguishing characteristics, Morphological, cultural characteristics and their reproduction

Unit V

14. Cultivation of bacteria, Nutritional requirements: Nutritional Classification of bacteria-phototrophs, chemotrophs, autotrophs and heterotrophs.
15. Bacteriological Media: Types of media
16. Physical condition required for the growth: Temperature, pH, oxygen and pressure.

Unit VI

17. Bacterial Metabolism and Growth: Reproduction of bacteria, Binary fission, Budding.
18. Growth of bacteria: Growth curve, Continuous culture, Synchronous culture
19. Enumeration methods for microorganisms; Direct microscopic count, Enumeration of cell numbers, Plate count method and Membrane filter count
20. Turbidimetric methods, Determination of Nitrogen content and Determination of dry weight of cells
21. Pure culture; Methods of isolation of pure cultures
22. Maintenance and preservation of pure cultures; Culture collections.

Unit VII

23. Control of microorganisms; Physical agents - High temperature, Thermal death time and Decimal reduction time.
24. Control of microorganisms; Physical agents - Low temperatures, Desiccation, Osmotic pressure, Radiation, U.V. light, x-rays, Gamma rays, Cathode rays, Bacteriological filters.
25. Control of microorganisms; Chemical agents- Characteristics of an ideal antimicrobial chemical agent. Phenol and phenolic compounds, lactose
26. Alcohols, Halogens, Heavy metals, dyes, Synthetic detergents, Quaternary ammonium compounds, Aldehydes, Gases as Agents

Unit VIII

27. Bacterial genetics; Bacterial recombination- bacterial transformation, bacterial conjugation and bacterial transduction
28. Mutations: Types of mutations
29. Structure and functions of DNA and its types
30. Structure and functions of RNA and its types
31. Overview of replication of DNA
32. Regulation and expression of gene activity: Lac operon

Practical

No.	Practical Outline
1	Introduction to microbiology laboratory and its equipment's
2	Experiment on Microscope

3 Experiment on Micrometry
4 Cleaning and sterilization of glassware
5 Preparation of nutrient agar media and Techniques of inoculation
6 Staining methods- Study on Monochrome staining
7 Study on Gram staining
8 Study on Negative staining
9 Study on Capsule staining
10 Study on Flagella staining
11 Study on Endospore staining
12 Pure culture techniques (Streak plate/Pour plate/Spread plate)
13 Introduction to Identification procedures (Morphology and Cultural characteristics)
14 Growth characteristics of Fungi: Determination of microbial numbers, direct plate count, generation time
15 Factors influencing growth: pH, growth curves for bacteria
16 Factors influencing growth: Temperature growth curves for bacteria

References

1. James, C and Natile, S. (10th Ed.) 2014. Microbiology A Laboratory Manual. Pearson education Services Pvt. Ltd., South Asia
2. Madigan, M. Martinko, J.M and Parker, J. Brock Biology of Microorganisms. (14Ed.) hall of India Pvt Ltd., New Delhi.
3. Pelczar Jr. M.J., Chan, E.C.S. and Krieg, N.R. 1998. Microbiology. 5th edn. Tata McGraw-Hill Education, New Delhi.
4. Prescott, L.M., Harley, J.P. and Klein, D.A. (9th Ed.) 2014. Microbiology. McGraw Hill Publishers, New York
5. Stanier, Roger Y., Michael Doudoroff, and Edward A. Adelberg. General Microbiology 4th and 5th edition 1987. Macmillan education Ltd.
6. Tortora, G.J., Funke, B.R. and Case, C.L. 2014. Microbiology: An Introduction. 12th edn. Prentice-Hall, NY, USA.
7. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 9th edn. McGraw-Hill Higher Education, NY, USA

FSQA 132 Food Chemistry I 3(2+1)

Objectives

1. Learn the chemical aspects of food and bio- materials and its importance in food processing
2. Gain an understanding of various water and macro- molecules
3. Have an idea of about the effect of processing on these biomolecules

Course Outlines

Theory

Water; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems. Carbohydrates; Monosaccharides, disaccharides and polysaccharides, modification of carbohydrates, dietary fibers and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates. Proteins in foods: Proteins: Classification, structure and properties, Proteins and nutrition, Functional properties of proteins, Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein. Lipids in foods: Classification, structure and properties of lipids; Role and use of lipids/ fat, crystallization and consistency, chemical aspects of lipids, lipolysis, autooxidation, thermal decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, use of oils and fats in food formulation. Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques, chemical aspects of lipids, antioxidants.

Practical

Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Rheological properties of food systems; Determination of crude proteins by micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and concentrate of proteins; Determination of acid value, saponification value and iodine number of fat/oil; Assay of amylases, papain and lipases

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Nature, scope and development of food chemistry

2 Moisture in foods, role, types of water in foods, water activity

3 Phase diagram, glass transition, sorption phenomena, moisture sorption isotherms and its applications in food processing

Unit II

4 Dispersion systems of foods: classification and properties of dispersed Systems, applications

5 Sols, Gels and Suspensions: Physicochemical aspects and its properties

6 Foams, Emulsions: Physicochemical aspects and its properties.

7 Rheology of diphase systems - definition, importance, factors that affect rheological properties

8 Structure and classification, carbohydrate composition of various natural foods, carbohydrates digestibility

Unit III

9 Enzymatic and chemical reactions of carbohydrates

10 Enzymatic and chemical reactions of carbohydrates

11 Functional properties of carbohydrates: Solubility, cryoprotection, sweetening effect, hygroscopicity, crystallization inhibition, flavor encapsulation, and coating ability

12 Physicochemical Properties: solubility, mutarotation, inversion of sugar, taste, crystallization, absorption of water, hydration properties (swelling, water-holding and water-binding capacity)

Unit IV

13 Effect of food processing on carbohydrates, gelatinization, retrogradation, factors affecting gelatinization and retrogradation, Starch - texturization

14 Enzymatic and non-enzymatic browning, maillard reaction, caramelization, methods to control enzymatic and non-enzymatic reactions

15 Modification of carbohydrates- unmodified and modified starches, modified celluloses, Effects of Food Processing on Dietary Carbohydrates

16 Dietary fibers: NDF, ADF, Cellulose, hemicellulose, pectin, Lignin

Unit V

17 Proteins in foods: Protein content and composition in various foods- cereal grains, legumes and oilseed proteins, proteins of meat, milk, egg and fish

18 Proteins: Classification, structure and properties

19 Proteins and nutrition, Unconventional sources of proteins- SCP fish protein concentrates, leaf proteins

20 Functional properties of proteins in foods – water and oil binding, foaming, gelatin, emulsification

Unit VI

21 Effects of processing on functional properties of proteins heat processing alkali treatments, chilling, freezing, dehydration and radiations

22 Processing induced, physical, chemical and nutritional changes in protein, formation of toxic compounds

23 Chemical modification of protein effect, applications, disadvantages: alkylation, acylation, phosphorylation, sulfitolysis and esterification

24 Enzymatic modification of protein effect, applications, disadvantages: enzymatic hydrolysis, plastein reaction, protein cross linking.

Unit VII

25 Lipids in foods: Classification, structure, crystallization and consistency, Polymorphism and its application, use of oils and fats in food formulation

26 Enzymatic and chemical reactions of fats: Esterification, transesterification, Reichert Meissl number, Polenske number, Saponification Number, Iodine Number, Acid number., Acetyl Value, lipase action on triglycerides, enzymatic lipolysis by lipoxygenase

27 Deteriorative Changes in Fats and Oils and their Prevention - hydrolysis, reversion, lipolysis, auto-oxidation, thermal decomposition, Drying of oil, Safety use of oils and fats in food formulation. antioxidants

28 Physicochemical aspects of fatty acids in natural foods: Fatty acid composition, Solid fat content (SFC), Melting profile, Polymorphism, Viscosity, Plasticity, shortening function, Rheological properties

Unit VIII

29 Oil processing: Refining, hydrogenations, inter esterification,

30 Chemistry of frying technology of fat and oil

31 Rancidity and its types, detection techniques

32 Antioxidants: Natural and synthetic antioxidants, antioxidant activity, antioxidant applications in foods

Practical

No.	Practical Outline
1	Determination of moisture content of foods using different methods
2	Studies of sorption isotherms of different foods
3	Rheological properties of food systems
4	Swelling and solubility characteristics of starches
5	Total carbohydrate estimation of food sample
6	Determination of crude proteins by micro-Kjeldhal method
7	Determination of essential amino acids – lysine, tryptophan, methionine
8	Isolation of egg and milk protein
9	Preparation of protein isolate and concentrate of proteins
10	Determination of acid value of fat/oil
11	Determination of Saponification value of fat/oil
12	Determination of Iodine number of fat/oil
13	Enzymatic Assay of amylase
14	Enzymatic Assay papain
15	Enzymatic Assay lipase
16	Practical Examination

References

1. Brady, J.W. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.
2. Belitz, H. D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-Verlag Berlin Heidelberg.
3. Fennema, O.R. 1996. Food Chemistry, 3rd edn. Marcel Dekker, Inc., New York, USA.
4. Meyer, L.H. 1974. Food Chemistry. The AVI Publishing Co Inc., Connecticut, MA, USA.

FSQA 231 Food Chemistry II 3 (2+1)

Objectives

1. Study chemical aspects of food and bio-materials and their importance in food processing
2. Gain an understanding of chemicals responsible for flavor, pigments and colorants
3. Have an idea of about the effect of processing on these biomolecules
4. Gain the knowledge about role of enzymes in food processing

Lecture Outlines

Theory

Philosophy and definitions of flavor, Chemistry of food flavor; flavourmatics / flavoring compounds, sensory assessment of flavor, technology for flavor retention. Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behavior; Technology for retention of natural colors of food stuffs.

Popular colors used in food and their fictional properties; Regulatory use of regulatory dyes; Color losses during thermal processing. Vitamin functions in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins, optimization and retention of vitamins. Important minerals and their function in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals. Various anti-nutritional factors their mode of action and inactivation. Enzymes in Food Processing: Carbohydrases, proteases, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid, enzyme specificity, Michaelis- Menten equation, regulation mechanism.

Practical

Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium; Determination of phosphorus; Determination of iron;

Estimation of magnesium; Estimation of tannins and phytic acid from food; Determination of vitamin A (Total carotenoids), C, E; Determination of ascorbic acid by dye method; Determination of thiamin and riboflavin; Determination of food colors; Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Philosophy and definitions of flavor, Chemistry of food flavor
2	Flavourmatics / flavoring compounds in vegetables
3	Flavoring compounds in fruits and spice flavors
4	Flavor volatiles – lactic acid, ethanol fermentation, fats and oils
Unit II	
5	Thermally Induced Process Flavors, sensory assessment of flavor, technology for flavour retention
6	Pigments in animal and plants kingdoms: Heme pigments
7	Cured mat pigments, stability of meat pigments
8	Chlorophyll - Structure of Chlorophylls and Derivatives - Physical Characteristics - Alterations of Chlorophyll - Color Loss during Thermal Processing - Technology of Color Preservation
Unit III	
9	Carotenoids – structure, occurrence, distribution, physical properties, chemical properties and stability during processing
10	Phenolic - Effect of substituents on the color of anthocyanidins – effect of pH on structural transformation and color of anthocyanins- effect of temperature, pH, O_2, ascorbic acid, light, sugar and their derivatives-metals, sulfur dioxide, copigmentation, enzyme reactions
11	Flavonoids - Physical Properties - Importance in Foods Proanthocyanidins - Tannins - Quinoids and Xanthones
12	Betalins-Physical Properties, Chemical properties, Oxygen and Light, Conversion of Betacyanin to Betaxanthin
Unit IV	
13	Effect of processing on pigment behavior- Technology for retention of natural colors of foods
14	Popular colors used in food and their functional properties
15	Regulatory use of regulatory dyes
16	Color losses during thermal processing

Unit V

17 Vitamin functions in body and deficiency conditions, Requirements, allowances, Bioavailability of vitamins

18 Losses of vitamins: General causes of variation/losses of vitamins in food, optimization and retention of vitamins, guidelines for addition of vitamins – RDA, RDI, Enrichment, restorations, fortifications

19 Vitamin A - Structure and General Properties, Stability and Modes of Degradation, Bioavailability

20 Vitamin D - Structure and General Properties Stability and Modes of Degradation, Bioavailability,Fortification

Unit VI

21 Vitamin E and K-Structure and General Properties, Stability and Mechanism of degradation, bioavailability, fortification

22 Ascorbic Acid - Structure and General Properties, Stability and modes of degradation, Bioavailability of ascorbic Acid in foods

23 Thiamin -Structure and general Properties, stability and modes of degradation, stability Mechanisms of Degradation, Bioavailability

24 Riboflavin (Vitamin B_2), Niacin, Vitamin B_6 -Structure and General Properties, Stability and Modes of Degradation, Bioavailability

Unit VII

25 Folic acid - stability and modes of degradation, folate stability, degradation mechanisms, fortification, factors affecting folate stability

26 Biotin, Pantothenic Acid, Vitamin B_{12} - Structure and General Properties, Stability of Biotin, Bioavailability

27 Important minerals and their function in body and deficiency conditions, Requirements, allowances

28 Losses of minerals, optimization and retention of minerals, Enrichment, restorations, fortifications

UNIT VIII

29 Enzyme specificity, Michaelis-Menten equation, regulation mechanism

30 Enzymes in Food Processing: Carbohydrases, proteasase, lipases, modification of food using enzymes

31 Role of endogenous enzymes in food quality, enzymes use as processing aids

32 Various anti-nutritional factors their mode of action and inactivation

Practical

No	Practical Outline
1.	Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidationss)

2. Estimation of calcium
3. Determination of phosphorus
4. Determination of iron
5. Estimation of magnesium
6. Estimation of tannins from food
7. Estimation of Phytic acid from food
8. Determination of vitamin A (Total carotenoids)
9. Determination of vitamin E
10. Determination of ascorbic acid by dye method
11. Determination of thiamin
12. Determination of riboflavin
13. Determination of food colors
14. Assessment of hydrocolloids as food additives
15. Assessment of pectinases activity from fruits and vegetables.
16. Practical Examination

References

1. Belitz, H.-D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-Verlag Berlin Heidelberg.
2. Fennema, O.R. 1996. Food Chemistry, 3rd edn. Marcel Dekker, Inc., New York, USA

FSQA 232 Food Microbiology 3 (2+1)

Objectives

1. Microbiology of different foods
2. Food borne toxins
3. Understand spoilage of food

Lecture Outlines

Theory

Importance and significance of microbes in food science; Sources of microorganisms in foods and their effective control; Factors affecting growth and survival of microorganisms in foods; Intrinsic factors i.e., pH, water activity, nutrients, redox potential, oxygen etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere etc. Normal Microbiological quality of Foods and its significance: milk and milk products, fruits and vegetables, cereals and cereal products, meat and meat products, fish and other sea foods, poultry and eggs; sugar and sugar products, slats and spices and canned foods; Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-

nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances; Shelf life: Calculation of shelf life, Shelf-life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf-life simulation for moisture, oxygen, and light sensitive products; Microbial toxins; Bacterial toxins, fungal toxins, algal toxins and mushroom toxins; Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions; Food borne viruses: types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms.

Practical

Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation; Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation; Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation; Microbial examination of milk and milk products: Identification, isolation and confirmation; Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation; Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of *Staphylococcus aureus* from food sample.

Theory

No.	Lecture Outline
Unit I	
1	Types of microorganisms, their importance and significance of microbes in food science
2	Sources of microorganisms in foods and their effective control; green plants and fruits, animals, sewage, soil, water, air and their effective control
3	Microbial spoilage of foods. Cause of spoilage classification of foods by ease of spoilage. Factors affecting kinds and numbers of microorganisms in food
4	Factors affecting growth and survival of microorganisms in foods. Intrinsic factors – Nutrient content, pH, buffering capacity, redox potential (En), Inhibitory substances and biological structures (Antimicrobial barriers and constituents) water activity
Unit II	
5	Extrinsic factors: Relative Humidity, Temperature, Gaseous Atmosphere.
6	Chemical changes caused by microorganisms - changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, Lipids, Pectic substances
7	Microbiological quality of Foods and its significance:moulds, yeasts and bacteria

8 Microbiology of milk and milk products-Sources of contamination, spoilage and prevention

Unit III

9 Spoilage of milk and cream, gas production proteolysis, ropiness, changes in milk fat. Alkali production. Flavors changes and colour changes

10 Spoilage of milk at different temperatures. Condensed and dry milk products. Flavour defects, colour defects

11 Microbiology of fruits and vegetables

12 Spoilage of fruits and vegetables

Unit IV

13 Microbiology of cereals and cereal products: contamination, preservation and spoilage of flours

14 Microbiology of cereal products: Spoilage-Bread, Mold, Rope, Red bread, Chalky Bread

15 Microbiology of meat and meat products: Contamination, preservation

16 Spoilage of meat and meat products. Invasion of tissues by microorganisms and growth of microorganisms in meat

Unit V

17 General types of spoilage of meats. Spoilage under anaerobic conditions, spoilage of different kinds of meats

18 Microbiology of fish and other sea foods. Contamination, preservation, spoilage

19 Factors influencing kind and rate of spoilage, evidences of spoilage, bacteria causing spoilage

20 Microbiology of poultry and eggs: Contamination, preservation, spoilage. Changes during storage. Changes not caused by microorganisms and changes caused by microorganisms

Unit VI

21 Microbiology of sugar and sugar products: Sources of contamination, spoilage and prevention

22 Microbiology of salts and spices: sources of contamination, spoilage and prevention

23 Microbiology of canned foods: Causes of spoilage, appearance of the unopened container, types of biological spoilage of canned foods. Flat sour spoilage, TA spoilage, sulfide spoilage

24 Shelf life: calculation of shelf life, shelf-life requirements, deteriorative reactions, accelerated testing

Unit VII

25 Simulations of product: Package environment interaction, shelf-life simulation for moisture, oxygen, and light sensitive products

26 Bacterial toxins and its types

27 Fungal toxins and its types

28 Algal toxins and its types

Unit VIII

29 Mushroom toxins and its types

30 Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions

31 Food borne viruses: Polio, Hepatitis A & E

32 Food borne viruses: noroviruses, rota viruses, prion diseases, types of food involved, toxicity and symptoms.

Practical

No	Practical Outline
1	Isolation of bacteria and Molds from foods: vegetable and fruits/meat and meat products / fish and other sea foods/ eggs and poultry/ milk and milk products/ sugar, salts and spices/Fermented foods
2	Microbial examination of cereal and cereal products: Identification, isolation and confirmation
3	Microbial examination of vegetable and fruits: Identification, isolation and confirmation
4	Microbial examination of meat and meat products: Identification, isolation and confirmation
5	Microbial examination of fish and other sea foods: Identification, isolation and confirmation
6	Microbial examination of eggs and poultry: Identification, isolation and confirmation
7	Microbial examination of milk and milk products: Identification, isolation and confirmation
8	Microbial examination of salts and spices: Identification, isolation and confirmation
9	Microbial examination of sugar: Identification, isolation and confirmation
10	Microbial examination of canned products: Identification, isolation and confirmation
11	Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus)
12	Thermal death time determination
13	Detection of *Salmonella* from food sample
14	Detection of coliforms from water by MPN method
15	Detection of *Staphylococcus aureus* from food sample
16	Practical Examination

References

1. Adams, M.R. and Moss, M.O. 2008. Food Microbiology, 3rdedn, The Royal Society of Chemistry, Cambridge, UK.

2. Banwart, G.J. 1989. Basic Food Microbiology, 2nd edn. Chapman and Hall, New York, USA.
3. Bibek Ray and Arun Bhunia. 2008. Fundamental Food Microbiology, 4th Ed., CRC press, Taylor and Francis Group, USA.
4. Frazier, W.C. and Westfoff, D.C. 1987. Food Microbiology, 4thedn. Tata McGraw-Hill Education, New Delhi.
5. Jay, J.M. 2000. Modern Food Microbiology, 6thedn. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
6. Ray, B. And Bhunia, A. 2008. Fundamental Food Microbiology, 4thedn., CRC press, Taylor and Francis Group, USA.

FSQA 233 Food Plant Sanitation 3(2+1)

Objectives

1. Importance of sanitation and hygiene and its application to food
2. Gain knowledge of Hazard Analysis and Critical Control Point
3. Learn good manufacturing practices

Course Outlines

Theory

Sanitation and food industry: Sanitation, sanitation laws, regulations, and guidelines, establishment of sanitary Practices. Foodborne bioterrorism: Potential risks and protection measures for bioterrorism. The Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks and its control measures. The Relationship of allergens to sanitation: Food allergens and its control measures. Food contamination sources: Sources of contamination, contamination of foods, protection against contamination. Personal hygiene and sanitary food handling: Personal hygiene, employee hygiene, sanitary food handling, role of employee supervision, employee responsibility. Cleaning compounds and sanitizers: Classification, selection of cleaning compounds and sanitizers, CIP and COP, handling and storage, precautions. Pest and Rodent Control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management. Sanitary design and construction for food processing: Site selection, site preparation, building construction considerations, processing and design considerations, pest control design. Waste product handling: solid waste and liquid waste management. Role of HACCP in sanitation: Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices.

Practical

Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand); Determination of hardness of water; Good Manufacturing Practices

(GMPs) and personal hygiene; Sewage treatment: Primary, secondary, tertiary and quaternary; Aerobic and anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant; Isolation and identification of Actinomycetes; Enrichment and isolation of cellulose degrading bacteria; Biodegradation of phenol compounds; Bacteriological examination of water: Coliform MPN test; Sampling of airborne microorganisms; Sampling of surfaces - equipment and physical plant; Aerosol sampling and measurement guidelines.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Sanitation - Sanitation and the food industry
2	Sanitation laws and regulations, guidelines, establishment of sanitary practices
3	Foodborne bioterrorism: Potential risks and protection measures
4	Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks; control measures
Unit II	
5	Relationship of allergens to sanitation: Food allergens and its control measures
6	Food contamination: Sources of contamination, contaminants of food, protection against contamination
7	Personal hygiene: Personal hygiene, employee hygiene
8	Sanitary food handling, role of employee supervision, employee responsibility
Unit III	
9	Cleaning compounds and sanitizers: Classification, selection of cleaning compounds and sanitizers
10	Concept of Cleaning in Place (CIP) and Cleaning Out Place (COP) in Food industry
11	Handling and storage, precautions of cleaning compounds and sanitizers in food industry
12	Pest and Rodent Control: Insect infestation, cockroaches, insect destruction
Unit IV	
13	Control of rodents and birds, use of pesticides, integrated pest management in pest control
14	Sanitary design and construction for food processing: Site selection, site preparation
15	Building construction considerations, processing and design considerations, pest control design in Food processing
16	Waste product handling: solid waste management
Unit V	
17	Waste product handling: liquid waste management
18	Role of HACCP in sanitation of food industry

19 Good manufacturing practices in food industry

20 Current good manufacturing practices in food industry

Unit VI

21 Standard operating procedures in food industry

22 Good laboratory practices in food industry

23 Low-moisture food manufacturing and storage sanitation-sanitary construction, considerations, receipt and storage of raw materials, cleaning of low-moisture food manufacturing plants

24 Dairy processing plant sanitation-role of pathogens, sanitary construction considerations, soil characteristics in dairy plants, sanitation principles, cleaning equipment

Unit VII

25 Meat plant sanitation - role of sanitation, sanitation principles, cleaning compounds for meat and poultry plants, sanitizers for meat and poultry plants, sanitation practices, sanitation procedures

26 Poultry plant sanitation - role of sanitation, sanitation principles, cleaning compounds for meat and poultry plants, sanitizers for meat and poultry plants, sanitation practices, sanitation procedures

27 Sea food plant sanitation-sanitary construction considerations, contamination, sources, sanitation principles, recovery of byproducts

28 Fruit processing plant sanitation-contamination sources, sanitary, construction considerations, cleaning considerations, cleaning of processing plants, cleaners and sanitizers, cleaning procedures, evaluation of sanitation effectiveness

Unit VIII

29 Vegetable processing plant sanitation - contamination sources, sanitary, construction considerations, cleaning considerations, cleaning of processing plants, cleaners and sanitizers, cleaning procedures, evaluation of sanitation effectiveness

30 Beverage plant sanitation-mycology of beverage manufacture plant, sanitation, principles

31 Non-alcoholic beverage plant sanitation

32 Brewery sanitation, winery sanitation, distillery sanitation

Practical

No.	Practical Outline
1	Estimation of BOD and COD
2	Determination of hardness of water
3	Practical on Good Manufacturing Practices (GMPs) and personal hygiene
4	Sewage treatment: Primary, secondary, tertiary and quaternary

5 Aerobic and anaerobic sludge treatment
6 Lab demonstration on state of water
7 Study of CIP plant
8 Isolation and identification of actinomycetes
9 Enrichment and isolation of cellulose degrading bacteria
10 Biodegradation of phenol compounds
11 Bacteriological examination of water - Coliform MPN test
12 Bacteriological examination of water - Coliform MPN test
13 Sampling of airborne microorganisms
14 Sampling of surfaces - equipment and physical plant
15 Aerosol sampling and measurement guidelines
16 Practical Examination

References

1. Cramer, M.M. 2013. Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices. CRC Press, Boca Raton, FL, USA.
2. Hui, Y.H., Bruinsma, B.L., Gorham, J.R., Nip, W.-K., Tong, P.S and Ventresca, P. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.
3. Mitchell, R and Gu, J. D. 2010. Environmental Microbiology, 2nd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
4. Marriott, N.G and Gravani, R.B. 2006. Principles of Food Sanitation, 5th edn. Springer Science and Business Media, Inc., NY, USA.
5. Pepper, I.L and Gerba, C.P. 2005. Environmental Microbiology: Laboratory Manual, 2nd edn. Elsevier Academic Press, Amsterdam.

FSQA 234 Food Quality, Safety Standards and Certification 2(2+0)

Objectives

1. To develop skills to ensure that food products meet standards for quality, such as taste, texture, appearance, and nutritional value.
2. To acquaint the comply with regulations: Ensure compliance with local, national, and international regulations and standards

Course Outlines

Theory

Introduction: Definition, its role in food industry, Quality attributes; Quality Defects: Classification, Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring. Pathological defects; Mechanical defects,

extraneous or foreign material defects. Measurement of defects by different techniques; Quality assessment; Quality assessment of food materials on the basis of sensory evaluation, physical, chemical microbiological methods; Quality of products during and after processing; Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage conditions, processing conditions, packaging and storage conditions of finished products. Role of QC and QA Quality: Quality Control, Quality Assurance, Concepts of quality control and quality assurance, functions in food industries; Quality Improvement Total Quality management: Quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map. Quality improvement tools, customer focus, cost of quality.

Food Laws and Standards: National and International food laws. Mandatory and voluntary food laws. Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities. AGMARK, BIS, FPO, Weights and Measures Act, CODEX; Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification, FPO –standards and certification process Weights and Measures Act and Packaged commodity rules; Role of CODEX in food safety and standards, Food safety issues and risk analysis; FSMS 22000, Food Safety Management Systems, ISO 22000 – 2005 and other Global Food safety management systems. Principles, implementation; documentation, types of records; Auditing, certification procedures, certifying bodies, accrediting bodies.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Quality attributes, Classification: color and gloss – definition, different colors, color measurement by spectrophotometer, munell color system and Lovibond tintometer, role in food quality

2 Role of consistency and viscosity in food quality, physical properties: size and shape, weight, volume, weight to volume ratio, length, width, diameter, symmetry, curvature and area

3 Defects – classification, genetic and physiological factors: structural, off color character; entomological defects: holes, scars, lesions, off coloring, pathological defects, mechanical defects, extraneous or foreign materials defects. Measurement of defects: Improving visibility by dilution, white background, color differences, standardization of conditions, reference standards, counts and measures, isolation of defects by floatation, elution, electronic sorting and internal defects

4 Flavor – definition and its role in food quality, taste – classification, taste qualities, relative intensity, reaction time, effect of disease, temperature and taste, medium on taste, basic tastes, interaction of tastes

Unit II

5 Odor: Definition, classification, neutral mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odor intensities, olfaction, visual, auditory, tactile and other senses, vision, audition, oral perception other than taste

6 Quality of raw materials: sampling and methods of sampling, physical, chemical and microbial quality, quality of products during and after processing: color, taste, texture, flavor and appearance

7 Factors influencing the food qualities: soil, field practices, harvesting practices, procedures, packaging, transportation, storage conditions, processing conditions, packaging and storage conditions of finished products. Recording and reporting of quality. Quality inspection, quality control

8 Food quality – definition and its role in food industry. Quality recording and reporting of quality. Quality inspection, quality control quality and quality assurance functions in food industries

Unit III

9 Quality Improvement: Quality evolution, quality gurus, Quality improvement tools, customer focus, cost of quality.

10 Total Quality Management (TQM) – concept and need for quality, components of TQM, principals of TQM, stages in implementation, TQM road map

11 GMP, GHP, GLP, GSP, SSOPs, allergen management practices

12 Quality management systems, QSS, Quality circles, SQC, ISO system

Unit IV

13 Food Laws and Standards, National food laws

14 International food laws

15 Mandatory and voluntary food laws

16 Indian Food Regulations and Certification

Unit V

17 Food Safety and Standards Act, FSSAI Rules, food adulteration, misbranding, common adulterants in foods

18 Duties and responsibilities of Food Safety Authorities

19 AGMARK, BIS, FPO, Weights and Measures Act

20 CODEX, Role of CODEX in food safety and standards

Unit VI

21 Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification

22 FPO –standards and certification process

23 Weights and Measures Act and Packaged commodity rules

24 Food safety issues and risk analysis

Unit VII

25 Study of HACCP

26 FSMS 22000, Food Safety Management Systems

27 ISO series: ISO 22000 – 2005

28 Global Food safety management systems- principles, implementation; documentation, types of records, certifying bodies, accrediting bodies

Unit VIII

29 Auditing - audit, mock audit, third party Quality certifying audit, auditors and lead auditors, certification

30 Certification, certification procedures, certifying bodies, Accrediting bodies, international bodies

31 Food Standards and Regulations in India

32 International Organizations and Agreements in the Area of Food Standards, Quality, Research and Trade

References

1. Alli, I. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA.
2. Hester, R.E. and Harrison, R.M. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK
3. Hester, R.E. and Harrison, R.M. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK

FSQA 331 Food Biochemistry and Nutrition 3(2+1)

Objectives

1. To gain understanding of nutrition and diets
2. To impart knowledge on the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration

Course Outlines

Theory

Concepts of Food and Nutrition; Functions of food; Basic food groups; nutrients supplied by food; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Mechanism of Enzyme action; Introduction to enzyme and characteristics, coenzymes, kinetics and mechanism of enzyme action; Derivation of Michaelis- Menten Equation, Enzyme inhibition

by pH, allosteric enzymes; Nucleic acids, structures of various components of DNA and RNA. Nutrients; Functions, sources, digestion, absorption, assimilation, transport of carbohydrates; Functions, sources, digestion, absorption, assimilation, transport of proteins; Functions, sources, digestion, absorption, assimilation, transport of fats; Metabolism of carbohydrates. Introduction to carbohydrates metabolism, glycolysis, TCA cycle; Electron transport chain, oxidative and substrate level phosphorylation; Metabolism of Lipids; Introduction to lipid metabolism, âoxidation of long chain fatty acids, Ketosis, breakdown of phospholipids; Biosynthesis of fatty acids, triglycerides and phospholipids; Introduction to protein metabolism, transamination; Deamination and decarboxylation; Fixation of Nitrogen, Urea Cycle; Functions, sources, absorption, deficiency of macro minerals, microminerals and trace minerals; Functions, sources, absorption, deficiency of Vitamins A &D, Vitamins E and K and water-soluble vitamins Information about hormones and relation between vitamins and hormones.

Practical

Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates; Qualitative and quantitative determination of amino acids; Qualitative and quantitative determination of proteins; Qualitative and quantitative determination of lipids; Qualitative and quantitative determination of vitamins; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pka of acid; Determination of pI for casein; Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of amino acid using Biuret reaction; Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis; Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples; Estimation of â-carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Introduction on fundamentals of foods and human nutrition – Functions of food-Important definitions- food–nutrients, nutrition and health etc, - specific nutrients in food-Macro nutrients and micronutrients and their functions
2	Basic food groups - Types of basic food groups (grains, vegetables, fruits, proteins, dairy products) and their nutritional facts
3	Water and energy balance, water intake and losses, basal metabolism
4	Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups

Unit II

5 Potentially toxic substance in human food

6 Concept of balanced diets–Definition, importance of balanced diet, health benefits, classification of balanced diet, preparation of balanced diet for various groups

7 Malnutrition - Definition, causes and symptoms of kwashiorkor and marasmus - Differences between kwashiorkor and marasmus, prevention and treatment strategies. Obesity, assessment of nutritional status

8 Fad diets, types, classification, reasons of adoption, impact, faddism

Unit III

9 Recommended Dietary Allowances (RDA)–Definition, calculation of RDA, significance of RDA for different age groups based on sex, age, activity level and physiological state

10 Nutritional requirements - Among different age groups, impact of age on nutrient absorption and metabolism

11 Definition, Importance of enzymes; Classification of enzymes with reactions; Properties of Enzymes – Enzyme specificity: Features of Active Site; Cofactors and Coenzymes Mechanism of Enzyme Action: Lock-and-Key vs. Induced Fit Models; Mechanism of enzyme action by lowering activation energy

12 Mechanism of enzyme catalysis; Factors affecting enzyme activity – concentration of enzyme, substrate, effect of temperature, pH & product concentration; feedback inhibition and its role in metabolic pathways

Unit IV

13 Michaelis-Menten Kinetics - Km and Vmax; Enzyme inhibition– Irreversible inhibition, Reversible inhibition - Types of Enzyme Inhibition: Competitive, Non- Competitive

14 Functions of Nucleic acids; Structure of Nucleotides; Components and Classification of Nucleic Acids: DNA and RNA, Structure of DNA & RNA; Denaturation of DNA Strands – Melting temperature

15 Structure of RNA; classification, functions

16 Carbohydrates as nutrients - Definition, types of carbohydrates, functions of carbohydrates – Sources - digestion, absorption, transport of nutrients

Unit V

17 Digestion of carbohydrates, enzymes involved in carbohydrate digestion, absorption of simple sugars in the small intestine, assimilation, transport of carbohydrates

18 Proteins as nutrients - Definition, types of proteins-. Functions of proteins, sources

19 Digestion of proteins, enzymes involved in protein digestion (gastric and pancreatic enzymes) amino acid absorption, assimilation and transport

20 Fats and Lipids as nutrients-Definition, types of fats (saturated, unsaturated, trans fats) Functions of fats, sources

Unit VI

21 Digestion of fats - enzymes involved in fats digestion (Lipase activity) and fat absorption in the small intestine transport of lipids (Chylomicrons, Lipoproteins)

22 Metabolism of nutrients – Overview of anabolism and catabolism, Introduction to carbohydrate metabolism, glycolysis, TCA cycle

23 Electron transport chain, oxidative and substrate level phosphorylation- Inter conversion of nutrients (Gluconeogenesis, Lipogenesis)

24 Metabolism of Lipids; Introduction to lipid metabolism, âoxidation of long chain fatty acids, Ketosis, breakdown of phospholipids

Unit VII

25 Biosynthesis of fatty acids, triglycerides and phospholipids

26 Introduction to protein metabolism, transamination; deamination and decarboxylation

27 Fixation of Nitrogen, Urea cycle

28 Functions, sources, absorption, efficiency of macro minerals, micro minerals and trace minerals

Unit VIII

29 Overview of Water-Soluble Vitamins (B-Complex, Vitamin C); Metabolic Functions, Coenzymes; Deficiency Symptoms; Dietary Sources

30 Overview of Fat-Soluble Vitamins (Vitamins A, D, E, K); Absorption, Transport, and Storage of Fat-Soluble Vitamins; Biological Functions, Deficiency Symptoms, Associated Disorders and Dietary Sources

31 Hormones, Function, examples - Vitamins, function, examples - relation between vitamins and hormones, deficiency diseases

32 Micronutrient deficiencies (Iron, Iodine), vitamin deficiencies, prevention strategies (fortification, supplementation)

Practical

No.	Practical Outline
1	Preparation of various solutions and buffers
2	Qualitative and quantitative determination of carbohydrates; estimation of sugars by Anthrone method
3	Qualitative and quantitative determination of amino acids; estimation of amino acid using Biuret reaction
4	Qualitative and quantitative determination of proteins, estimation of protein by Lowry method
5	Qualitative and quantitative determination of lipids
6	Qualitative and quantitative determination of vitamins
7	Isolation of enzymes from various sources

8 Measurement of energy using bomb calorimeter
9 Determination of pka of acid and pI for casein
10 Separation of amino acids using paper chromatography; thin layer chromatography
11 Separation of amino acids using electrophoresis
12 Estimation of phosphorus, Iron and calcium in food sample
13 Estimation of â-carotene using column chromatography
14 Estimation of ascorbic acid using dye method
15 Effects of acids and alkali on pigments
16 Practical Examination

References

1. Berdanier, C.D., Feldman, E.B. and Dwyer, J. 2008. Handbook of Nutrition and Food, 2nd edn. CRC Press, Boca Raton, FL, USA.
2. Berg, J.M., Tymoczko, J.L., Stryer, L. and Gatto Jr., G.J. 2002. Biochemistry, 7thedn. W.H. Freeman and Company, NY, USA.
3. Buchanan, B.B., Gruissem W. and Jones, R.L. 2002. Biochemistry and Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.
4. Moe, G., Kelley, D., Berning, J. and Byrd-Bredbenner, C. 2013. Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.
5. Nelson, D.L. and Cox, M.M. 2012. Lehninger Principles of Biochemistry, 6thedn. Macmillan Learning, NY, USA.
6. Satyanarayana, U. 2017. *Biochemistry* (4th ed.). Elsevier Health Sciences.
7. Srilakshmi, B. 2018. *Food science* (7th ed.). New Age International Publishers.
8. Voet, D and Voet, J.G. 2011. Biochemistry, 4thedn. John Wiley and Sons, Inc., NY, USA.

FSQA 332 Food Additives and Preservatives 2(1+1)

Objectives

1. Look at the ingredient label of a food product and be able to assign functions to most of it.
2. Able to suggest alternative ingredient choices for food products
3. Discuss the contributions and the limitations of food additives in food supply.
4. Able to apply the methods used for evaluating the safety of food additives

Course Outlines

Theory

Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food

color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action; Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic);Identification of food colour by TLC (organic and inorganic);Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in foods; Role of leavening agent in baked food product; Preservation of food samples using humectants.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Introduction: Definition - Role of food additives in food processing -functions - classification -intentional and unintentional food additives, naturally occurring food additives

2 Toxicology and safety evaluation of food additives - beneficial effects and harmful effects of food additives – categories of food additives under generally recognized as safe (GRAS) - tolerance levels and toxic levels in foods – ADI and LD50 values of food additives

3 Food colors and dyes: Regulatory aspects of dyes, permitted, non-permitted and provisionally listed colors, dyes and lakes their sources, importance and utilization; safe doses and toxic effects food color

4 Food colors – natural and artificial food colors, pigments and their importance and utilization as food color; processing of natural and artificial food colorants- natural and synthetic food colors - types -their chemical nature - their impact on health

Unit II

5 Flavoring agents - definition, types, sources, mechanism of action and application in processed foods-permitted levels and toxic effects; natural flavors and synthetic flavors - examples and their chemical nature -role of flavoring agents in food processing, taste enhancers

6 Nutritional and non-nutritional sweeteners-definition, types of nutritional and non-nutritional sweeteners (natural and synthetic) - functions, special dietary supplements and their health implication - role in food processing permitted levels and toxic effects

7 Food preservatives and their chemical action; Role and mode of action of Class I and Class II preservatives, safe doses/permitted levels of usage in food and toxic effects

8 Anti-oxidants and chelating agents - what are anti-oxidants - their role in foods - types of antioxidants-natural and synthetic - examples - what are chelating agents - their mode of action in foods –examples

Unit III

9 Stabilizers and thickeners - examples - their role in food processing. Algal polysaccharides, plant-based gums, cellulose derivatives, gelatin, pectin. Modified starches – properties, applications and permitted levels in processed foods

10 Starch modifiers: what are starch modifiers - chemical nature - their role in food processing

11 Flour bleaching and maturing agents - definition, types of bleaching and maturing agents in bread industry, functions, their mechanism of action in food products, permitted levels and toxic effects

12 Leavening agents- definition, types of leavening agents – natural and chemical leavening agents – baking powders and classification of baking powders based on acid component and mode of action - permitted levels and toxic effects

Unit IV

13 Humectants/polyhydric alcohol, anti-caking agent, firming agent, Acidity regulators: definition, functions, their mechanism of action in food products, permitted levels and toxic effects

14 Enzymes play important roles in various aspects of food processing

15 Fat substitutes- definition, types, functions, sources, production of fat substitutes, role and mechanism of action in processed foods

16 Emulsifiers- definition, classification, properties, mechanism of action and applications, surface activity in O/W and W/O systems – HLB value and critical micellar concentration and their significance in defining the role of emulsifiers and permitted levels and toxic effects

Practical

No.	Practical Outline
1	Evaluation of GRAS aspect of food additives
2	Estimation of chemical preservatives by TLC (organic)
3	Estimation of chemical preservatives by TLC (inorganic)
4	Identification of food color by TLC (organic)
5	Identification of food color by TLC (inorganic)

6 Quantitative estimation of added dyes
7 Isolation and identification of naturally occurring food pigments by paper chromatography
8 Isolation and identification of naturally occurring food pigments by TLC
9 Role and mode of action of chelating agent in fruit juice
10 Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream)
11 Role and mode of clarifying agent in fruit juices
12 Role and mode of antioxidant in frozen fish
13 Role of leaving agent in baked food product
14 Preservation of coconut shreds using humectants
15 Thin Layer Chromatographic detection of antioxidant and emulsifiers
16 Practical Examination

References

1. Belitz, H. D., Grosch, W. and Schieberle, P. (2009). Food Chemistry. 4th edn. Springer-Verlag, Berlin, Heidelberg.
2. Deshpande, S.S. (2002). Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.
3. Belitz, H. D., Grosch, W. and Schieberle, P. (2009). Food Chemistry. 4th edn. Springer-Verlag, Berlin, Heidelberg.
4. Mahindru, S. N. (2008). Food Additives: Characteristics, Detection and Estimation. APH Publishing Corporation, New Delhi.

FSQA 333 Sensory Evaluation of Food Products 2(1+1)

Objectives

1. To understand basic concept of sensory evaluation
2. To gain knowledge about consumer study

Course Outlines

Theory

Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation; Principles of good practice: the sensory testing environment, test protocol considerations, Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Flavour: Definition and its role in food quality; Taste:

Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odour testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste; Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests. Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling; dilution procedures, descriptive sensory analysis, contour method, other procedures; Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.

Practical

Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo- trio, triangle); Determination of threshold value for various odours; Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Descriptive analysis methodology; Sensory evaluation of various food products using different scales, score cards and tests; Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.

Lecture Outlines

No.	Lecture Outline
Unit I	
1	Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects
2	Factors affecting food acceptance, terminology related to sensory evaluation
Unit II	
3	Principles of good practice: the sensory testing environment, test protocol considerations
4	Basic principles: senses and sensory perception, physiology of sensory organs

Unit III

5 Threshold value factors affecting senses visual, auditory, tactile and other senses. Flavour: definition and its role in food quality; Taste: classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes

6 Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odour testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste

Unit IV

7 Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment

8 Relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis, requirements of sensory evaluation, sampling procedures

Unit V

9 Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests

10 Quality evaluation application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control

Unit VI

11 Laboratory quality measurement: Panel selection and testing environment, serving procedures, instruction to judges

12 Difference tests, directional difference tests, classification of difference tests, two-sample tests, three sample tests

Unit VII

13 Multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling; dilution procedures, descriptive sensory analysis, contour method, other procedures

14 Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, Information obtained from consumer study, factors influencing results from consumer surveys, methods of approach

Unit VIII

15 Development of the questionnaire, types of questionnaires, serving procedures

16 Comparison of laboratory panels with consumer panels; Limitations of consumer survey

Practical

No.	Practical Outline
1	Determination of threshold value for basic tastes - sweetness, saltiness
2	Determination of threshold value for basic tastes- sourness, bitterness
3	Odour recognition test in different foods by sensory methods

4 Difference (PC, duo-trio, triangle) tests

5 Determination of threshold value for various odours

6 Selection of judging panel

7 Training of judges for recognition of certain common flavour and texture defects using different types of sensory tests- hedonic rating

8 Training of judges for recognition of certain common flavour and texture defects using different types of sensory tests- numerical scoring

9 Training of judges for recognition of certain common flavour and texture defects using different types of sensory tests- composite scoring

10 Descriptive analysis methodology- flavour profile and dilution flavor profile methods

11 Sensory evaluation of various food products using different scales, score cards and tests line scaling method

12 Determination of Texture using sensory methods

13 Estimation of colour

14 Relationship between objective and subjective methods

15 Designing a sensory laboratory

16 Practical Examination

References

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic
3. Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood
4. Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker
5. Lawless, H.T. and Heymann. H. 2010. Sensory Evaluation of Food: Principles and Practices, 2nd edn. Springer, New York or Dordrecht Heidelberg, London
6. Macrae, R., Robinson, R.K. and Sadler, M.J. 1994. Encyclopedia of Food Science and Technology and Nutrition. Vol. XI. Academic Press
7. Moskowitz, H. R. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA
8. Piggot, J.R. 1984. Sensory Evaluation of Foods. Elsevier Science and Technology

Department of Food Business Management

FDBM 141 Farming Based Livelihood System 3 (2+1)

Objectives

1. To make the students aware about farming- based livelihood systems in agriculture.
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood.
3. To make the students understand about farming- based livelihood systems in agriculture by exposure.

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and 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 and 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 and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and 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 and 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 and their functional aspects for integration of production, processing and 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 and profit analysis, Case study of Start-Ups in agri-sectors.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Indian Agriculture - Importance, scope, Key Crops and Agricultural regions; major challenges in agriculture; status of agriculture in different states of India; production and yield for different crops in India and state wise
2	Definition of Income; different sources of income to rural people and farmers, challenges, rural employment and income distribution
3	Livelihood-Definition, concept, key components of livelihood; livelihood pattern in urban and rural areas, types, factors affecting rural livelihood
4	Different indicators to study livelihood systems–definition of indicators, types of indicators to measure livelihood systems in India
Unit II	
5	Agricultural livelihood systems (ALS): Meaning, definition, core components of ALS, approaches-sustainable livelihood approach, agro-ecological approach, value chain approach, integrated rural development approach and farming systems approach
6	Framework of agricultural livelihood systems (ALS)
7	Farming systems–Definition, concept, objectives, scope, classification, key elements of farming system.
8	Farming-based livelihood systems–definition, scope; prevalent farming systems in India contributing to livelihood-crop based farming system, mixed farming systems, horticulture-based system
Unit III	
9	Livestock based farming systems, fishery-based systems, integrated farming systems; contribution of farming systems to livelihood in India
10	Traditional farming systems - meaning, definition, types - shifting cultivation, subsistence farming, pastoralism, mixed farming, terrace farming.
11	Modern farming systems–meaning, types-monoculture farming, commercial farming, Agro-forestry, hydroponics and aquaponics, precision farming, vertical farming, genetically modified farming; difference between traditional farming and modern farming.
12	Components of farming system/farming-based livelihood systems - crops and cropping systems-key types of cropping systems- monocropping, mixed cropping, intercropping, crop rotation, agropastoral systems.

Unit IV

13 Livestock based systems - dairy, piggery, goatry, poultry, duckry, sheep, horticultural crops, agro-forestry systems, silvopastoral systems, agro-silviculture, Agri-Horti forestry

14 Integrated livestock systems – mixed crop – livestock farming, aquaculture systems-Duck/Poultry cum fish farming, dairy cum fish farming, piggery cum fish farming etc., special integrated livestock systems

15 Enterprise - Small, medium and large enterprises as a livelihood component for farmers

16 Value chains in agriculture – primary and secondary components of value chain

Unit V

17 Secondary enterprises as livelihood components for farmers – Agri-tourism, processing of farm products, animal husbandry, crafts and handicrafts, renewable energy production, transport and logistics, Input supply and equipment leasing

18 Role of enterprises in supporting farmer livelihoods; challenges and opportunities in value chain for smallholder farmers

19 Factors affecting integration of various enterprises of farming for livelihood – environmental factors, economic factors, technological factors and social and cultural factors, policy and institutional factors and ecological sustainability

20 Feasibility of different farming systems for different agro-climatic zones

Unit VI

21 Commercial farming- livelihood models by NABARD – Integrated watershed management program (IWMP), Agri–Clinic and Agri- business centers (ACABA), model bank projects, NABARD'S Rural Infrastructure Development Fund (RIDF), Farmer Producer Organization (FPOs).

22 Commercial farming-livelihood models by ICAR–KVK, AICRP, NAIP, ABIC, and other Government sector

23 Commercial farming- livelihood models by and private sector schemes, state initiatives and NGO models

24 Case studies on different livelihood enterprises associated with the farming

Unit VII

25 Risk and success factors in farming-based livelihood systems

26 Schemes and programs by Central and State Government

27 Public organizations involved in promotion of farming-based livelihood opportunities

28 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 – Circular economy,

30 Green Economy

31 Impact of climate change in Agriculture

32 Digitalization and changing life style

Practical

1 Practical survey of farming systems
2 Practical survey of agricultural-based livelihood enterprises
3 Study of different Agricultural Livelihood System (ALS) approaches and framework
4 Study of components of important farming- based livelihood models/ systems in different agro-climatic zones
5 Study of production and profitability of crop based & livestock-based livelihood models
6 Study of production and profitability of processing based and integrated farming-based livelihood models
7 Field visit of innovative farming system models
8 Field visit to livestock farming &Aqua culture systems
9 Visit of agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors
10 Study of agri-enterprises value Chain Models involved in industry
11 Study of agri-enterprises value Chain Models involved in service sectors
12 Study about the project formulation on farming-based livelihood systems along with cost and profit analysis
13 Study about the project formulation on farming-based livelihood systems along with cost and profit analysis
14 Case study of Start-Ups in agri-sectors
15 Case study of Start-Ups in agri-sectors
16 Final Practical Examination

References

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C.; Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7. [Google Scholar].
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy. Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy.
4. Dixon, J. and A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA.
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali,

Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna 800 014, Bihar.

6. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi. 5. Singh, J.P., et al. 2015.
7. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
8. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
9. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

FDBM 142 Communication Skills 2(1+1)

Objectives

1. To acquire competence in oral, written and non-verbal communication
2. To develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Précis writing/ Abstracting/Summarizing; Style of technical communication. Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions. Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbal's; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: précis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners:

grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

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 Précis writing: Definition, meaning, characteristics of good précis, do's and don'ts of précis. 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: 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 Précis Writing, summarizing and Abstracting: Recapitulation of definition, meaning and characteristic features of good précis. Allocation of topics and finding out the précis writing, abstracting/summarizing skills of students.

15 Interview Techniques: 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: cum discussion on definition, meaning purpose, steps and tips in organization and evaluation of event. Group exercise on organization and evaluation of event.

References

1. Allport, GW.1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Brandreth Gyles. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter, S J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar, S and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication: A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman, M and Singh, P. 2000. Business Communication. Oxford University Press.
9. Raymond Murphy. 2024. Essential English Grammar Cambridge University Press. (Latest Edition)
10. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
11. Thomson, A J and Martinet, A V. 1977. A Practical English Grammar. Oxford University.
12. Wren and Martin. November, 2023. English Grammar and composition. Revised by Dr. NDV Prasada Rao. S. Chand School Publication. (Latest Edition).

FDBM 143 **Environmental Studies and Disaster Management** **3 (2+1)**

Objectives

1 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 ecosystems. 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: (i) Air pollution. (ii) Water pollution. (iii) Soil pollution. (vi) Marine pollution. (v) Noise pollution. (vi) Thermal pollution (vii) 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	Introduction to environment - environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies
2	Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere.
3	Natural Resources: Classification - Forest resources: Use and overexploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
4	Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
Unit II	
5	Natural Resources: Mineral resources - Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
6	Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
7	Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
8	Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
Unit III	
9	Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem, Producers, consumers, decomposers
10	Energy flow in the ecosystem - Energy flow, ecological succession, food chains, food webs, ecological pyramids.
11	Types of Eco system: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
12	Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity

Unit IV

13 Biodiversity hot spots. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts.

14 Endangered and endemic species of India. Conservation of biodiversity - In-situ and Ex-situ conservation of biodiversity.

15 Environmental Pollution: Definition, cause, effects and control measures of: (i) Air pollution, (ii) Water pollution. (iii) Soil pollution.

16 Definition, cause, effects and control measures of: (vi) Marine pollution, (v) Noise pollution, (vi) Thermal pollution and (vii) light pollution.

Unit V

17 Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production

18 Causes, effects and control measures of urban and industrial wastes.

19 Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management.

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

Unit VI

21 Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.

22 Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programmes.

23 Environment and human health: Human Rights, Value Education, Women and Child Welfare.

24 Role of Information Technology in Environment and human health.

Unit VII

25 Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves.

26 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.

27 International and National strategy for disaster reduction

28 Concept of disaster management, national disaster management framework

Unit VIII

29 Financial arrangements, role of NGOs in disaster management

30 Community-based organizations and media in disaster management.

31 Central, state, district and local administration in disaster control

32 Armed forces in disaster response, Police and other organizations in disaster management.

Practical

No.	Practical Outline
1	Visit to a local area to document environmental assets river/ forest/ grass land / hill / mountain
2	Production of Biogas from organic wastes
3	Visit to wind mill / hydro power / solar power generation units
4	Assessment of biodiversity in farming system
5	Floral and faunal diversity assessment in polluted and un polluted system
6	Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds
7	Practical on Environmental sampling and preservation
8	Estimation of pH, EC and TDS of water
9	Estimation of Acidity, Alkalinity
10	Estimation of water hardness
11	Estimation of DO, BOD and COD in water samples
12	Assessment of Suspended Particulate Matter (SPM)
13	Enumeration of E. coli in water sample
14	Study of simple ecosystem – Visit to pond/river/hills
15	Visit to areas affected by natural disaster
16	Practical Examination

References

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M and Umesh Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India (In press)
5. Prasanthrajan M and Mahendran, P. P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition.

6. Prasanthrajan M. 2018. Objective environmental studies and disaster management. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009, Ecology and Environment. Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

FDBM 241 Engineering Mathematics - I 2 (2+0)

Objectives

1. Gain knowledge about curves and their expression in mathematical form
2. Develop equations for a process and its integration

Course Outlines

Theory

Taylor's and Maclaurin's expansions, indeterminate form: Curvature, asymptotes, tracing of curves function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima; Reduction formulae, Gamma and Beta functions: Rectification of standard curves, volumes and surfaces of revolution of curves Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume;

Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation; Differential equations of higher orders, methods of finding complementary functions and particular integrals, Method of variation of parameters simultaneous linear differential equations with constant coefficients, Cauchy's and Legendre's linear equations, Bessel's and Legendre's differential equations series solution techniques; Differentiation of vectors, scalar and vector point functions, vector differential operator Del: Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, Identities involving Del, second order differential operator Line, Surface and volume integrals, Stoke's, divergence and Green's theorems.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Concept of Taylor's
2	Maclaurin's expansions

3 Maclaurin's expansions with problems

4 Indeterminate form with problems

Unit II

5 Partial differentiation with problems

6 Homogeneous functions with problems

7 Euler's theorem with problems

8 Composite functions with problems

Unit III

9 Total derivations with problems

10 Derivative of an implicit function, Problems on implicit functions

11 Problems on change of variables, Jacobians, error evaluation

12 Maxima and minima with problems; Reduction formulae, Gamma and Beta functions: Rectification of standard curves, volumes and surfaces of revolution of curves

Unit IV

13 Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume

14 Exact and Bernoulli's deferential equations

15 Equations reducible to exact form by integrating function

16 Equations of first order and higher degree

Unit V

17 Clairaut's equation and problems

18 Differential equations of higher order and problems

19 Methods of finding complimentary functions and problems

20 Particular integrals and problems

Unit VI

21 Method of variation of parameters simultaneous linear differential equations with constant coefficients and problems

22 Cauchy's and Legendre's differential equations and problems

23 Bessel's and Legendre's differential equations series solution techniques

24 Differentiation of Vectors, Scalars, and vector point functions

Unit VII

25 Vector deferential operator Del: Gradient of a scalar pointfunction

26 Divergence and curl of a vector point function and their physical interpretation and problems

27 Identities involving Del

28 Second order differential operator line

Unit VIII

29 Surface and volume integrals

30 Stocks's theorem and problems

31 Divergence theorem and problems

32 Green's theorem and problems

References

1. Grewal, G.S., 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
2. Narayan, S. 2004. A text book of Matrices. S.Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2004. A text book of Vector Calculus. S.Chand and Co. Ltd., New Delhi.
4. Narayan, S. 2004. Differential Calculus. S.Chand and Co. Ltd., New Delhi.
5. Narayan, S. 2004. Integral Calculus. S.Chand and Co. Ltd., New Delhi.
6. Ramana, B.V. 2008. Elementary mathematics, Tata McGraw-Hill Book Co, New Delhi.

FDBM 242 Agricultural Informatics and Artificial Intelligence 3(2+1)

Objectives

1. To orient students in basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision-making processes
2. Imparting basic knowledge of computer relating applications in agriculture
3. Insights into agricultural-Informatics, its components and applications in agriculture

Lecture Outlines

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts 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.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power - point for creating, editing and presenting a scientific document, 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; Anatomy of Computers; Memory Concepts, Units of Memory, Basic Operations using computers
2	Operating System: Definition and types; Applications of MS-Office for creation, editing, formatting, flow diagrams, header and footer, borderlines in document

3 Operating system: data presentation, screening, tabulation, formulas, data filtration, statistical analysis, presentation of data in different types of graphs

4 Mathematical expressions in MS office, Database-concepts and types, creating database, uses of database management system in agriculture

Unit II

5 Internet and World Wide Web- Concepts and components

6 Introduction to Visual Basic- Java, Fortran, C/C++, etc; concepts and standard input/ output operations

7 e-Agriculture-concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in agriculture

8 Computer Models in Agriculture: statistical, weather analysis and crop simulation models

Unit III

9 Computer Models in Agriculture: structure, inputs outputs files, limitation, advantages

10 Computer Models in Agriculture: Application of models for understanding plant processes, sensitivity, verification, calibration and validation

11 IT applications for computation of water and nutrient requirement of different crops

12 Computer-controlled devices (automated systems) for Agri-input management

Unit IV

13 Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management, forecasting of weather

14 Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information

15 Decision support systems: Concepts, components and applications in Agriculture

16 Decision support systems: Agriculture Expert System-meaning, importance, various types of systems in agriculture

Unit V

17 Decision support systems: Soil Information Systems etc. for supporting farm decisions.

18 Preparation of contingent crop-planning and crop calendars using IT tools

19 Overview on digital India and schemes to promote digitalization of agriculture in India

20 Digital agriculture Mission: agri. stack, *KRISHI* decision support system; Digital crop estimation, drought / flood monitoring, groundwater/water availability data

Unit VI

21 Introduction to artificial intelligence (AI) and machine learning, background and applications

22 Introduction to Turing test, deep learning, Generative AI, weak AI and strong AI, ethics and governance of AI

23 Control strategies- breadth-first search, depth-first search, Heuristics search techniques

24 A* algorithm, IoT and Big Data; Relationship between IoT and Big Data; Merits and demerits of A* algorithm, IoT and Big data

Unit VII

25 Use of AI in agriculture for autonomous crop management, pest, wed and disease management, water management, nutrition management

26 Use of AI in agriculture health monitoring of livestock, livestock feed management, animal nutrition management

27 Use of AI in Agriculture- intelligent pesticide application, precise pesticide application, diagnosis of pest and diseases

28 Use of AI in Agriculture- yield mapping, yield history analysis, processing of yield analysis and predictive analysis

Unit VIII

29 Use of artificial intelligence in automatic weeding, harvesting, sorting of produce

30 Artificial intelligence in food processing; merits, demerits and applications in food processing

31 Concepts of smart agriculture-Information and communications technology, Internet of Things, Artificial intelligence and machine learning and Automation and robotics

32 AI in food and nutrition science, Risks and Considerations for AI in Food Science, Scope of AI in food design

Practical

No	Practical Outline
1	Introduction of different operating systems viz., Windows, Unix/ Linux, creating files and folders, file management
2	Practice on tools in MS-WORD and MS Power-point for creating, editing and presenting a scientific document
3	Practice on tools in MS-EXCEL for data edition, screening, sorting, viewing, transforming
4	Practice on statistical tools in MS-EXCEL, writing expressions, Creating graphs,
5	Practice on analysis of scientific data, handling macros
6	Practice on using of MS-ACESS for creating database, preparing queries and reports
7	Demonstration of Agri- information system
8	Introduction to World Wide Web (WWW) and its components
9	Introduction of programming languages - Visual Basic, Java, Fortran
10	Introduction of programming languages- C, C++
11	Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst / Wofost
12	Practice on preparation of input file for CSM and study of model outputs

13 Computation of water and nutrient requirements of crop using CSM and IT tools

14 A practical on use of smart phones and other devices in agro-advisory and dissemination of market information

15 Practice on hands on practice for preparation of Decision Support System, Preparation of contingent crop planning

16 Practical Examination

References

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India
2. Fundamentals of Computer by V. Rajaroman
3. Introduction to Information Technology by Pearson
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication

FDBM 243 Engineering Mathematics - II 2(2+0)

Objectives

1. To familiarize the students with basic concept of mathematics
2. Gain knowledge about matrix and their transformations
3. Develop partial differential equations and their applications

Course Outlines

Theory

Elementary transformation and rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix; Consistency and solution of linear equations; Eigen value and vectors, Cayley-Hamilton theorem; Linear and orthogonal transformations; Diagonalization of matrices, Bilinear, Quadratic forms; Limit, continuity, derivative of function of complex variable; Analytical function, C-R equations, conjugate function, harmonic functions; Fourier series: Infinite series and its convergence, periodic function, Euler's formulae for calculating Fourier coefficients, Dirichlet's conditions; Fourier series of functions with arbitrary period; Fourier series of odd and even functions; Half range sine and cosine series, Harmonic analysis; Formation of partial differential equations; Lagrange's linear equation; Higher order linear partial differential equation with constant coefficients; Solution of nonlinear partial differential equation (Charpit's method); application of partial differential equations: One dimensional wave e.g., one dimensional heat equation, two dimensional steady state heat equation i.e. Laplace equation.

Lecture Outlines

Theory

No.	Lecture Outline
1	Elementary transformation and problems
2	Range of matrix and problems
3	Reduction to normal form and problems
4	Gauss-Jordan method to find inverse of matrix
5	Consistency and solution of linear equations
6	Eigen values and vectors and problems
7	Cayley-Hamilton theorem and applications
8	Problems on Cayley-Hamilton theorem
9	Linear and orthogonal transformations
10	Problems on Linear and orthogonal transformations
11	Diagonalization of matrices and problems
12	Limits and continuity and problems
13	Derivative of function of complex variables
14	Problems on Derivative functions
15	Fourier Series and problems
16	Infinite series and its convergence
17	Periodic functions and problems
18	Euler's formulae for calculating fourier coefficients
19	Dirichlet's conditions
20	Fourier series of functions with arbitrary period
21	Fourier series of odd and even functions
22	Half range sine and problems
23	Half range cosine and problems
24	Harmonic analysis and problems
25	Formation of partial differential equations
26	Legrange's linear equation
27	Problems on Legrange's linear equation
28	Higher order linear partial differential equation with constant coefficient
29	Problems on Higher order liner differentiation equations with constant coefficient
30	Solution of Non-linear partial differential equation (Charpit's Method)
31	Applications of partial differential equations and Problems
32	One dimensional heat equation and Laplace equation

References

1. Grewal, G.S. 2004. Higher Engineering Mathematics, Khanna Publishers, Delhi.
2. Narayan, S. 2004, A text book of Matrices, S.Chand and Co. Ltd., New Delhi.
3. Ramana, B.V. 2008. Elementary Mathematics. Tata McGraw-Hill Book Co, New Delhi.

FDBM 244 Entrepreneurship Development and Business Management 3(2+1)

Objectives

1. To provide an insight into the concept and scope of entrepreneurship
2. To expose on various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Course Outlines

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 know-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	Practical Examination

References

1. Charantimath, P.M. 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai, V. 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Gupta, C.B. 2001. Management Theory and Practice. Sultan Chand & Sons.
4. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka, S.S. 1999. Entrepreneurial Development. S. Chand & Co.
6. Mehra, P. 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey, M. and Tewari, D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
9. Singhal, R.K. 2013. Entrepreneurship Development & Management, Katson Books.
10. Tripathi, P.C and Reddy, P.N. 1991. Principles of Management. Tata McGraw Hill.
11. Vasant Desai. 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

FDBM 245 Personality Development 2(1+1)

Objectives

1. To make students realize their potential strengths
2. To cultivate their inter-personal skills and improve employability

Course Outline

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's selfactualization 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.

Course Outlines

Theory

No. Lecture Outline

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 behaviors, Personality and Organizational Behavior

4 Foundations of individual behavior and factors influencing individual behavior, models of individual behavior

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 behavior, 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 ofintelligence, theories of intelligence,measurements of intelligence, factors influencing intelligence

Unit VI

11 Organizational Behavior:Meaning, definition, scope and importance of organizational behavior, models of organizational behavior

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 VII

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 behavior
14	Practical exercise on negotiation skills and stress management
15	Practical exercise on Time management and conflict management
16	Practical examination

References

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Fred, Luthans. Organizational Behaviour- Seventh Edition (International Edition) McGraw-Hill.

3. Heller, Robert, 2002, Effective Leadership. Essential Manager series. DK Publishing.
4. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. DK Publishing.
5. Kumar, Pravesh, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
6. Lucas, Stephen. 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
7. Mile, D.J., 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
8. Smith, B, 2004. Body Language. Delhi: Rohan Book Company.
9. Shaffer, D. R. 2009, Social and Personality Development (6th edn). Belmont, CA: Wadsworth.

FDBM 341 Project Preparation and Management 2(1+1)

Objectives

1. Understand concepts of project management
2. Develop knowledge to develop a project plan and its analysis

Course Outlines

Theory

Project and project Management, Evolution of project management, Forms and environment of project management; Project life cycle; Project Identification, Screening, Project Appraisal, Project Selection, Project Proposal and Project Scope; Project Planning; Work break down structure and Network Scheduling; Critical Path Method; Program Evaluation and Review Technique; Time-cost relationship in project; Resource Considerations in Projects, Resource Profiles and levelling, limited Resource Allocation; Project Implementation, Monitoring and Control: Project management Process and role of project manager, team building, Leadership in Projects, Organizational and behavioural issues in Project Management; Project Monitoring and Control; Project Completion and Review; Project Management - Recent trends and Future Directions. Computers in Project Management.

Practical

Brainstorming exercise to identify a set of projects and their evaluation; work break down structure for different projects; Network Scheduling and Drawing network charts for different projects; Formulation of CPM scheduling for a specific project; Formulation of PERT scheduling for a specific project; Reduction of Project Duration: Time/cost trade off; Resource Profiles and levelling; PERT/Cost Method, Earned value analysis.

Lecture Outlines

Theory

No.	Lecture Outline
	Unit I
1	Project and Project Management, evolution of project management
2	Forms and Environment of project management
	Unit II
3	Project life cycle
4	Project Identification, screening, project appraisal and project selection
	Unit III
5	Project proposal & project scope
6	Project Planning - Work Break Down Structure and Network Scheduling
	Unit IV
7	Critical Path Method (CPM)
8	Program Evaluation & Review Technique (PERT)
	Unit V
9	Time-cost relationship in project
10	Resource considerations in projects, resource profiles and levelling, limited resource relocation
	Unit VI
11	Project implementation, monitoring and control: project management process and role of project manager, team building and leadership in projects
12	Organizational and behavioral issues in project management
	Unit VII
13	Project monitoring and control
14	Project completion and review
	Unit VIII
15	Project management - recent trends and future directions
16	Computers in project management

Practical

No.	Practical Outline
1	Identifying the primary characteristics of a project
2	Brainstorming exercise to identify a set of projects and their evaluation
3	Study on the project life cycle related to food industry

4 Studying various tools for project management
5 Project evaluation techniques – Undiscounted cash flows
6 Project evaluation techniques – Discounted cash flows
7 Construct work break down structure for different projects related to food industry
8 Network Scheduling and Drawing network charts for different projects related to food industry
9 Study and drawing of Gantt Chart -1
10 Formulation of CPM scheduling for a specific project
11 Formulation of PERT/Cost Method
12 Formulation of Earned value analysis
13 Reduction of Project Duration: Time/cost trade off
14 Project network – construction and analysis
15 Preparation of a project report
16 Practical Examination

References

1. Chandra, P. 1980. Projects- Preparation, Appraisal, Budgeting and Implementation. Tata McGraw-Hill Publication, New Delhi.
2. Chandra, P. 2014. Projects – Planning, Analysis, Selection, Financing, Implementation, and Review. Tata McGraw-Hill Publishing Company Ltd.
3. Gopalakrishnan, P and Rama Moorthy, V.E. 2014. Textbook of Project Management. Laxmi Publications Pvt. Limited
4. Kerzner, H. 2006. Project Management – A System Approach to Planning, Scheduling, and Controlling. CBS Publishers and Distributors.
5. Nicholas, J.M. 2005. Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.
6. Panneerselvam, R. 2004. Operations Research, 2nd edn. International Book House, Mumbai.

FDBM 342 Agricultural Marketing and Trade 3(2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

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 and 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 agricommodities; 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	Agricultural Marketing: Concepts and definitions of market
2	Marketing and Agricultural Marketing
3	Market Structure
4	Marketing Mix and Market Segmentation
Unit II	
5	Classification and characteristics of agricultural markets
6	Nature of demand and supply, determinants of demand and supply of farm products.
7	Producer's surplus: meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities;
8	Pricing strategies: pricing considerations and approaches – cost based and competition based pricing.
Unit III	
9	Promotion strategies – advertising & personal selling
10	Promotion strategies - sales promotion
11	Publicity – meaning, merits and demerits
12	Marketing process concentration, dispersion and equalization.
Unit IV	
13	Marketing functions: Exchange functions – buying and selling; Physical functions – storage, transport and processing:
14	Facilitating functions – packaging, branding, grading, quality control and labelling (Agmark)
15	Market functionaries : Classification
16	Importance of agencies involved in agricultural marketing
Unit V	
17	Meaning and definition of marketing channel; marketing channels for different farm products.
18	Meaning, definition and types of market integration;
19	Marketing efficiency; marketing costs, margins and price spread
20	Factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs
Unit VI	
21	Role of Govt. in agricultural marketing, Role of APMC and its relevance in the present day context

22 Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions

23 Cooperative marketing in India

24 Major institutions in Cooperative marketing NAFED, MARKFED.

Unit VII

25 Risk in marketing: Types of risk in marketing; measures to reduce the risks in marketing,

26 Contract farming & spreading sales

27 Speculation and hedging, an overview of futures trading.

28 Meaning and functions of price; administered prices; need for innovations in agricultural price policy

Unit VIII

29 Concept of International Trade, theories of absolute and comparative advantage.

30 Present status and prospects of international trade in agri-commodities; WTO

31 Agreement on Agriculture (AoA) and its implications on Indian agriculture

32 IPR - Intellectual Property Rights.

Practical

No	Practical Outlines
1	Plotting and study of demand and supply curves and calculation of elasticities
2	Study of relationship between market arrivals and prices of some selected commodities -I
3	Study of relationship between market arrivals and prices of some selected commodities- II
4	Computation of marketable and marketed surplus of important commodities
5	Study of price behaviour over time for some selected commodities
6	Study of price behaviour over time for some selected commodities
7	Construction of index numbers
8	Construction of index numbers
9	Visit to a local market to study various marketing functions performed by different agencies
10	Identification of marketing channels for selected commodity
11	Collection of data regarding marketing costs and margins presentation of report in the class
12	Collection of data regarding price spread and presentation of report in the class
13	Visit of any two market institutions - NAFED, SWC, CWC, cooperative marketing society, to study their organization and functioning
14	Visit of any two market institutions - NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning

15 Application of principles of absolute and comparative advantage of international trade.

16 Present status of Indian Trade in Agriculture

References

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, New Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, PrenticeHall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 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 Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi. 9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

FDBM 441 ICT Applications in Food Industry 2(0+2)

Objectives

1. Understand the requirement of information and its computerization and SCADA systems
2. Learn different software tools like MATLAB, GAMBIT, Fluent, LabVIEW etc.
3. Learn different techniques like Fuzzy logic, Neural network, Image processing etc.

Practical

Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add-Ins in spread sheet and statistical data analysis using Analysis Tool pack; Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet; Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB; Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software; Creation of geometry for laminar flow through pipe using GAMBIT; Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using FLUENT; Introduction to LabVIEW and NI-DAQ.

Practical

No.	Practical Outline
1	Acquainting of various features in spreadsheets
2	Solving problems using functions in spreadsheets
3	Use of Add-Ins in spread sheet & Statistical data analysis using Analysis Tool pack
4	Solution of problems on regression analysis using Analysis Tool pack in spreadsheet
5	Solution of problems on regression analysis using Analysis Tool pack in spreadsheet
6	Solution of problems on optimization using solver package in spreadsheet
7	Solution of problems on optimization using solver package in spreadsheet
8	Acquainting to MATLAB software
9	Writing code using MATLAB programming
10	Solution of problems using Curve Fitting
11	Solution of problems using Curve Fitting
12	Toolbox in MATLAB
13	Solution of problems using Fuzzy Logic Toolbox in MATLAB
14	Solution of problems using Fuzzy Logic Toolbox in MATLAB
15	Solution of problems using Neural Network Toolbox in MATLAB
16	Solution of problems using Neural Network Toolbox in MATLAB
17	Solution of problems using Image Processing Toolbox in MATLAB
18	Solution of problems using Image Processing Toolbox in MATLAB
19	Acquainting to GAMBIT software
20	Acquainting to GAMBIT software
21	Creation of geometry for laminar flow through pipe using GAMBIT
22	Creation of geometry for laminar flow through pipe using GAMBIT
23	Acquainting to FLUENT software
24	Acquainting to FLUENT software
25	Import of geometry
26	Application of boundary conditions
27	Application of boundary conditions
28	Solution of problems on laminar flow using FLUENT
29	Solution of problems on laminar flow using FLUENT
30	Introduction to Lab VIEW
31	Introduction to NI-DAQ
32	Practical Examination

References

1. Anderson, J.D., 2017. Computational Fluid Dynamics: The Basics with Applications. 3rd ed. New York: McGraw-Hill Education.
2. Bailey, D. and Wright, E., 2003. Practical SCADA for Industry. 1st ed. Oxford: Newnes.
3. Berk, Z., 2018. Food Process Engineering and Technology. 3rd ed. San Diego: Academic Press.
4. Fellows, P.J., 2009. Food Processing Technology: Principles and Practice. 4th ed. Boca Raton: CRC Press.
5. Moore, H., 2012. MATLAB for Engineers. 1st ed. Boston: Cengage Learning.
6. Ragsdale, C.T., 2014. Spreadsheet Modelling & Decision Analysis. 7th ed. Stamford: Cengage Learning.

DEPARTMENT OF FOOD PLANT OPERATIONS

FDPO 251 Food Plant Utilities and Services 3(2+1)

Objectives

1. Gain knowledge of various Utilities and services required in a food processing plant
2. Understanding working of different services
3. Understand cleaning, maintenance and trouble shooting

Course Outlines

Theory

Introduction to Food Plant Utilities, Importance of utilities in food processing. Overview of common utilities and services, energy management in food plants. Regulatory and safety considerations. Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing; Electrical System- Introduction to electric power supply systems, electrical billing, electrical load management and maximum demand control, power factor improvement and benefits, transformers, system distribution losses, harmonics, trouble shooting of electrical power system. Electrical motors-Types, losses in Induction motor, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Compressed air system - requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and efficiency. HVAC and refrigeration system - requirement, vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance and saving opportunities. Vapor absorption refrigeration system: working principle, types and comparison with VCR system, saving potential; Fans and blowers - requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities, pumps and pumping systems- requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. DG set system- requirement, introduction, factors affecting selection; Fuel and combustion - Introduction to fuels; properties of fuel oil, coal and gas; storage; handling and preparation of fuels; principles of combustion, combustion of oil, coal and gas; draft system. Boilers- boiler specification, Indian boiler regulation, system components, types, combustion in boilers, performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities; Steam system - properties of steam, assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings; Waste heat recovery- classification, advantages and application, commercially viable waste heat recovery devices, saving potential; other utilities and services - lighting, CIP system, waste water/drainage,

water treatment, dust removal, fire protection and maintenance system. Wastewater treatment and recycling: sources and composition of wastewater in food plants, wastewater treatment techniques: primary, secondary, and tertiary treatment, zero liquid discharge systems, environmental compliance and sustainability, Solid Waste Management in Food Plants: types of solid waste generated (organic, packaging), waste segregation, composting, and recycling techniques, energy recovery from organic waste (biogas generation), regulatory requirements for solid waste disposal. Safety, Standards, and Compliance: OSHA and food safety standards for utilities, risk assessment and hazard management, documentation and record-keeping, training and capacity building utility

System Automation: Role of automation in utility management Utility Control Systems: SCADA and PLC systems in utility management, Realtime monitoring and control. Simulation and Modelling: Tools for utility design simulation, Optimizing utility operation through modelling software. IoT and Automation in Utilities: Smart utility monitoring systems, Predictive maintenance using IoT.

Practical

Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities; electrical power supply system, billing and load estimation; motors and variable speed drives specification, selection, performance terms and definitions; compressed air system components and performance terms and definitions; refrigeration and HVAC system components, performance terms and definitions and load estimation of a plant; fans and blowers, types, specification, performance terms and definitions. pumps types, specification, selection, performance terms and definitions; plant lighting system and their components; DG system their specification and selection; combustion of oil, gas and coal; boiler performance terms and assessment. Study on cost of steam; waste heat recovery devices. Recuperates, Regenerators, Heat wheel, Heat pipes, Economizers, Heat exchanger (Shell and tube, PHE, run around coil exchanger, direct contact HX), Waste heat recovery boilers, Heat pumps and Thermocompressor. ClP system components; water treatment plant; effluent treatment plant; fire control operations and use of fire extinguishers.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Introduction to food plant utilities, Importance of utilities in food processing. Overview of common utilities and services, energy management in food plants. Regulatory and safety considerations
2	Classification of various utilities and services in food plant / industry
3	Commercial energy pricing; Electrical System-Introduction to electric power supply systems, electrical billing, electrical load management and maximum demand control, power factor improvement and benefits

4 Transformers, system distribution losses, harmonics, trouble shooting of electrical power system

Unit II

5 Electrical motors-types, losses in Induction motor, motor efficiency, factors affecting motor performance

6 Motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors

7 Compressed air system - requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and efficiency

8 HVAC and Refrigeration system - Requirement, vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity

Unit III

9 Factors affecting refrigeration and air conditioning system performance and saving opportunities

10 Vapor absorption refrigeration system: working principle, types and comparison with VCR system and saving potential

11 Fans and blowers - requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

12 Flow control strategies and energy conservation opportunities

Unit IV

13 Pumps and pumping systems-requirement, types, performance evaluation, efficient system operation

14 DG set system- requirement, introduction, factors affecting selection

15 Fuels and combustion - Introduction to fuels, properties of fuel oil, coal and gas and its storage, handling and preparation of fuels

16 Principles of combustion, combustion of oil, coal and gas; draft system.

Unit V

17 Boilers- boiler specification, Indian boiler regulations

18 Boiler system components, types, combustion in boilers

19 Performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities

20 Steam system - properties of steam

Unit VI

21 Assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings

22 Waste heat recovery - classification, advantages and application

23 Commercially viable waste heat recovery devices and its saving potential

24 Other utilities and services- Lighting, CIP system, waste water/drainage, water treatment, dust removal, fire protection and maintenance system

Unit VII

25 Wastewater treatment and recycling: Sources and composition of wastewater in food plants, wastewater treatment techniques: primary, secondary, and tertiary treatment. Zero liquid discharge systems, environmental compliance and sustainability

26 Solid waste management in food plants: Types of solid waste generated (organic, packaging), Waste segregation, composting, and recycling techniques

27 Energy recovery from organic waste (biogas generation), regulatory requirements for solid waste disposal

28 Safety, Standards, and Compliance: OSHA and food safety standards for utilities, risk assessment and hazard management, documentation and record-keeping, training and capacity building

Unit VIII

29 Utility System Automation: Role of automation in utility management

30 Utility Control Systems: SCADA and PLC systems in utility management, Real-time monitoring and control

31 Simulation and Modelling: Tools for utility design simulation, optimizing utility operation through modelling software

32 IoT and Automation in Utilities: Smart utility monitoring systems, predictive maintenance using IoT

Practical

No.	Practical Outlines
1	Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities
2	Study on electrical power supply system, billing and load estimation
3	Motors and variable speed drives specification, selection, performance, terms and definitions
4	Tutorials on compressed air system components and performance terms and definitions
5	Tutorials on HVAC system components, performance terms, definitions and load estimation of a plant
6	Study on fans and blowers, types, specification, performance terms and definitions
7	Study on pumps type, specification, selection, performance terms and definitions
8	Study on plant lighting system and their components
9	Study on DG system, specification and selection
10	Study on combustion of oil, gas and coal; boiler performance terms and assessment
11	Study on cost of steam and waste heat recovery devices

12 Study on Recuperates, Regenerators, Heat wheel, Heat pipes, Economizers, Heat exchanger (Shell and tube, PHE, run around coil exchanger, direct contact HX), waste heat recovery boilers, heat pumps and thermo compressor

13 Study on ClP system components

14 Study on water treatment plant and effluent treatment plant

15 Study on fire control operations and use of fire extinguishers

16 Practical Examination

References

1. A Survey of Water Use in the Food Industry by W. E. Whitman, S. D. Holdsworth. Published by British Food Manufacturing Industries Research Association.
2. Chilton's Food Engineering. Published by Chilton Co., 1979.
3. Energy Efficiency and Management in Food Processing Facilities by Lijun Wang. Published by CRC Press, 2008.
4. Energy-saving Techniques for the Food Industry by M. E. Casper. Published by Noyes Data Corp., 1977.
5. Ed Bausbacher and Roger Hunt. 1993. Process Plant Layout and Piping Design. P.T.R. Prentice-Hall, Inc., New Jersey
6. Practical Design, Construction, and Operation of Food Facilities - This book by J. Peter Clark
7. Tufail Ahmad. 2003. Dairy Plant Engineering and Management. KitabMahal, Allahabad

DEEKSHARAMBH & PHYSICAL EDUCATION

COCA 101 DEEKSHARAMBH (2 weeks Program) 2(0+2)NG

The activities to be taken under Deeksharambh shall aim at creating a platform for students to

- Help for cultural Integration of students from different backgrounds,
- Know about the operational framework of academic process in university
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- Students shall be made aware about the field of food processing, the industry, production systems, importance of nutrition, packaging, quality issues involved, shelf life and the legal standards available using simple day to day examples.
- In addition, the students shall be exposed to the job opportunities at various levels like production, product development, entrepreneurship opportunities and research opportunities that are existing in this area of food processing technology.
- The students will be encouraged to develop deep interest in the field in which now they have entered. It will also make it clear about the skill enhancement courses that they need to choose during the study to decide their future.
- 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 • Activities to enhance cultural Integration of students from different backgrounds.
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

COCA 102 **NCC-I/ NSS-I** **1(0+1)**

Objectives

1. To evoke social consciousness among students through various NSS activities.
2. 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 youth adult partnership. Social harmony and national integration. Indian history and culture, role of youth in nation building, conflict resolution and peace building. Volunteerism and 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.

Lecture Outlines

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 NCC-II/NSS-II 1(0+1)

Objectives

1. 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
2. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Lecture Outlines

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 Practices andMeditation 2(0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices.
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

Lecture 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, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan - left leg right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan.
- Suryanamskar 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, Shuttle Badminton, Volleyball, Basketball, Ball Badminton, Tennikoit) 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

No.	Practical Outline
1	Physical education; Training and Coaching - Meaning and Concept
2	Methods of Training; aerobic and aerobic exercises, Calisthenics
3	Weight Training - Circuit Training - Interval Training - Fartlek Training
4	Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems
5	Balanced Diet and Nutrition, Effects of Diet on Performance
6	Physiological changes due to ageing and role of regular exercise on ageing process
7	Personality, its dimensions and types; Role of sports in personality development
8	Motivation and Achievements in Sports
9	Learning and Theories of learning, Adolescent Problems and its Management
10	Posture; Postural Deformities; Exercises for good posture
11	Introduction to Yoga, History of Yoga, Types of Yoga
12	Asanas - Definition and Importance of Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan
13	Definition and Importance of Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
14	Suryanamskar, Pranayama (Definition and Importance), Omkar
15	Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
16	Meditation (Definition and Importance)
17	Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
18	Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra

19 Role of yoga in sports

20 Teaching of Asanas - demonstration, practice, correction and practice

21 History of sports and ancient games

22 Governance of sports in India, Important national sporting events; Awards in Sports

23 History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major game; Cricket and Football

24 Table Tennis - Shuttle Badminton

25 Volleyball - Basketball

26 Ball Badminton - Tennikoit

27 Athletics

28 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

29 Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries.

30 First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract.

31 First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings.

32 First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

SKILL ENHANCEMENT COURSE MODULES (SECM)

Food Processing Technology Department

SECM 112 Introduction to Drying Technology and Dryers 2(0+2)

Objectives

1. Understand principles of drying technology and dryers
2. Learn the Knowledge of industry-specific regulations safety standards, critical thinking and problem-solving skills

Course Outlines

Practical

Definition and importance of drying, basic principles and applications of drying Psychrometry: Understanding moisture content, equilibrium moisture, Free moisture vs. bound moisture and humidity; Determination of moisture content Dry basis and wet basis. The drying curve: Constant rate period vs. falling rate period. Types of drying methods, solar drying, mechanical drying. Mechanical drying methods – contact drying, convective drying, radiation drying, freeze drying, super-heated drying, osmotic drying, desiccated air drying. Classification of dryers based on heat transfer, drying mechanisms, and material types. Factors affecting drying performance (e.g., temperature, humidity, airflow) and basic components of drying systems: heat source, material feed, airflow system Types of dryers – Batch and Continuous flow dryers. Deep bed dryers, flat bed dryers, recirculating dryers, LSU dryers, spouted bed dryers, Tray dryer etc. Rotary Dryers: Working principle, design considerations: drum length, diameter, rotation speed, material flow, Application in food processing & troubleshooting common issues in rotary dryers, Fluidized Bed Dryers: Working principle, design considerations: particle size, airflow, and moisture content control, Application in food processing & troubleshooting common issues in fluidized bed dryers Spray Dryers – principle and working of spray dryers, design considerations – atomization, drying chamber, nozzle types, Application in food processing & troubleshooting common issues in Spray dryers. Freeze drying –overview of freeze-drying process, equipment design – freezing, vacuum and sublimation chambers, quality control during freeze drying. Application in food processing & troubleshooting common issues in freeze dryers. Vacuum Dryers – working principle, applications in heat sensitive materials, design of vacuum dryers – chamber and pump systems, Application in food processing & troubleshooting common issue in vacuum dryers, Advanced drying systems – microwave and radio frequency drying its applications, Superheated steam drying and its applications Membrane drying techniques and its applications Solar and hybrid drying technologies, super critical drying and its applications, Green drying technologies; Solar drying, Heat pump dryers and its applications Dryer selection and process optimization - Factors to consider in selecting the right dryer for a specific

material Impact of Drying on Product Quality - Effect of drying on texture, colour, Nutritional quality of products, Methods to prevent over drying and under-drying Energy consumption and efficiency in drying, Energy requirements for different drying processes and efficiency optimization in drying systems Heat recovery techniques and process integration and comparison of drying methods in terms of energy use Drying process control and automation – process monitoring – moisture control, automation in drying process, Sensors and control systems used in drying (moisture sensors, temperature sensors)

Lecture Outlines

Practical

No.	Practical Outline
1	Definition and importance of drying, basic principles and applications of drying
2	Psychrometry: Understanding moisture content, equilibrium moisture, Free moisture vs. bound moisture and humidity
3	Determination of moisture content dry basis and wet basis
4	The drying curve: Constant rate period vs. falling rate period
5	Types of drying methods, solar drying, mechanical drying
6	Mechanical drying methods - contact drying, convective drying, radiation drying, freeze drying, super-heated drying, osmotic drying, desiccated air drying
7	Classification of dryers based on heat transfer, drying mechanisms, and material types
8	Factors affecting drying performance (e.g., temperature, humidity, airflow) and basic components of drying systems: heat source, material feed, airflow system
9	Types of dryers - Batch and Continuous flow dryers
10	Deep bed dryers, flat bed dryers, recirculating dryers, LSU dryers, spouted bed dryers, Tray dryer etc
11	Rotary Dryers: Working principle, design considerations: drum length, diameter, rotation speed, material flow
12	Application in food processing & troubleshooting common issues in Rotary Dryers
13	Fluidized Bed Dryers: Working principle, design considerations: particle size, airflow, and moisture content control
14	Application in food processing & troubleshooting common issues in fluidized bed dryers
15	Spray Dryers - principle and working of spray dryers, design considerations - atomization, drying chamber, nozzle types
16	Application in food processing & troubleshooting common issues in Spray dryers
17	Freeze drying - overview of freeze-drying process, equipment design - freezing, vacuum and sublimation chambers, quality control during freeze drying and its challenges
18	Application in food processing & troubleshooting common issues in freeze dryers
19	Vacuum Dryers - working principle, applications in heat sensitive materials, design of vacuum dryers - chamber and pump systems

20 Application in food processing & troubleshooting common issues in vacuum dryers
21 Advanced drying systems – microwave and radio frequency drying its applications
22 Superheated steam drying and its applications
23 Membrane drying techniques and its applications
24 Solar and hybrid drying technologies, super critical drying and its applications
25 Green drying technologies; Solar drying, Heat pump dryers and its applications
26 Dryer selection and process optimization - Factors to consider in selecting the right dryer for a specific material
27 Impact of Drying on Product Quality - Effect of drying on texture, color
28 Nutritional quality of products, Methods to prevent over-drying and under-drying
29 Energy consumption and efficiency in drying, Energy requirements for different drying processes and efficiency optimization in drying systems
30 Heat recovery techniques and process integration and comparison of drying methods in terms of energy use
31 Drying process control and automation – process monitoring – moisture control, automation in drying process
32 Sensors and control systems used in drying (moisture sensors, temperature sensors)

References

1. Chakraverty, A. and Singh, R.P. 2014. Post Harvest Technology and Food Process Engineering CRC Press, Boca Raton, FL, USA.
2. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
3. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.
4. Hui, Y.H, Bernyard L. Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong and Phil Ventresca. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.
5. Jafari, S. M., &Malekjani, N. (Eds.). 2023. Drying technology in food processing: unit operations and processing equipment in the food industry. Elsevier.
6. Mujumdar, A.S. (Ed.). 2014. Handbook of Industrial Drying (4th ed.). CRC Press. https://doi.org/10.1201/b17208.
7. Perdue, R. E., & Watson, W. D. 1983. Principles of Food Drying. Wiley-Interscience
8. Ramaswamy, H and Marcotte, M. 2005. Food Processing Principles and Applications. Taylor & Francis Group is the Academic Division of T&F Informa plc.
9. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.

SECM 212 **Introduction to Processing of Extruded Products** **2(0+2)**

Objectives

To understand the basic principles, techniques in extrusion and impart hands-on, skill-oriented training in extrusion technology of various food products.

Lecture Outlines

Practical

No.	Practical Outline
1	Study on the classification of extruders
2	Study on cereal based extruded products
3	Visit to food extrusion unit
4	Process technology in the production of puffed rice snacks
5	Process technology in the production of puffed corn snacks
6	Determination of degree of expansion and bulk density of product on exit of the extruder
7	Determination of hardness and crispness of the extruded products
8	Determination of starch characteristics of extruded products
9	Determination of protein quality of extruded products
10	Visit to pasta food industry
11	Experiment on production of pasta
12	Experiment on production of noodles
13	Experiment on production of extruded multi grain snacks
14	Experiment on production of extruded gluten-free snacks
15	Experiment on production of extruded Fiber-enriched snacks
16	Sensory evaluation of extruded snacks
17	Study on sugar based extruded products
18	Process technology in the production of toffee
19	Process technology in the production of fruit gums
20	Visit to food extrusion industry
21	Study on protein based extruded products
22	Process technology in the production of Texturized Vegetable Protein (TVP)
23	Process technology in the production of extruded products from meat
24	Process technology in the production of extruded products from meat
25	Process technology in the production of surimi from fish
26	Experiment with different die shapes to create various snack shapes
27	Process technology in the production of cold extruded snacks
28	Visit to cereals extrusion plant

29 Production of extruded probiotic snacks
30 Production of extruded baby food products
31 Visit to extrusion plant
32 Practical Examination

SECM 111 Introduction to Milling (Rice, Dal, Spices etc.) 2(0+2)

Objectives

Practical

1. To understand different types of milling technologies and machineries.
2. To impart hands-on, skill-oriented training in milling technology of cereals, pulses, spices and oil seeds.

Course Outlines

Practical

Study of different rice milling machinery, Determination of milling characteristics of rice, Production of parboiled rice, Visit to commercial rice mill, Study of different flour milling machinery, Production of multi grain flour, flour mixes, Visit to commercial flour mill, Preconditioning and milling of wheat into whole wheat flour, refined wheat flour and semolina, Study of different Dhal milling machinery, Preconditioning and milling of black gram into gota and dhal, Preconditioning and milling of green gram into dhal, Preconditioning and milling of bengal gram into dhal, Preconditioning and milling of red gram into dhal, Visit to commercial dhal mill, Production of turmeric powder, chilli powder, coriander powder, pepper powder, sambar powder, garam masala powder, Visit to commercial spice processing industry, Study of different oil extraction machinery, Production of groundnut oil, sunflower oil, sesame oil, Study of refining and purification of oils, Visit to commercial oil mill.

Lecture Outlines

Practical

No.	Practical Outline
1	Study of different rice milling machinery
2	Determination of milling characteristics of rice
3	Production of parboiled rice
4	Visit to commercial rice mill
5	Study of different flour milling machinery
6	Production of multi grain flour
7	Production of instant flour mixes
8	Visit to commercial flour mill

9 Preconditioning and milling of wheat into whole wheat flour
10 Preconditioning and milling of wheat into refined wheat flour
11 Preconditioning and milling of wheat into semolina
12 Study of different Dhal milling machinery
13 Preconditioning and milling of black gram into gota
14 Preconditioning and milling of black gram into dhal
15 Preconditioning and milling of green gram into dhal
16 Preconditioning and milling of bengal gram into dhal
17 Preconditioning and milling of red gram into dhal
18 Visit to commercial dhal mill
19 Production of turmeric powder
20 Production of chilli powder
21 Production of coriander powder
22 Production of pepper powder
23 Production of sambar powder
24 Production of garam masala powder
25 Visit to commercial spice processing industry
26 Study of different oil extraction machinery
27 Production of groundnut oil
28 Production of sunflower oil
29 Production of sesame oil
30 Study of refining and purification of oils
31 Visit to commercial oil mill
32 Practical Examination

References

1. Chakraverty, A. 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chakraverty, A. and Singh, R.P. 2014. Post-Harvest Technology and Food Process Engineering.CRC Press, Boca Raton, FL, USA.
3. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc.,NY, USA.
4. Champagne, E.T. 2004. Rice: Chemistry and Technology, 3rdedn. AACC International, Inc., St.Paul, MN, USA.
5. Gunstone, F.D. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.

6. Hirasa, K. and Takemasa, M. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
7. Panda, H. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi
8. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
9. Shahidi, F. 2005. Bailey's Industrial Oil and Fat Products, 6th edn., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA

SECM 211 Milk and Milk products Processing 2(0+2)

Objectives

Practical

1. To learn the processing, packaging, storage of milk and dairy products.
2. To understand technology and manufacturing equipment used in production of milk and milk, dairy products

Course Outlines

Practical

Study of different equipment used in raw milk receiving dock; Demonstration of platform tests (COB, alcohol test), physical, chemical properties of liquid milk, adulterants in liquid milk; pasteurizer unit, homogenization and homogenizer; Standardization of different milks (toned, double toned, skim milk etc); Processing technology of Imitation, flavored, reconstituted, condensed milk and milk powder; Cream separation from liquid milk; Visit to chilling centre; making of butter, ghee, dahi and yoghurt, fermented milk beverages, coagulated milk (Panneer, Channa), channa based sweets (Rasogulla, Rasmalai), khoa (Sweetened, Unsweetened); Khoa based sweets–I, II, Basundi, Cheese, cheese spreads, traditional dairy products, Ice creams, Frozen desserts; Visit to dairy plant.

Practical

No.	Practical Outline
1	Study of different equipment used in raw milk receiving dock
2	Demonstration of platform tests (COB, Alcohol test, Sediment & Iodine test)
3	Demonstration of physical properties of liquid milk
4	Demonstration of chemical and microbial properties of liquid milk
5	Demonstration of adulterants in liquid milk
6	Study of pasteurizer unit
7	Study of homogenization and homogenizer

8 Standardization of different milks (toned, double toned, skim milk etc)
9 Processing technology and formulation of Imitation milk
10 Processing technology and formulation of flavored milks
11 Processing technology and formulation of reconstituted milk
12 Processing technology of condensed milk
13 Processing technology of milk powder
14 Cream separation from liquid milk
15 Visit to milk chilling centre
16 Processing technology of Butter
17 Processing technology of Ghee
18 Processing technology of Dahi, Buttermilk and Yoghurt
19 Processing technology and formulation of fermented milk beverages
20 Processing technology of coagulated milk (Panneer, Channa)
21 Processing technology and formulation of channa based sweets (Rasogulla, Rasmalai)
22 Processing technology and formulation of khoa (Sweetened, Unsweetened)
23 Processing technology and formulation of Khoa based sweets –I (Peda, burfi, pantua)
24 Processing technology and formulation of Khoa based sweets –II (Kalakhand, milk cake)
25 Processing technology and formulation of Basundi, Rabri
26 Processing technology and formulation of cheese
27 Processing technology and formulation of cheese spreads
28 Processing technology and formulation of traditional dairy products
29 Processing technology and formulation of Ice creams
30 Processing technology and formulation of Frozen deserts
31 Visit to dairy plant
32 Practical examination

References

1. Ashok Kumar Agarwal and Megh R. Goyal. 2021. Processing Technologies for Milk and Milk Products. CRC Press, Boca Raton, FL, USA.
2. FSSAI 2016. Manual Methods of Analysis of Foods: Milk and Milk products, New Delhi, India.
3. Kanekanian. 2014. Milk and Dairy products as Functional Foods. John Wiley & Sons, Ltd., UK.
4. Pandurang Gangasagare. 2018. A textbook of Traditional Dairy Products. Oxford Books Publishers, New Delhi, India.
5. Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.

6. Rajagopal, S and Roy, S.K. 2020. Milk and Milk Product Technology. BS Publications, Hyderabad, Telangana, India.
7. Savita Sinha. 2014. Milk and Milk Products Technology. Anmol Publications, New Delhi, India.
8. Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi, India.

FOOD SAFETY AND QUALITY ASSURANCE DEPARTMENT

SECM 231 Introduction to Food Safety and Sanitation 2(0+2)

Objectives

1. Gain an understanding of safety, sanitation and hygiene to be maintained in a food industry.
2. To acquaint students' basic techniques for food safety and sanitation.

Lecture Outlines

Practical

General safety and operational guidelines; Preparation of culture media for cultivation of bacteria, molds and yeasts; Different methods of isolation of microorganisms; Different methods of maintenance and preservation of cultures of microorganisms; Microbial analysis of foods- yeast, and mold count in food sample; Microbial analysis of foods- yeast, and mold count in food sample; Microbial quality of water; Estimation of TDS in water; Detection of Escherichia coli and coliforms; Detection of Bacillus ; Detection of Staphylococcus aureus; Biochemical tests for characterization of bacteria (IMVIC); Tests for identification of bacteria by enzymatic activity;

Microbial analysis of milk-Total count and MBRT; Detection and quantification of pathogenic bacteria in raw meat products; Microbial load of palm and fingers - Total Plate Count; Microbial quality of sugar-based foods; Assessment of surface sanitation by swab/ rinse method; Sampling of surfaces - equipment and physical plant; Visit to water purification plant

Visit to Food Processing Plant / Restaurants / Food Mall etc., Microbial Load on frozen foods; Study of microorganisms from effluent; Microbial quality of air; Microbial quality of fermented food; Hand-Washing Effectiveness; pH and Bacterial Growth in Food Products; Study the factors affecting food spoilage – sugar, temperature, moisture; Testing of sanitizers, disinfectants for antimicrobial activity; Visit to food processing industry; Methods of pest control in food industries rodents / cockroaches

Visit to food industry to study microbial safety; Preparation of plans for implementation of FSMS - HACCP, ISO: 22000

Practical

No.	Practical Outlines
1	General safety and operational guidelines
2	Preparation of culture media for cultivation of bacteria, molds and yeasts.
3	Different methods of isolation of microorganisms
4	Different methods of maintenance and preservation of cultures of microorganisms.
5	Microbial analysis of foods- yeast, and mold count in food sample
6	Microbial quality of water
7	Estimation of TDS in water
8	Detection of *Escherichia coli* and coliforms
9	Detection of *Bacillus*
10	Detection of *Staphylococcus aureus*
11	Biochemical tests for characterization of bacteria (IMVIC)
12	Tests for identification of bacteria by enzymatic activity
13	Microbial analysis of milk-Total count and MBRT
14	Detection and quantification of pathogenic bacteria in raw meat products
15	Microbial load of palm and fingers - Total Plate Count
16	Microbial quality of sugar based foods
17	Assessment of surface sanitation by swab/rinse method
18	Sampling of surfaces - equipment and physical plant
19	Visit to water purification plant
20	Visit to Food Processing Plant / Restaurants / Food Mall etc
21	Microbial Load on frozen foods
22	Study of microorganisms from effluent
23	Microbial quality of air
24	Microbial quality of fermented food
25	Hand-Washing Effectiveness
26	pH and Bacterial Growth in Food Products
27	Study the factors affecting food spoilage – sugar, temperature, moisture
28	Testing of sanitizers, disinfectants for antimicrobial activity
29	Visit to food processing industry
30	Methods of pest control in food industries rodents / cockroaches
31	Visit to food industry to study microbial safety
32	Preparation of plans for implementation of FSMS - HACCP, ISO: 22000

References

1. Environmental Microbiology: Laboratory Manual, 2nd edn. Elsevier Academic Press, Amsterdam.
2. Graham-Rack, B and Bmsted, R. 1993. Hygiene in Food Manufacturing and Handling. Cambridge: Woodhead Publishing.
3. Marriott, N.G and Gravani, R.B. 2006. Principles of Food Sanitation, 5th edn. Springer Science and Business Media, Inc., NY, USA. Pepper, I.L. and Gerba, C.P. 2005.
4. Weiser, H. H., Mountney, G. J and Gord, W. W. 1988. Practical Food Microbiology and Technology (2nd ed.). New York: Van Nostrand Reinhold. Gaston, E., & Tiffney, J. 1995. Guide to Improving Food Hygiene. London: Blackwell Publishing.

SECM 132 Introduction to Good laboratory practices 2(0+2)

Objectives

1. To develop GLP awareness and familiarize students with the principles, importance, and regulatory requirements of GLPs.
2. To ensure safety by training students in laboratory following safety protocols and emergency preparedness.
3. To enhance practical competencies in handling laboratory equipment, materials and processes.
4. To promote data integrity by practicing documentation, reporting, and ethical research practices.

Lecture Outlines

Practical

Introduction to the structure of food Labs, design considerations for setting up lab for instruments, and equipment safety; Identification and use of laboratory signage and symbols, Environmental conditions, personnel safety, and other requirements; Handling and disposal of chemicals, glassware & biological waste; Laboratory Test Methods and Equipment maintenance procedures; Identification of certified reference materials, microbial cultures and standard operating procedures for testing products; Requirements for equipment calibration and performance assessment; Requirements for purchase of equipment and consumables in the laboratory, Preparation of standard solutions and dilution series; Sampling and sample handling, sample storage, test portion sampling, referrals for test portions and disposal in laboratories; Quality Assurance Measures, Definition, Procedures and external proficiency testing;

Review of Internal quality checks, external performance evaluations, and Preparation of Quality Assurance manuals; Implementation of Quality Assurance Programmes and maintenance of laboratory records; Preparation of laboratory reports and retention of lab

records; Quality Control of India (QCI), Vision and mission, Administrative and governance structure; National Board of Accreditation laboratories, Vision and mission, Accreditation process and procedures; Types of analysis in basic food laboratories and Quality control procedures; Calibration of equipment, frequency and procedures for calibration, Calibration report preparation; Importance of LIMS in laboratories, Sample flow and process flow procedures, Introduction to AOAC, importance and organizational structure; Types of laboratories, operational procedures and preparation of Draft Project Report for setting up food laboratory; Determination of accuracy and precision by replicate analysis; Recovery study by sample spiking (fortification method); Correlation and regression analysis using analytical data;Preparation of control charts and SQC for analytical results; Swab test for surface sanitation (TVC/Coliform count); Sanitation chemicals, ATP-bioluminescence test for sanitation effectiveness; Preparation of Sanitation Standard Operating Procedure (SSOP) for food laboratories; Importance of non-conformance and corrective action (CAPA) in food laboratories. Method validation and verification guidelines for food testing labs, Requirements and recommendations for method validation; Schemes of MOFPI, its pattern of assistance in setting up & upgradation of Food testing labs; Technical specifications for Analytical balances, Atomic Absorption Spectrophotometer by FSSAI; Technical specifications for Automatic fibre analyzer, Automatic fat analyzer, Protein analyzer, Bomb calorimeter by FSSAI Technical specifications for (HPLC) With (PDA), (FLD) AND (RID), pH meter and UV Visible Spectrophotometer as per FSSAI Technical Specifications of equipments in microbiology labs, Laminar Air flow chambers, Autoclaves, Incubators, water bath & Microscopes as per FSSAI.

Practical

No.	Practical Outline
1	Introduction to the structure of food Labs, design considerations for setting up lab for instruments, and equipment safety
2	Identification and use of laboratory signage and symbols, Environmental conditions, personnel safety, and other requirements
3	Handling and disposal of chemicals, glassware & biological waste
4	Laboratory Test Methods and Equipment maintenance procedures
5	Identification of certified reference materials, microbial cultures and standard operating procedures for testing products
6	Requirements for equipment calibration and performance assessment
7	Requirements for purchase of equipment and consumables in the laboratory, Preparation of standard solutions and dilution series
8	Sampling and sample handling, sample storage, test portion sampling, referrals for test portions and disposal in laboratories
9	Quality Assurance Measures, Definition, Procedures and external proficiency testings
10	Review of Internal quality checks, external performance evaluations, and Preparation of Quality Assurance manuals

11 Implementation of Quality Assurance Programmes and maintenance of laboratory records

12 Preparation of laboratory reports and retention of lab records

13 Quality Control of India (QCI), Vision and mission, Administrative and governance structure

14 National Board of Accreditation laboratories, Vision and mission, Accreditation process and procedures

15 Types of analysis in basic food laboratories and Quality control procedures

16 Calibration of equipment, frequency and procedures for calibration, Calibration report preparation

17 Importance of LIMS in laboratories, Sample flow and process flow procedures, Introduction to AOAC, importance and organizational structure

18 Types of laboratories, operational procedures and preparation of Draft Project Report for setting up food laboratory

19 Determination of accuracy and precision by replicate analysis

20 Recovery study by sample spiking (fortification method)

21 Correlation and regression analysis using analytical data

22 Preparation of control charts and SQC for analytical results

23 Swab test for surface sanitation (TVC/Coliform count)

24 Sanitation chemicals, ATP-bioluminescence test for sanitation effectiveness

25 Preparation of Sanitation Standard Operating Procedure (SSOP) for food laboratories

26 Importance of non-conformance and corrective action (CAPA) in food laboratories

27 Method validation and verification guidelines for food testing labs, Requirements and recommendations for method validation

28 Schemes of MOFPI, its pattern of assistance in setting up & upgradation of Food testing labs

29 Technical specifications for Analytical balances, Atomic Absorption Spectrophotometer by FSSAI

30 Technical specifications for Automatic fibre analyzer, Automatic fat analyzer, Protein analyzer, Bomb calorimeter by FSSAI

31 Technical specifications for (HPLC) With (PDA), (FLD) AND (RID), pH meter and UV Visible Spectrophotometer as per FSSAI

32 Technical Specifications of equipment in microbiology labs, Laminar Air flow chambers, Autoclaves, Incubators, water bath & Microscopes as per FSSAI

References

1. A guidance document by FSSAI for setting up Food Testing Laboratories, 2021
2. A guidance document by National Accreditation Board for Testing and Calibration Laboratories (NABL) for auditing labs.

3. International Accreditation Service, Guidelines for Food Testing labs, August, 2015
4. A Textbook on "Principles of Food Chemistry" by John M. deMan
5. A guidance document by "Official Methods of Analysis of AOAC International."
6. A Textbook on "Good Laboratory Practice Regulations" by Sandy Weinberg.

SECM 131 Basic Food Analysis and Laboratory Techniques 2(0+2)

Objectives

1. To impart information on hazards and precautions in use of the chemicals and glassware.
2. To guide the careful handling of chemicals and glassware.
3. To provide the basic principles and analytical procedures applied in the analysis.
4. To impart proper knowledge about the working principles of the equipment.
5. To enhance the lab skills.

Lecture Outlines

Practical

Introduction to food quality, importance, quality attributes, grades, standards. Safety concepts in quality control laboratories to avoid potential hazards associated with handling chemicals, glassware, samples. Laboratory equipment use and working principle. General glassware and apparatus. Concentration of Solutions. Protocol for preparation of chemical reagents. Examination of foods for extraneous materials. Sample preparation. Sieve analysis.

Determine the titratable acidity and pH of food samples. Determination of Brix and TDS in food samples. Gelatinization of starch. Determination of fiber in food samples. % Transmittance spectrum, % Reflectance spectrum. Determination of carbohydrates in food samples. Determination of fiber in food samples. Determination of proteins in foods. Determination of oil content in food samples. Determination of Specific Gravity of oils. Determine the peroxide value of fats and oils. Mineral estimation in food samples. Iron Determination in food samples. Sodium Determination in food. Flavor /aroma tests: Creatinine test, Acetaldehyde test, bitterness units. Sensory Analysis guidelines. Sensory Analysis Tests. Different types of scales used in the sensory analysis. Presentation of sensory analysis test results. Detection of adulteration in food products: milk, ghee. Detection of adulteration in food products: honey, spices, pulses, oils, sweets.Preparing nutrition labels for sample food formulas.

Practical

No.	Practical Outline
1	Introduction to food quality, importance, quality attributes, grades, standards

2 Safety concepts in quality control laboratories to avoid potential hazards associated with handling chemicals, glassware, samples
3 Laboratory equipment and use and working principle
4 General glassware and apparatus - volumetric glassware, and mechanical pipettes. Dispensing from a volumetric pipette and a graduated pipette
5 Concentration of Solutions - preparation of different concentration solutions Molarity, Normality,% Concentration, ppm and ppb
6 Protocol for preparation of chemical reagents
7 Examination of foods for extraneous materials
8 Sample preparation
9 Sieve analysis- Determination of granularity in flours: Sieving Method
10 Determine the titratable acidity and pH of food samples
11 Determination of Brix and TDS in food samples
12 % Transmittance spectrum, % Reflectance spectrum
13 Determination of carbohydrates in food samples
14 Determination of fiber in food samples
15 Determination of browning in foods
16 Determination of proteins in foods
17 Determination of proteins in foods
18 Determination of oil content in food samples.
19 Determination of Specific Gravity of oils
20 Determine the peroxide value of fats and oils
21 Mineral estimation in food samples
22 Iron Determination in food samples
23 Sodium Determination in food
24 Flavor /aroma tests: Creatinine test, Acetaldehyde test, bitterness units
25 Sensory Analysis guidelines
26 Sensory Analysis Tests
27 Different types of scales used in the sensory analysis
28 Presentation of sensory analysis test results
29 Detection of adulteration in food products: milk, ghee
30 Detection of adulteration in food products: honey, spices, pulses, oils, sweets
31 Preparing nutrition labels for sample food formulas
32 Practical examination

References

1. Food Analysis. Nielsen. Springer.
2. Food Analysis. Khetarpaul. Daya Publications.

3. Food quality & safety. Kumar. M. CBS Publications.
4. Hand book of analysis and quality control. Ranganna. MGH.
5. Food Quality Evaluation. Eram S Rao. Variety Books, New Delhi
6. Book of Laboratory Safety. Keith Frurrl A. CRC Press.

Food Process Engineering Department

SECM 222 Introduction to Electrical and Control Systems 2(0+2)

in Food Industry

Objectives

1. To introduce automation in food manufacturing and intelligent control systems.
2. To expose the importance of computerized control systems in food factories.
3. To ensure food safety and quality.
4. To enhance operational efficiency and optimize energy usage in the food industry.

Lecture Outlines

Practical

Introduction to Sensors and Overview of measurement principles. Signal processing: analogue and digital signals and Key characteristics: sensitivity, accuracy, precision Overview of different types of temperature sensors: thermocouples, thermistors, resistance temperature detectors (RTDs), and semiconductor sensors. Practical demonstration of temperature detection in a water bath shaker using thermocouples. Determining temperature in an incubator using thermistor sensors. Practical calibration of temperature sensors used in blast freezers for food preservation. Measurement of temperature using Resistance Temperature Detectors (RTDs) in food processing plants. Mechanism and demonstration of temperature detection in smart refrigerators using semiconductor sensors. Introduction to Humidity Sensors: Relative humidity, types of humidity sensors, and their applications in food processing. Measurement of humidity using capacitive humidity sensors in Grain Dryers and Chocolate Storage Cabinets. Working principles and demonstration of humidity measurement in drying ovens using Thermal Conductivity Sensors Measurement of humidity using optical sensors in freeze dryers Study of Mechanism of humidity control in cold storage units. Introduction to Pressure Sensors: Types of pressure sensors and their importance in food processing. Practical demonstration of high-pressure measurement in homogenizers. Calibration of capacitive pressure sensors in beverage filling systems. Measurement of pressure in extruder barrels during snack or pasta production by using strain gauge pressure sensors. Pressure monitoring in autoclaves and retorts using piezo resistive sensors. Tracking pressure drops across filters in water purification and beverage production systems.

Determination of pressure in spray dryer liquid feed systems. Calibration of pressure using barometric sensors. Mechanism of moisture measurement in grain dryers using moisture sensors. Practical demonstration of moisture monitoring in bakery dough mixers. Detection of moisture content in spray dryers using infrared moisture sensors. Determination of precise moisture levels in food samples for quality control using a gravimetric moisture analyzer. Mechanism of moisture detection using fiber optic sensors in Food Storage Silos and Fermentation Tanks. Determination of liquid level using float sensors in Fermentation Tanks and Beverage Dispensers. Working principle and demonstration of capacitive level sensors in oil tanks. Water level detection in boilers using conductive level sensors. Mechanism of liquid level detection using optical sensors. Determination of CO_2 levels in carbonation systems. Air quality monitoring in food processing facilities using Metal Oxide Semiconductor (MOS) gas sensors.

Practical

No.	Practical Outline
1	Introduction to Sensors and Overview of measurement principles.
2	Signal processing: analogue and digital signals and Key characteristics: sensitivity, accuracy, precision.
3	Overview of different types of temperature sensors: thermocouples, thermistors, resistance temperature detectors (RTDs), and semiconductor sensors.
4	Practical demonstration of temperature detection in a water bath shaker using thermocouples.
5	Determining temperature in an incubator using thermistor sensors.
6	Practical calibration of temperature sensors used in blast freezers for food preservation.
7	Measurement of temperature using Resistance Temperature Detectors (RTDs) in food processing plants.
8	Mechanism and demonstration of temperature detection in smart refrigerators using semiconductor sensors.
9	Introduction to Humidity Sensors: Relative humidity, types of humidity sensors, and their applications in food processing.
10	Measurement of humidity using capacitive humidity sensors in Grain Dryers and Chocolate Storage Cabinets.
11	Working principles and demonstration of humidity measurement in drying ovens using Thermal Conductivity Sensors.
12	Measurement of humidity using optical sensors in freeze dryers.
13	Study of Mechanism of humidity control in cold storage units.
14	Introduction to Pressure Sensors: Types of pressure sensors and their importance in food processing.
15	Practical demonstration of high-pressure measurement in homogenizers.
16	Calibration of capacitive pressure sensors in beverage filling systems.

17 Measurement of pressure in extruder barrels during snack or pasta production by using strain gauge pressure sensors.

18 Pressure monitoring in autoclaves and retorts using piezo resistive sensors.

19 Tracking pressure drops across filters in water purification and beverage production systems.

20 Determination of pressure in spray dryer liquid feed systems.

21 Calibration of pressure using barometric sensors.

22 Mechanism of moisture measurement in grain dryers using moisture sensors.

23 Practical demonstration of moisture monitoring in bakery dough mixers.

24 Detection of moisture content in spray dryers using infrared moisture sensors.

25 Determination of precise moisture levels in food samples for quality control using a gravimetric moisture analyzer.

26 Mechanism of moisture detection using fiber optic sensors in Food Storage Silos and Fermentation Tanks

27 Determination of liquid level using float sensors in Fermentation Tanks and Beverage Dispensers.

28 Working principle and demonstration of capacitive level sensors in oil tanks.

29 Water level detection in boilers using conductive level sensors.

30 Mechanism of liquid level detection using optical sensors.

31 Determination of CO_2 levels in carbonation systems.

32 Air quality monitoring in food processing facilities using Metal Oxide Semiconductor (MOS) gas sensors

References

1. Automation in the Food Industry, C.A Moore, Springer.
2. Food Safety (Quality Control and Management), Mohammad Kuddus, Syed Amir Ashraf, Pattanathu Rahman- CRC press
3. Kress-Rogers, E., Brimelow, C. J.B. 2001, Instrumentation and Sensors for the Food Industry, 2nd edn, Woodhead, Cam-bridge.
4. Measurement and Control in Food Processing, Manabendra Bhuyan, Ph.D. Published in 2007 by CRC Press Taylor & Francis Group.
5. Moreira, R. G. 2001, Automatic Control for Food Processing Systems, Aspen, New-York.

SECM 121 Introduction to Mechanical Systems in Food Industry 2(0+2)

Objectives

To provide hands-on experience in operating, maintaining, and troubleshooting mechanical systems commonly used in food processing.

Lecture Outlines

Practical

Demonstration of basic food processing machines (mixer, grinder, conveyor, cleaners, dryers, etc.); Study on basic conveyor system; Development of troubleshooting skills for Conveyors and Mixers; Determination of efficiency of a screw conveyor, belt conveyor and bucket elevator; Design of conveying systems for food products; Visit to food processing plant; Study on different Mixing and Agitation Techniques to process food materials; Determination efficiency of mixing and agitation systems; Development of troubleshooting skills for Mixers.

Study of homogenizers and its effect on liquid food products; Study on Separation Techniques Using different types of Filters; Experiment on membrane filtration, ultra filtration and Reverse osmosis; Experiment with centrifugal pumps to transfer liquids and determination of its performance; Study on various grinders and mills to reduce the size of food products; Experiment on size reduction of grains by Hammer mill; Visit to milling industry; Study on the operation of refrigeration systems in food preservation; Effect of refrigeration system with food materials; Visit to cold chamber; Estimation of refrigeration load for food products; Determination of efficiency of heat exchangers with food-based materials; Visit to Dairy plant; Study on different types of drying techniques; Experiment on drying of food products by solar dryers; Study on different types of cleaning equipment; Determination of cleaning efficiency of cleaners.

Practical

No.	Practical Outline
1	Demonstration of basic food processing machines (mixer, grinder, conveyor, cleaners, dryers, etc.)
2	Demonstration of basic food processing machines (mixer, grinder, conveyor, cleaners, dryers etc.)
3	Study on basic conveyor system
4	Development of troubleshooting skills for Conveyors and Mixers
5	Determination of efficiency of a Screw Conveyor
6	Determination of efficiency of a belt Conveyor
7	Determination of efficiency of a bucket elevator
8	Design of conveying systems for food products
9	Visit to food processing plant
10	Study on different Mixing and Agitation Techniques to process food materials
11	Determination efficiency of mixing and agitation systems
12	Development of troubleshooting skills for Mixers
13	Study of homogenizers and its effect on liquid food products
14	Study on Separation Techniques Using different types of Filters

15 Experiment on membrane filtration
16 Experiment on ultra-filtration
17 Experiment on Reverse osmosis
18 Experiment with centrifugal pumps to transfer liquids and determination of its performance
19 Study on various grinders and mills to reduce the size of food products
20 Experiment on size reduction of grains by Hammer mill
21 Visit to milling industry
22 Study on the operation of refrigeration systems in food preservation
23 Effect of refrigeration system with food materials
24 Visit to cold chamber
25 Estimation of refrigeration load for food products
26 Determination of efficiency of heat exchangers with food-based materials
27 Visit to Dairy plant
28 Study on different types of drying techniques
29 Experiment on drying of food products by solar dryers
30 Study on different types of cleaning equipment
31 Determination of cleaning efficiency of cleaners
32 Practical examination

References

1. Amalendu Chakraverty and R. Paul Singh. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
2. Amalendu Chakraverty, Arun S. Mujumdar, G. S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. Arora, C.P. 2000. Refrigeration and Air Conditioning, 2nd Ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
4. Carl W. Hall and Denny C. Davis. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
5. Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
6. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.
7. Henderson, S. M and Perry, R.L. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.
8. Sahay, K.M and Singh, K. K. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida.

SECM 221 Introduction to Auto CAD 2 (0+2)

Objectives

1. The purpose of CAD is to optimize and streamline the designer's work flow.
2. CAD allows users to create digital 2D drawing and 3D models.

Lecture outlines

Practical

Introduction to CAD and its importance; CAD system components and computer hardware for CAD and explanation of various drafting packages; Overview of CAD window – explanation of various toolbars on drawing screen; Study of draw tool bar and practice on draw tool bar, dimension and dimensional editing tool bar and practice on dimension tool bar; Create a 2D view of the given diagram using CATIA V5 2D for 2D Drawing -1, 2D Drawing –2, 2D Drawing –3, 2D Drawing -4, 2D Drawing -5, 2D Drawing -6; 3D Modeling -1.

Create a 3D view of the V Block using CATIA V5, Open bearing using CATIA V5 , Angular block using CATIA V, Dove tail Bracket using CATIA V5, Dove tail Bracket using CATIA V5, Tool post-1 using CATIA V5, Tool post-2 using CATIA V5, Piston using CATIA V5; Assembling and Preparation of sleeve and Cotter joint-1,2 using CATIA V5, GIB and Cotter joint using CATIA V5, pin and hole joint-1, 2 using CATIA V5; Real-time modeling-1,2,3 preparation of agricultural tool using CATIA V5; Introduction to CAM and its importance; Codes used in CNC; CAM system components and computer hardware for CAM and explanation; Manual part programming & machining using auto cad for CNC turning, CNC milling.

Practical

No.	Practical Outline
1	Introduction to CAD and its importance
2	CAD system components and computer hardware for CAD and explanation of various drafting packages
3	Overview of CAD window – explanation of various toolbars on drawing screen
4	Study of draw tool bar and practice on draw tool bar
5	Study on dimension and dimensional editing tool bar and practice on dimension tool bar
6	2D Drawing -I, create a 2D view of the given diagram using CATIA V5 2D
7	2D Drawing -2, Create a 2D view of the given diagram using CATIA V5 2D
8	2D Drawing -3, Create a 2D view of the given diagram using CATIA V5 2D
9	2D Drawing -4, Create a 2D view of the given diagram using CATIA V5 2D
10	2D Drawing -5, Create a 2D view of the given diagram using CATIA V5 2D

11 2D Drawing -6, Create a 2D view of the given diagram using CATIA V5 2D
12 3D Modeling -1, Create a 3D view of the V Block using CATIA V5
13 3D Modeling -2, Create a 3D view of the Open bearing using CATIA V5
14 3D Modeling -3, Create a 3D view of the Angular block using CATIA V5
15 3D Modeling -4, Create a 3D view of the Dove tail Bracket using CATIA V5
16 3D Modeling -5, Create a 3D view of the Tool post using CATIA V5
17 3D Modeling -5, Create a 3D view of the Tool post using CATIA V5
18 3D Modeling -6, Create a 3D view of the Piston using CATIA V5
19 Assembly - Preparation of sleeve and Cotter joint using CATIA V5
20 Assembly - Preparation of sleeve and Cotter joint using CATIA V5
21 Assembly - Preparation of GIB and Cotter joint using CATIA V5
22 Assembly - Preparation of pin and hole joint using CATIA V5
23 Assembly - Preparation of pin and hole joint using CATIA V5
24 Real-time modeling-1, preparation of agricultural tool using CATIA V5
25 Real-time modeling-2, preparation of agricultural tool using CATIA V5
26 Real-time modeling-3, preparation of agricultural tool using CATIA V5
27 Introduction to CAM and its importance
28 Explanation of Codes used in CNC
29 CAM system components and computer hardware for CAM and explanation
30 Manual part programming & machining using auto cad for CNC turning
31 Manual part programming using auto cad for CNC milling
32 Practical Examination

References

1. Bhat, N.D and Panchal, V. M. 1995. Machine Drawing. Charotar Publishing House, Anand.II
2. Ibrahim Zeid. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.
3. Kunwoo Lee. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.

FOOD PLANT OPERATIONS DEPARTMENT

SECM 251 Maintenance of Food Processing Equipment 2(0+2)

Objectives

1. To understand the different equipment operating procedures
2. Gain an understanding of various food process equipment care and maintenance
3. Develop skills in troubleshooting of common equipment issues
4. Gain hands-on experience in the maintenance and repair of food processing machinery

Lecture Outlines

Practical

Food processing equipment – materials of construction, fabrication techniques, basic principles of maintenance - preventive, corrective and predictive maintenance, importance of regular maintenance and its impact on production; Basic safety protocols and personal protective equipment (PPE) usage in maintenance; Types of failures - common equipment failures in food processing, mechanical failures, electrical failures, process failures; root cause analysis – techniques for identifying underlying issues, problem solving methods; Hands-on practice regarding basic operation of various equipments in food processing; Hands-on practice regarding basic repair techniques on food processing equipment; Mechanical components and troubleshooting – disassembly, inspection and reassembly of mechanical parts like gears, shafts, belts, bearings and seals or gaskets; Lubrication exercises and alignment of machine components; Hydraulic and Pneumatic systems – principles of hydraulic and pneumatic operation; maintenance of pumps, valves and air compressors;

Electrical components and Maintenance – hands on exercises in wiring, grounding and insulating practices, troubleshooting control panel, sensors; testing and replacement of common electrical components like fuses, relays; Rice milling equipment, Pulse milling equipment, millet processing equipment, trouble shooting, care and maintenance - cleaning equipment, graders, dehusker, dehuller, separators, splitters, polishing equipment, colour sorter, pulverizer, sifter; Performance evaluation of millet processing equipment - cleaning equipment, dehusker, dehuller, splitter, pulverizer, sifter; Visit to modern rice and pulse milling units; Visit to millet processing unit; Oil milling equipment, care and maintenance – cleaning equipment, shellers, decorticators, screw press, hydraulic press, plate and frame filter press; Spice processing equipment, care and maintenance - pounding machines, pulverizers; Fruits and vegetables processing plant equipment, trouble shooting, care and maintenance - graders, washers, blanchers, slicers, juice extractors, evaporators, Heat exchangers, peelers, fruit crusher, mixing tank, homogenizer, pasteurizer, Canning equipment, bottling machine; Performance evaluation of fruit pulper; Visit to fruit processing industry; Dryers, trouble shooting, care and maintenance - tray dryer, solar dryer, tunnel dryer, freeze dryer, infrared

dryer, drum dryer, spray dryer, fluidized bed dryer; Milk processing plant equipment, care and maintenance; Butter, ghee, cheese manufacturing equipments, care and maintenance; Ice cream processing equipment, care and maintenance; Visit to milk processing unit and modern dairy industry; Bakery equipments, care and maintenance, Visit to bakery unit; Study of meat and poultry processing equipment, care and maintenance, visit to modern meat processing industry; Alcoholic beverage processing equipment, care and maintenance;

Visit to sugar industry and Jaggery processing unit; Tutorials on tea, coffee post-harvest processing equipment; Different material handling equipment – belt conveyor, bucket elevator, screw conveyor, chain conveyor, troubleshooting conveyor systems – Identifying and addressing common conveyor issues like misalignment, jams, motor failures; Different packaging machines, care and maintenance – form fill sealing machine, vacuum packaging machine, controlled atmospheric packaging and modified atmospheric packaging equipment, shrink wrapping machine, band sealing machine; Cleaning and sanitation of food processing equipment – cleaning and sanitizing of various food processing equipment, implementation of CIP systems and monitoring cleaning effectiveness; Food safety and Hygiene standards, Regulatory standards and compliance – Food safety regulations (FDA, USDA, HACCP etc.), importance of preventing contamination through equipment maintenance; Good Manufacturing Practices (GMP).

Practical

No.	Practical Outline
1	Food processing equipment –materials of construction, fabrication techniques, basic principles of maintenance – preventive, corrective and predictive maintenance, importance of regular maintenance and its impact on production.
2	Basic safety protocols and personal protective equipment (PPE) usage in maintenance
3	Types of failures – common equipment failures in food processing, mechanical failures, electrical failures, process failures; root cause analysis – techniques for identifying underlying issues, problem solving methods.
4	Hands-on practice regarding basic operation of various equipment in food processing; Hands-on practice regarding basic repair techniques on food processing equipment.
5	Mechanical components and troubleshooting – disassembly, inspection and reassembly of mechanical parts like gears, shafts, pulleys, belts, bearings and seals or gaskets.
6	Lubrication exercises and alignment of machine components; Hydraulic and Pneumatic systems – principles of hydraulic and pneumatic operation; maintenance of pumps, valves and air compressors.
7	Electrical components and Maintenance – hands on exercises in wiring, grounding and insulating practices, troubleshooting control panel, sensors; testing and replacement of common electrical components like fuses, relays.
8	Rice milling equipment, Pulse milling equipment, millet processing equipment, trouble shooting, care and maintenance – cleaning equipment, graders, dehusker, dehuller, separators, splitters, polishing equipment, colour sorter, pulverizer, sifter.

9 Performance evaluation of millet processing equipment - cleaning equipment, dehusker, dehuller, splitter, pulverizer, sifter

10 Visit to modern rice and pulse milling units

11 Visit to millet processing unit

12 Oil milling equipment, care and maintenance – cleaning equipment, shellers, decorticators, screw press, hydraulic press, plate and frame filter press.

13 Visit to oil milling unit

14 Spice processing equipment, care and maintenance – pounding machines, pulverizes.

15 Fruits and vegetables processing plant equipment, troubleshooting, care and maintenance – graders, washers, blanchers, slicers, juice extractors, evaporators, Heat exchangers, peelers, fruit crusher, mixing tank, homogenizer, pasteurizer, canning equipment, bottling machine.

16 Performance evaluation of fruit pulper

17 Visit to fruit processing industry

18 Dryers, trouble shooting, care and maintenance – tray dryer, solar dryer, tunnel dryer, freeze dryer, infrared dryer, drum dryer, spray dryer, fluidized bed dryer

19 Milk processing plant equipment, care and maintenance.

20 Butter, ghee, cheese manufacturing equipment, care and maintenance.

21 Ice cream processing equipment, care and maintenance.

22 Visit to milk processing unit and modern dairy industry.

23 Bakery equipment, care and maintenance, Visit to bakery unit.

24 Study of meat and poultry processing equipment, care and maintenance, visit to modern meat processing industry.

25 Alcoholic beverage processing equipment, care and maintenance.

26 Visit to sugar industry and Jaggery processing unit.

27 Tutorials on tea, coffee post-harvest processing equipment

28 Different material handling equipment – belt conveyor, bucket elevator, screw conveyor, chain conveyor, troubleshooting conveyor systems – identifying and addressing common conveyor issues like misalignment, jams, motor failures.

29 Different packaging machines, care and maintenance – form fill sealing machine, vacuum packaging machine, controlled atmospheric packaging and modified atmospheric packaging equipment, shrink wrapping machine, band sealing machine.

30 Cleaning and sanitation of food processing equipment – cleaning and sanitizing of various food processing equipment, implementation of CIP systems and monitoring cleaning effectiveness.

31 Food safety and hygiene standards, regulatory standards and compliance – food safety regulations (FDA, USDA, HACCP etc.), importance of preventing contamination through equipment maintenance; Good Manufacturing Practices (GMP).

32 Practical examination

References

1. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
2. Chakraverty, A. and Singh, R.P. 2014. Post-Harvest Technology and Food Process Engineering CRC Press, Boca Raton, FL, USA.
3. Coles, R, McDowell B and Kirwan, M.J. 2003. Food Packaging Technology, Blackwell Publishing Ltd., Oxford, UK.
4. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
5. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.
6. Gordon L. Robertson. 2014. Food Packaging: Principles and Practice, 3rd Ed. CRC Press, Boca Raton, FL, USA.
7. Green, D.W. and Perry, R.H. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
8. Gupta, S. 2007. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
9. Hui, Y.H, Bernyard L. Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong and Phil Ventresca. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.
10. Joshi, M.V. 1976. Process Equipment Design. SG Wasani for The Macmillan Company of India Limited, Rakesh Press, New Delhi.
11. Lindley, R.H and Mobley, R. K. 2002. Maintenance Engineering Handbook. Sixth edition, McGraw-Hill, New York.
12. NIIR Board of consultants & Engineers. 2014. The complete Technology Book on Bakery Products (Baking Science with Formulation & Production), 3rd Ed. NIIR, New Delhi.
13. Panda, H. 2010. Hand book on spices and condiments (Cultivation, processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
14. Ramaswamy, H and Marcotte, M. 2005. Food Processing Principles and Applications. Taylor & Francis Group is the Academic Division of T&F Informa plc.
15. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
16. Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
17. Vikas, N. 2014. Meat, Egg and Poultry Science & Technology. I.K. International Publishing House Pvt. Limited., New Delhi.

SECM 252 Introduction to Bottling and Canning Line 2(0+2)

Objectives

1. To understand the different equipment operating procedures
2. Gain an understanding of various food process equipment care and maintenance
3. Develop skills in troubleshooting of common equipment issues
4. Gain hands-on experience in the maintenance and repair of food processing machinery

Lecture Outlines

Practical

Performance of Sterilization and cleaning of bottles, Testing the bottles by swab test, Performance of hot filling of bottles for jams and sauces, Performance of aseptic filling of bottles for liquid foods, Study of bottle strength, permeability and compatibility with the products, Performance Evaluation of Carbonated Beverage Bottling Method, Performance Evaluation of non-Carbonated Beverage Bottling Method, Study of vacuum and pressure sealing methods for bottles, Performance of Bottling Processes for Fermented Foods, Performance Evaluation of temperature stability of bottle foods, Study of Bottling Techniques for Fruits, Study of Bottling Techniques for Vegetables, Sealing and Closure Testing Methods for Bottles, Study of Manual Bottle filling Methods, Study of semi-automatic bottling filling method, Study of automatic bottling filling method.

Study of Various Canning Techniques, Study of Cans: Materials, Designs, and Applications, Study of canning process and thermal calculations, Study of Industry Standards for Canning Operations, Development of metal cans, aluminum cans and tin cans, Development of two piece cans and three piece cans, Performance of canning for Mango/Guava/ Papaya, Performance of canning for vegetables, Performance of canning for sea foods, Study of bacteriology of canning and defects and spoilage of canning, Study of steps in canning-syruping, brining foods, Performance of canning for acidic, Performance of canning for nonacidic, Performance of quality assurance and defects in canned products, Visit to bottling industry and canning industry.

Practical

No.	Practical Outline
1	Performance of Sterilization and cleaning of bottles
2	Testing the bottles by swab test
3	Performance of hot filling of bottles for jams and sauces
4	Performance of aseptic filling of bottles for liquid foods
5	Study of bottle strength, permeability and compatibility with the products
6	Performance Evaluation of Carbonated Beverage Bottling Method

7 Performance Evaluation of non-Carbonated Beverage Bottling Method
8 Study of vacuum and pressure sealing methods for bottles
9 Performance of Bottling Processes for Fermented Foods
10 Performance Evaluation of temperature stability of bottle foods
11 Study of Bottling Techniques for Fruits
12 Study of Bottling Techniques for Vegetables
13 Sealing and Closure Testing Methods for Bottles
14 Study of Manual Bottle filling Methods
15 Study of semi-automatic bottling filling method
16 Study of automatic bottling filling method
17 Study of Various Canning Techniques
18 Study of Cans: Materials, Designs, and Applications
19 Study of canning process and thermal calculations
20 Study of Industry Standards for Canning Operations
21 Development of metal cans, aluminium cans and tin cans
22 Development of two-piece cans and three-piece cans
23 Performance of canning for Mango / Guava / Papaya
24 Performance of canning for vegetables
25 Performance of canning for sea foods
26 Study of bacteriology of canning and defects and spoilage of canning
27 Study of steps in canning- syruping, brining foods
28 Performance of canning for acidic
29 Performance of canning for non-acidic
30 Performance of quality assurance and defects in canned products
31 Visit to bottling industry and canning industry
32 Practical Examination

References

1. Gordon L. Robertson. 2012. Food Packaging: Principles and Practice, Third Edition.
2. Lal, G., Siddaappa, G. S. and Tandon, G.L. 2009. Commercial canning. In: Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Dehli. P:7-26
3. Larousse, Jean, and Bruce E. Brown. Food canning technology. Wiley-VCH, 1997.
4. Ranganna, S. 2000. Handbook of Canning and Aseptic Packaging. McGraw Hill Publishing Company Ltd.
5. Srivastava, R. P and Kumar, S. 2001. Canning and bottling of fruits and vegetables. In: Fruit and Vegetable Preservation: Principle and Practices, International Book Distributing Co. P: 101-124.

SECM 151 Introduction to Manufacturing of Bakery 2(0+2)

Products

Objectives

1. To learn the processing, packaging, storage of bakery products.
2. To understand technology and manufacturing equipments used in production of bakery products

Lecture Outlines

Practical

Study of different equipment used in Bakery; Gluten estimation; Physical, chemical and rheological properties; Biscuit manufacturing line, making of Salt and sweet biscuits, fruit biscuits, biscuits with millets/other grains, crackers, wafers/ matzos, Cookies with low fat, Cookies with high fat; physical, chemical parameters of cookies/biscuits; making of tarts, puff pastry; role of leavening agents; processing technology of yeast raised bakery products –I, II, Bread/ Buns/ types of bread; Quality evaluation of Bread/ yeast raised bakery products –I, processing technology of Pizza base, Sponge Cakes, High ratio cake, Swiss rolls/ cream roll, Muffins/ cupcakes; Textural properties of breads, cakes; Visit to bread/ biscuit and cake manufacturing unit.

Practical

No.	Practical Outline
1	Study of different equipment used in Bakery
2	Estimation of Gluten (Dry and wet gluten)
3	Determination of physical properties of different ingredients in bakery – I
4	Determination of chemical properties of different ingredients in bakery -– II
5	Determination of rheological properties of dough
6	Study of Biscuit manufacturing line
7	Biscuit making – Salt and sweet biscuits
8	Processing technology and formulation of fruit biscuits
9	Processing technology and formulation of biscuits with millets/other grains
10	Processing technology and formulation of crackers
11	Processing technology and formulation of wafers/ matzos
12	Processing technology and formulation of Cookies with low fat
13	Processing technology and formulation of Cookies with high fat
14	Evaluation of physical parameters of cookies / biscuits
15	Evaluation of chemical parameters of cookies / biscuits

16 Processing technology and formulation of tarts (jam / lemon)
17 Processing technology and formulation of puff pastry
18 Demonstration of role of leavening agents
19 Processing technology and formulation of yeast raised bakery products –I
20 Processing technology and formulation of yeast raised bakery products -II
21 Processing technology and formulation of Bread/ Buns/ types of bread
22 Evaluation of quality parameters of Bread/ yeast raised bakery products –I
23 Processing technology and formulation of Pizza base
24 Processing technology and formulation of Sponge Cakes
25 Processing technology and formulation of High ratio cake
26 Processing technology and formulation of Swiss rolls/ cream roll
27 Processing technology and formulation of Muffins/ cup cakes
28 Evaluation of textural properties of breads
29 Evaluation of textural properties of cakes
30 Visit to bread/ biscuit manufacturing unit
31 Visit to cake manufacturing unit
32 Final practical examination

References

1. Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd Ed. Woodhead Publishing Limited, Cambridge, England.
2. FSSAI. 2015. Manual of methods of analysis of foods (cereal and cereal products).
3. Harold Corke, Ingrid De Leyn, Nanna A. Cross, Wai-Kit Nip, Y.H. Hui. 2006. Bakery Products: Science and Technology. Blackwell Publishing Ltd., Oxford, UK.
4. John J. Kingslee. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.
5. Joseph Amendola and Nicole Rees. 2003. Understanding Baking: The Art and Science of Baking, 3rd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
6. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
7. NIIR Board of Consultants & Engineers. 2014. The Complete Technology Book on Bakery Products (Baking Science with Formulation & Production), 3rd Ed. NIIR, New Delhi.
8. Pyler, E.J and Gorton, L.A. 2009. Baking Science & Technology, Vol. II: Formulation & Production, 4th Ed. Sosl and Publishing Company, Kansas City, MO, USA.
9. US Wheat Associates. Baker's Handbook on Practical Baking.

ELEVTIVE COURSES

FDPT 412 Design and Formulation of Foods 3(2+1)

Objectives

1. Understand about RDA for Indians
2. Design and formulation of new and innovative target foods
3. Gain knowledge about various functional foods

Course Outlines

Theory

Nutrients and their function, food classification and their nutritive value, antinutritional factors present in food; Concept of different food groups, recommended dietary allowances (RDA) for Indians; nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people; Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value addition; Therapeutic diets – Principles and objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation; Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods; Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defense services, sportsmen, space food.

Practical

To study the principles and planning menu; Develop diet plan using food exchange list and nutrient calculation for school children, adult, pregnant; Preparation and formulation of Indian Traditional Snack, Traditional Sweet; Preparation and development of food for pregnant and lactating women, foods for infants; Preparation and formulation of food and energy drinks for diabetic person (sugar free food products); sports person and osteoporosis; preparation of prebiotic and pro biotic food product; Preparation of functional food using millets; whey beverage probiotic beverage; Production of functional beverage and antioxidant determination; Visit to Food Processing Industries/ Expos.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Nutrients and their function – Carbohydrates, Proteins, Fats, Vitamins and Minerals

2 Food classification and their nutritive value - ICMR food groups

3 Anti-nutritional factors present in food – Inhibitors, Toxins, Aflatoxins, Flatulence factors, Phenolic compounds, Oxalates, Phytates

4 Concept of different food groups - Cereals, Pulses, Oilseeds, Fruits, Vegetables, Milk, Meat and Poultry

Unit II

5 Recommended dietary allowances (RDA) for Indians – Nutrient requirements and recommendation

6 Nutrition for infant – Nutritional requirements, weaning and supplementary foods

7 Nutrition for pre-school and school children - Nutritional requirements, convenience foods

8 Nutrition for adults (men and women) and old age people - nutritional requirements and consideration for diet planning

Unit III

9 Nutritional requirements for pregnant and lactating women – RDA and diet planning

10 Production and formulation of Indian traditional sweets from different food groups

11 Steps for quality improvement in the formulated and NPD (New Product Development)

12 Value addition in different food groups

Unit IV

13 Therapeutic diets – Principles and objectives of diet therapy

14 Diet for patient suffering from Diabetes mellitus

15 Diet for patient suffering from osteoporosis

16 Diet for patient suffering from cardiac problem

Unit V

17 Diet for patient suffering from upper gastrointestinal disorders

18 Diet for patient suffering from lower gastrointestinal disorders

19 Diet planning and use of exchange list in nutrient calculation

20 Functional foods - definition and concepts

Unit VI

21 Design and formulation of functional foods

22 Bioactive compounds as functional foods

23 Trends in the development of functional foods

24 Micronutrients as functional ingredients

Unit VII

25 Nutraceuticals food - definition and concepts

26 Design and development of nutraceutical foods

27 Recent trends in nutraceutical food formulation

28 Designing and formulation of antioxidant rich food products

Unit VIII

29 Nutritional concepts for formulation of foods for drought and disaster afflicted

30 Nutritional requirements and concepts for formulation of foods for defense services

31 Nutritional requirements and concepts for formulation of foods and beverages for sportsmen

32 Nutritional concepts for formulation of foods for space food and astronaut foods

Practical

No.	Practical Outline
1	To study the principles and planning menu
2	Develop diet plan using food exchange list and nutrient calculation for school children
3	Develop diet plan using food exchange list and nutrient calculation for adults
4	Preparation and formulation of Indian Traditional Snack
5	Preparation and formulation of Traditional Sweet
6	Preparation and development of food for pregnant and lactating women
7	Preparation and development of weaning foods for infants
8	Preparation and formulation of food and energy drinks for diabetic person (sugar free food products)
9	Preparation and formulation of food for sports person and osteoporosis
10	Preparation of probiotic and pro biotic food product
11	Preparation of functional food using millets
12	Processing technology of whey beverage probiotic beverage
13	Production of functional beverage
14	Antioxidant determination in functional foods
15	Visit to Food Processing Industries/Expos
16	Practical Examination

References

1. Antia, F.P. 1974. Clinical Dietetics and Nutrition, Oxford Medicine Publications.
2. Davidson, S., Passmore, R and Eastwood, M.A. 1986. Davidson and Passmore Human Nutrition and Dietetics. Churchill Livingstone.
3. Gopalan, C., Ramshastri, B.V and Balasubramaniam, S.C. 1989. Nutritive Value of Indian Foods National Institute of Nutrition, Hyderabad.
4. Pokorny, J., Yanishlieva, N and Gordon, M. 2001. Antioxidants in Food, Woodhead Publishing Limited, Abington Hall, Abington.
5. Potter, N. N and Hotchkiss, J.H. 1995. Food Science, 5th edn. Chapman & Hall, NY, USA.

6. Mazza, G.1998. Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.
7. Robinson, C. 1975. Basic Nutrition and Diet Therapy, Macmillan.
8. Swaminathan, M.1974. Essentials of Nutrition, Ganesh Co.
9. Steinkrauss, K.H. 1995. Handbook of Indigenous Fermented Foods, Marcel Dekker.

FSQA 431 Industrial Microbiology 3(2+1)

Objectives

1. Learn about industrially important microorganism and their growth
2. Understand bioreactor design and downstream processing

Theory

Overview of Industrial Microbiology; Introduction to industrial fermentations, Range of fermentation processes, Chronological development, Compartmental part of fermentation processes; Industrially Important Microorganisms. Criteria for Selection of Industrially Important Microorganisms, Overview of strain improvement of Industrially Important Microorganisms Preservation of industrially important microorganisms. Fermentation Media; Media selection, Medium Formulation, Medium for industrial fermentation; Microbial Growth; Typical Growth Curve, Synchronous growth, Batch Fermentations, Continuous Fermentation; Fed. Batch Fermentation. Bioreactor Design: Basic functions, Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories, Types of reactors; Problems related to scale up of Process; Upstream and Down Stream Processes: Upstream processes, Overview of Downstream Processing, Methods of cell destruction, Methods of purification of enzyme/product, Concentration and Packaging.

Practical

Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes, Production of citric acid/Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid; Standardization of physical factors for higher yields of citric acid; Isolation, identification of cultures producing bio-colours; Production, purification and estimation of beer/ ethanol; Production, purification and assay of fungal amylases/ proteases/Lipase; Production and assay of nisin from lactic acid bacteria; Single cell protein production; Starter activity of Baker's yeast Mushroom production.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Introduction to industrial fermentations-History of industrial microbiology

2 Range of fermentation processes

3 Chronological development, Compartmental part of fermentation processes

4 Criteria for Selection of Industrially Important Microorganisms

Unit II

5 Screening of microorganisms - primary screening - isolation of desired and interested microorganisms

6 Secondary screening - yield potential of microbes-qualitative and quantitative approach

7 Overview of strain improvement of Industrially Important Microorganisms

8 Preservation of industrially important microorganisms and organizations involved in microbial culture collection

Unit III

9 Fermentation media - characteristics of ideal production medium,

10 Raw materials as media, precursors and inducers, repressors, antifoams.

11 Sterilization of fermentation media

12 Medium Formulation, Medium for industrial fermentation

Unit IV

13 Typical Growth Curve, Synchronous growth

14 Batch Fermentations, Continuous Fermentation and Fed Batch Fermentation

15 Bioreactor Design: Basic functions, components of a fermentor

16 Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories

Unit V

17 Types of bioreactors/fermentors - stirred tank fermentors - packed bed fermentors - fluidized bed fermentors - bubble column fermentor - air lift fermentor –

18 Cylindrical fermentors – flocculated cell culture fermentor - multi phase bioreactors – trickling bed bioreactors - tubular fermentor

19 Mechanically agitated stirred tank reactors - deep jet fermentor - cyclone column fermentor - novel see saw bioreactor -stirred tank fermentor (CSTF)

20 Types of fermentations - solid substrate fermentation - submerged fermentation – factors affecting submerged culture

Unit VI

21 Batch fermentation and fed - batch fermentation

22 Continuous fermentation -multiple fermentations - multistage fermentations

23 Upstream processes in industrial microbiology

24 Downstream processing - steps involved in the purification of biological - Capture intermediate - polishing - cell disruption methods - chemical methods

Unit VII

25 Cell disruption methods -mechanical methods - sonication - freeze - thawing - concussion device – liquid shear - colloid mill - french press

26 Centrifugation - flocculation and coagulation - filtration - product concentration - extraction

27 Production of organic acids - citric acid, lactic acid-production - microorganisms & metabolisms - fermentation conditions - inoculums preparation - carbon and nitrogen source - trace elements - pH and temperature - aeration and agitation - yield and recovery - uses of organic acids

28 Production of antibiotics - penicillin - streptomycin - chemical nature and biosynthesis - commercial production - inoculums - media - fermentation process - temperature - aeration - pH - biomass production - recovery and purification - uses of antibiotics

Unit VIII

29 Probiotics - importance - organisms involved - beneficial effect - role in fermented dairy foods - Yoghurt - *Lactobacillus acidophilus* - *Bifidobacterium* – standard number of probiotics to be used and medicinal value - enhances digestion.

30 Biocolours - Angkak - production - using fungi – *Monascus purpureus* - history and traditional uses - morphology – fermentation conditions - pigment of *M.purpureus* - health benefits -toxicology – safe consumption

31 Production of vitamins - general aspects - nomenclature and classification - vitamin B complex - vitamin B12, Vitamin B2 - production of these vitamins -production by fermentation of Ashbya gossypii.

32 Production of SCP - single cell protein advantages - source of SCP – production of bacterial biomass - production using waste - starchy waste - from algae - nutritive value of SCP - consumption of SCP - uses of SCP

Practical

No.	Practical Outline
1	Isolation and screening of citric acid producing microorganisms
2	Isolation and screening of amylase producing microorganisms
3	Isolation and screening of protease producing microorganisms
4	Isolation and screening of antibiotic producing microbes
5	Production, purification and estimation of citric acid
6	Production, purification and estimation of lactic acid
7	Production, purification and estimation of acetic acid
8	Standardization of physical factors for higher yields of citric acid
9	Isolation, identification of cultures producing bio-colours

10 Production, purification and estimation of beer/Ethanol
11 Production, purification and assay of enzymes (fungal amylases, proteases and lipase)
12 Production and assay of nisin from lactic acid bacteria
13 Production and assay of single cell protein production (mushroom)
14 Production and assay of starter activity of baker's yeast
15 Preparation of food based fermented product
16 Practical Examination

References

1. Briggs, D.E., Boulton, C.A., Brookes, P.A. and Stevens, R. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.
2. Casida Jr., L.E. 1968. Industrial Microbiology. New Age International Publishers, New Delhi. 3. Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.
3. Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th edn. AVI Publishers, Connecticut, USA.
4. Stanbury, P.F., Whitakar, A. and Hall, S.J. 1995. Principles of Fermentation Technology, 2nd edn. Elsevier Science Ltd., Burlington, MA, USA.

FSQA 432 Introduction to Food Biotechnology 3(2+1)

Objectives

1. Understand various biotechnological terminology
2. Understand application of biotechnology in food systems

Course Outlines

Theory

Introduction, History and scope of biotechnology, Review of DNA replication, transcription, and translation. Review of DNA replication, transcription, and translation continued, Natural and artificial mechanisms of DNA transfer. Introduction to vectors, Selectable markers, Cloning vectors, Expression vectors, Shuttle vectors, Creation of recombinant DNA molecules, Creation of genomic and cDNA libraries. Library screening, Ligation, Restriction endonuclease digestion and mapping, Gel electrophoresis, Northern blotting, Southern blotting. Polymerase Chain Reaction (PCR), DNA sequencing and sequence analysis, Reverse transcriptase PCR, Real time PCR Week 8 Production of monoclonal antibodies, Immunoblotting. DNA microarrays, Protein microarrays. Introduction to bioinformatics. Applications of biotechnology: Genetically engineered foods, Bioremediation, DNA fingerprinting, Molecular diagnostics, Molecular forensics Transgenic organisms, Ethical issues in biotechnology, The future of biotechnology.

Practical

Study of auxotroph; Micro-propagation through tissue culture; Strain improvement through U.V. mutation for lactose utilization; Chemical mutagenesis using chemical mutagens (Ethidium bromide); Determination of survival curves using physical and chemical mutagens; Isolation and analysis of chromosomal/genomic DNA from *E. coli* and *Bacillus cereus*; Separation of protoplast using cellulytic enzymes; Production of biomass from fruit and vegetable waste; Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA; Pesticide degradation by *Pseudomonas.*

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Introduction of biotechnology-History in new development in the science of gene manipulation - human genome sequencing project - scope of biotechnology- potential for human therapy - regulation of transcription of particular genes - making easy to use cloning kits – recombinant DNA technology in all biological disciplines

2 Molecular genetics - cell division-chromosomes - genome - genes - chromonemata - nucleosomes - heterochromatin - organization of chromosomes - nature of gene - definitions of gene -classical - modern - gene as unit of physiological function - transmission - mutation -cistron - recon - muton - number of genes - functions of genes

3 Chemistry and biology of DNA - structural elements of nucleic acids - sugar – anionic group - nitrogenous bases - purines - pyrimidine's - nucleosides - nucleotides - phosphoric acid - ATP - GTP - CTP - UTP - TTP - functions of nucleotides - chemical energy carriers - building blocks of nucleic acids - physiological messengers - components of coenzymes - enzymes effectors- active substrates

4 Primary conformation of DNA - secondary conformation of DNA - Watson and Crick model - types of DNA- A, B, Z

Unit II

5 Tertiary conformation of DNA - higher level of chromatin structure - denaturation and renaturation - types of RNA - mRNA - rRNA- tRNA - sRNA - hnRNA- functions- scRNAs–snRNAs

6 Fundamentals of molecular biology - DNA as genetic material - Hershey and chase experiment - RNA as genetic material - viruses and bacteriophages - genetic material organization - transcription – translation

7 DNA replication - semi-conservative model -the Meselson stahl experiment

8 Requirements for DNA synthesis - substrate - primer - proteins - DNA polymerase - I, II, III - helicase - topoisomerase - primase - ligase - ssb proteins -mechanism of replication - initiation - elongation – termination

Unit III

9 Types of mutation, Physical and chemical metagens

10 DNA repair, mechanisms of repair of damaged DNA (photo reactivation, excision repair, recombination repair, SOS repair, mismatch repair)

11 Genetic recombination - conjugation - process - F plasmid - hfr factor

12 Transformation - competence - gram positive transformation - gram negative transformation

Unit IV

13 Generalized transduction- co-transduction - abortive transduction - specialized transduction

14 Micro injection - calcium chloride mediated - calcium phosphate mediated - electroporation - particle bombardment method

15 Gene manipulation tools - different enzymes used - helicases - premases - topoisomerases - RNA polymerase I, II - holoenzyme - sigma factor - DNA gyrase - DNA polymerase - I, II, III

16 Plasmids - occurrence - extra chromosomal DNA - cloning vectors - plasmids as vectors - bacteriophages - lambda phage vector - bacteriophage M13 vectors -cosmids as vectors - eukaryotes as vectors - plant viruses - pBR322 – insertion vector - replacement vector - shuttle vectors - phasmids - artificial chromosomes - bacterial artificial - yeast artificial (YAC)

Unit V

17 Recombinant DNA technology - selection of DNA - selection of suitable vehicle – cloning vector - selection of suitable enzyme - introduction of rDNA - screening of host cells - selection based on antibiotic resistance - complementation of nutritional defects - assay of biological activity - immunochemical method- colony hybridization - expression of target gene in the host cell

18 Restriction enzymes - restriction endonucleases - nomenclature of enzymes - three letter code - molecular scissors - nature of cutting ends - blunt ends - sticky ends - isoschizomers - recognition sites - star activity - neoisoschizomers - cleavage - mechanism of action - uses of restriction enzymes

19 Gene cloning- production of identical cells - isolation and purification of insert DNA - isolation of vector DNA - construction of recombined DNA - introduction of recombined DNA into host cell - identification and selection of cells containing cloned genes

20 Selection of cells containing cloned genes - selection based on antibiotic resistance - complementation of nutritional defects - assay of biological activity immuno chemical method - colony hybridization - expression of target gene in the host cell - shot gun method- DNA libraries - genomic DNA libraries - cDNA libraries - protoplast transformation

Unit VI

21 Gel electrophoresis for DNA observation

22 Northern blotting, Southern blotting techniques

23 Polymerase Chain Reaction (PCR) for DNA amplification

24 Reverse transcriptase PCR and Real time PCR

Unit VII

25 DNA sequencing and sequence analysis

26 Production of monoclonal antibodies, Immunoblotting.

27 DNA microarrays, Protein microarrays.

28 Introduction to bioinformatics

Unit VIII

29 Application of biotechnology in food - building up of high biological value protein – nucleic acid sequences as diagnostic tools - protein engineering - vitamin production - amino acid production - antibiotic production – biopolymers

30 Genetically engineered foods, Bioremediation, DNA fingerprinting

31 Molecular diagnostics, Molecular forensics Transgenic organisms

32 Ethical issues concerning GM foods and the future of biotechnology.

Practical

No.	Practical Outline
1	Study of auxotroph
2	Micro propagation through tissue culture
3	Strain improvement through U.V. mutation for lactose utilization
4	Chemical mutagenesis using chemical mutagens (*Ethidium bromide*)
5	Determination of survival curves using physical mutagens
6	Determination of survival curves using chemical mutagens
7	Isolation and analysis of chromosomal / genomic DNA from *E. coli*
8	Isolation and analysis of chromosomal / genomic DNA from *Bacillus cereus*
9	Separation of protoplasts using cellulytic enzymes
10	Production of biomass from fruit waste
11	Production of biomass from vegetable waste
12	Introduction of ELISA / southern blot / DNA finger printing
13	Introduction of Southern blot / DNA finger printing
14	Agarose gel electrophoresis of plasmid DNA
15	Pesticide degradation by *Pseudomonas spp.*
16	Practical Examination

References

1. Brandenberg, Oliver, Dhlamini, Zephaniah, Sensi, Alessandra, Ghosh, Kakoli and Sonnino, Andrea. 2011. Introduction to Molecular Biology and Genetic Engineering. FAO, Rome, Italy.
2. Paul, Meenakshi. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.
3. Primrose, S.B. and R.M. Twyman. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Victoria, Australia.
4. Renneberg, R. and Lorch, V. 2017. Biotechnology for Beginners. Academic Press
5. Singh, B.D. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.
6. Smith, J.E. 2009. Biotechnology, 5th edition, Cambridge University Press, Cambridge, UK
7. Stahl, U., Donalies, U.E.B. and Nevoigt, E. 2009. Food Biotechnology. Springer Berlin, Heidelberg.
8. Watson, James D. 2013. Molecular Biology of the Gene, 7th edn. Benjamin Cummings, San Francisco, USA.

FDBM 442 Business Management and Economics 2(2+0)

Objectives

To impart knowledge to the students on management of food industry and on the fundamentals of micro and macroeconomics.

Course Outlines

Theory

Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory. Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line, line and staff, matrix, hybrid. Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity; Markets: Types of markets and their characteristics. National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production; Law of variable proportions and law of returns to scale. Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Finance management: Definition, scope, objective; Different systems of accounting: Financial accounting, cost accounting, management accounting. Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Definitions, management principles
2	Scientific Principles
3	Administrative Principles
4	Functions of management: Planning, Organizing, Staffing, Directing, Controlling
Unit II	
5	Maslow's Hierarchy of needs theory
6	Organizational structures
7	Principles of organization
8	Types of organization: Formal and informal, line, line and staff, matrix, hybrid
Unit III	
9	Introduction to economics: Definitions
10	Nature, scope, difference between microeconomics and macroeconomics
11	Theory of demand and supply
12	Elasticity of demand
Unit IV	
13	Price and Income elasticity
14	Markets: Types of markets
15	Characteristics of markets
16	National income: GDP
Unit V	
17	National income: GNP, NNP
18	Disposable personal income, per capita income
19	Inflation
20	Theory of production
Unit VI	
21	Production function and factors of production
22	Law of variable proportions and law of returns to scale
23	Cost: Short run and long run cost, fixed cost, variable cost
24	Total cost, average cost, marginal cost and opportunity cost
Unit VII	
25	Break Even analysis
26	Finance management: Definition, scope, objective;

27 Different systems of accounting: Financial accounting - Definition, scope & objective

28 Cost accounting - Definition, scope & objective

Unit VIII

29 Management accounting - Definition, scope & objective

30 Human resource management: Definitions, objectives of manpower planning,

31 Process, sources of recruitment and process of selection;

32 Corporate social responsibility: Importance and business ethics

References

1. Dewett, K.K and Navalur, M.H. Modern Economic Theory. S. Chand and Sons, New Delhi.
2. Jain, S.P. Financial Accounting. Kalyani Publications, Ludhiana.
3. Harold, K. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
4. Prasad, L.M. 2001. Principles and Practices of Management, 9th edn. S. Chand and Sons, New Delhi.
5. Rao, P. Subba. Human Resource Management. Himalaya Publications.
6. Thomas, P.C. Managerial Economics, 9th edn. Kalyani Publishers.

FDBM 443 Statistical methods and Numerical Analysis 2(1+1)

Objectives

1. To learn different statistical tests
2. To understand design of experiments

Course Outlines

Theory

Statistical inference and testing of hypothesis - Z test, t test and F test**,** Chi-square test and its uses - testing the goodness of fit and test of independence (contingency table)**,** Correlation and regression analysis**.** Basic principles of experimental design Analysis of variance (ANOVA) – one way and two-way classification. Basic designs- Layout and analysis of completely randomized design (CRD) with equal and unequal number of observations, randomized block design (RBD), Latin square design (LSD). Response surface methodology.

Practical

Problems on Z test - One and two sample test Problems on t test - One and two sample (dependent and independent) test; Problems on F test, chi square test, correlation and regression; Fitting of simple linear regressions; Fitting of multiple regression equations;

ANOVA: One way/ two way; 22; Problems on CRD, RBD, LSD, Problems on response surface methodology.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Introduction to Statistical Inference
2	Concept of Testing of Hypothesis
Unit II	
3	Concepts of Z-Test, t test and F test
4	Chi-square test and its uses - testing the goodness of fit
Unit III	
5	Test of Independence
6	Concept of Correlation Analysis
Unit IV	
7	Concept of Regression analysis
8	Concept of Design of Experiments
Unit V	
9	Concept of Basic principles of Design of Experiments
10	Introduction of ANOVA
Unit VI	
11	Concept of ANOVA one way and two way classification data
12	Layout and analysis of CRD with equal observations
Unit VII	
13	Layout and analysis of CRD with un equal observations
14	Layout and analysis of RBD
Unit VIII	
15	Layout and analysis of LSD
16	Concept of Response Surface methodology

Practical

No.	Practical Outline
1	Problems on Z-test (One sample test)
2	Problems on Z-test (Two sample test)

3 Problems on t-test (one sample test)
4 Problems on t-test (two sample test)
5 Problems on F-test
6 Problems on Chi-square test
7 Problems on Correlation
8 Problems on fitting of Simple linear regressions
9 Problems on fitting of multiple linear regressions
10 Problems on ANOVA one way classification
11 Problems on ANOVA two way classification; 2^2
12 Problems on CRD with equal observations
13 Problems on CRD with unequal observations
14 Problems on RBD
15 Problems on LSD
16 Problems on Response Surface methodology

References

1. Grewal, G.S., 2004, Higher Engineering mathematics, Khanna Publishers, Delhi.
2. Gupta, PP. And malik, C.C. 1993, Calculus of finite differences and Numerical Analysis, Krishna Prakash Mandir, Meerut.
3. Kreyszig, E. 2006. Advanced Engineering Mathematics, 9th Edition. John Wiley and Sons, New York, USA.

FDPE 422 Instrumentation and Process Control in Food Industry 3(1+2)

Objectives

1. Learn different measurement and control parameters and instruments for their measurement
2. Understand process control in food processing

Course Outlines

Theory

Introduction, definitions, characteristics of instruments, static and dynamic characteristics, Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure. Liquid level measurement, different methods of liquid level measurement, flow measurement, differential pressure meters, variable area meters; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale,

Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples; Transmission: Pneumatic and electrical, Control elements: control actions, pneumatic and electrical control systems; Process control: Definition, simple system analysis, dynamic behavior of simple process, Laplace transform, process control hardware. Frequency response analysis, characteristics, Bode diagram and Nyquist plots and stability analysis; Controllers and indicators: Temperature control, electronic controllers, timers and indicators, discrete controllers, adaptive and intelligent controllers. Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer signal interfacing, examples in food processing; Introduction of 8051/ 8085 based system and applications in processing.

Practical

Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer; 8051 based programming examples; Programmable Logic Controllers (PLC) Hardware; PLC Ladder programming; control of Multiprocess system

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Introduction, definitions, characteristics of instruments, static and dynamic characteristics.
2	Pressure and pressure scales, Pressure elements differential pressure.
Unit II	
3	Temperature and temperature scales, thermocouples, pyrometers, resistance thermometer.
4	Liquid level measurement, flow measurement, Variable area meters.
Unit III	
5	Weight measurement: Mechanical scale, electronic tank scale, conveyor scale.
6	Measurement of Velocity and pressure using potentiometer.
Unit IV	
7	Transmission: Pneumatic and electrical, Control elements: Control actions
8	Process control: Definition, simple system analysis, dynamic behaviour of simple process.

Unit V

9 Laplace transform, process control hardware.

10 Frequency response analysis and its characteristics.

Unit VI

11 Bode diagram and Nyquist plots and stability analysis.

12 Controllers and indicators: Temperature control, electronic controllers.

Unit VII

13 Timers and indicators, discrete controllers, adaptive and intelligent controllers.

14 Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer.

Unit VIII

15 Signal interfacing, examples in food processing**.**

16 Introduction of 8051/8085 based system and applications in processing.

Practical

No.	Practical Outline
1	Study on instrumentation symbols
2	Study of process and instrumentation diagrams (P&ID)
3	Study the construction and working of Bourden pressure gauge
4	Determination of relative humidity by wet and dry bulb thermometer
5	Measurement of temperature by different thermometers.
6	Measurement of wind velocity by anemometer
7	Calibration of digital balance
8	Calibration of Rotameter
9	Measurement of velocity of fluid by using Venturi meter
10	Measurement of intensity of sun shine by sunshine recorders
11	Study of sunshine duration and graphical interpretation
12	Study of characteristics of pressure transducers
13	Calibration of pressure transducer and plotting output vs pressure
14	Real-time study of pressure transducers characteristics with PC
15	Determination of characteristics of IC temperature sensor
16	Determination of characteristics of platinum RTD
17	Study of thermistor characteristics and comparison with RTD
18	Study of thermocouple characteristics and cold-junction compensation.
19	Study of PID-based temperature control
20	Determination of linearity of LVDT
21	Determination of sensitivity of LVDT

22 Study of temperature-controlled alarm system
23 Study of water level to current conversion
24 Study of characteristics of capacitive transducer
25 Interfacing 8051 with relay and buzzer for alarm system
26 8051- based ADC and DAC interfacing for sensor data acquisition
27 Study of 8051 based programming examples
28 Study of Programmable Logic Controllers (PLC) Hardware
29 PLC ladder programming for basic logic gates (AND, OR, NOT)
30 PLC programming for timer and counter operations
31 Study of control of Multi process system
32 Practical Examination

References

1. Bela G. Liptak. 2003. Instrument Engineer's Handbook, Vol. I and II, 4th edn. CRC Press, Boca Raton, FL, USA.
2. Curtis D. Johnson. 2003. Process Control Instrumentation Technology, 7th edn. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGrawHill Co., Inc., NY, USA.
4. Murty, D.V.S. 2004. Transducers and Instrumentation. Prentice Hall of India Pvt. Ltd. New Delhi.

FSQA 433 Instrumental Techniques in Food Analysis 2(1+1)

Objectives

1. To give basic knowledge on instrumental methods of chemical analysis and train students
2. To perform practical work on real samples to get acquainted with instrumentation and equipment which is needed to assess the food quality

Course Outlines

Theory

Concepts of food analysis; Rules and regulations of food analysis Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods, Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations. Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy, atomic absorption and emission, florescence mass spectroscopy. Food compositional analysis and applications in the food industry.

Practical

Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultrafiltration, ultra-centrifugation, iso-electric focusing, chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Lecture Outlines

Theory

No.	Lecture Outline
	Unit I
1	Concepts of food analysis; Rules and regulations of food analysis. Principles and methodology involved in analysis of foods
2	Rheological analysis of foods
	Unit II
3	Textural profile analysis of foods
4	Food compositional analysis and applications in the food industry
	Unit III
5	Proximate constituents: moisture, minerals analysis
6	Proximate constituents: Total fat, crude fiber, protein,
	Unit IV
7	Adulterations in foods
8	Principles and methodology, food compositional analysis and applications in the food industry: spectroscopy, ultraviolet visible, florescence infrared spectroscopy
	Unit V
9	Principles and methodology, food compositional analysis and applications in the food industry: atomic absorption and emission, mass spectroscopy
10	Principles and methodology, food compositional analysis and applications in the food industry: Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ionexchange, size-exclusion method).
	Unit VI
11	Principles and methodology, food compositional analysis and applications in the food industry: gas-liquid, high performance liquid chromatography; Ion chromatography and others.

12 Separation techniques: Dialysis, Sedimentation, Ultrafiltration and Ultracentrifugation techniques: Dialysis, sedimentation, ultra-filtration

Unit VII

13 Separation techniques: electrophoresis, iso-electric focusing.

14 Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors

Unit VIII

15 Rapid microbiological methods: Overview, Conductance/impedance for microbial assay

16 Chemosensors, biosensors, immunosensors

Practical

No.	Practical Outline
1	Sampling Procedures
2	Quality evaluation of raw materials: Fruits products; Quality evaluation of raw materials: vegetables products
3	Quality evaluation of raw materials: cereals products and dairy products
4	Quality evaluation of food products for color and taste of marketed products (sweet)
5	Quality evaluation of food products for color and taste of marketed products (carbonated drinks
6	Quality evaluation of food products for color and taste of marketed products (Processed food)
7	Quality evaluation of food products for color and taste of marketed products (Chili powder)
8	Gel-electrophoresis for analytic techniques: Quantitative determination of sugars and fatty acid profile by GLE; Fatty acid profiling using gas chromatograph
9	Separation of amino acids by two-dimensional paper chromatography
10	Identification of organic acids by paper electrophoresis
11	Spectrophotometric method of total chlorophyll (A and B)
12	Analysis of foods for drug residues in milk/milk products; Analysis of foods for pesticide residues in fruit pesticide residues in vegetable; spices
13	Estimation of vitamin A, thiamine, riboflavin, nicotinamide, Lycopene, beta carotein using HPLC
14	Analysis of heavy metals using atomic absorption spectrophotometer (mercury/ lead/ arsenic/tin)
15	Fatty acid profiling using gas chromatograph.
16	Practical Examination

References

1. Nieisen, S.S. 2010. Food Analysis Laboratory Manual, 2nd edn. Springer, NY, USA.
2. Nieisen, S.S. 2003. Food Analysis, 3rd edn. Kluwer Academic, New York, USA.
3. Ötles, S. 2009. Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
4. Sun, D.W. 2008. Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.

FDPT 413 Traditional Indian Dairy Products 2(1+1)

Objectives

1. Understand the processes involved in the manufacture of heat desiccated and acid coagulated dairy products and a wide variety of traditional Indian sweets
2. Learn about the chemical composition and legal standards for traditional Indian sweets
3. Acquire knowledge about packaging options available for traditional dairy products and methods for their shelf life
4. Learn about mechanization of certain processes involved in the large-scale manufacture of traditional Indian dairy products

Course Outlines

Theory

Status and significance of traditional Indian milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. Khoa based sweets: Burfi, Peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture. Channa: Product description, standards method of manufacture, packaging and preservation. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. Paneer:

Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process. Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. MistiDahi: Product description method of manufacture and packaging process. Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk; Preparation of Burfi, Peda, Kalakhand, Milkcake and Gulabjamun; Preparation of Paneer from cow, buffalo and mixed milk; Preparation of Chhana from cow and buffalo milk and mixed milk; Preparation of Sandesh and Rasogolla; Preparation of kheer; Preparation of Rabri, MistiDahi, Chhana and Shrikhand; Visit to industry.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Status and significance of traditional Indian milk products in India
2	Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa.
Unit II	
3	Mechanization in manufacture of khoa and their compositional profile and manufacture practices.
4	Mechanization in manufacture of Khoa based sweets: Burfi and Peda, and their compositional profile and manufacture practices.
Unit III	
5	Mechanization in manufacture of Gulabjamun and their compositional profile and manufacture practices
6	Mechanization in manufacture of Gulabjamun and their compositional profile and manufacture practices
Unit IV	
7	Rabri and Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.
8	Channa: Product description, standards method of manufacture, packaging and preservation.
Unit V	
9	Chhana-based sweets: Rasogolla Mechanization of manufacturing process, advances in preservation and packaging
10	Chhana-based sweets Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging
Unit VI	
11	Paneer: Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process

12 Chakka/Maska: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects

Unit VII

13 Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects

14 MistiDahi: Product description method of manufacture and packaging process

Unit VIII

15 Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes

16 Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

No.	Practical Outline
1	Preparation of Khoa from cowmilk
2	Preparation of Khoa from buffalo and concentrated milk
3	Preparation of Burfi and Peda
4	Preparation of Kalakhand
5	Preparation of Milk cake
6	Preparation of Gulabjamun
7	Preparation of Paneer from cow milk
8	Preparation of Paneer from buffalo and mixed milk
9	Preparation of Chhana from cow, buffalo milk and mixed milk
10	Preparation of Chhana from buffalo milk and mixed milk
11	Preparation of Sandesh and Rasogolla
12	Preparation of kheer
13	Preparation of Rabri
14	Preparation of MistiDahi
15	Preparation of Chhana and Shrikhand
16	Visit to industry

References

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. (2002). Technology of Indian Milk Products. A Dairy India Publ., Delhi, India
2. Agarwala, S.P. (2006). Equipment for paneer making, Lecture compendium on developments in traditional dairy products. Short course organized by CAS from Dec. 10-30, 2006: pp-132-137.

3. Dharam Pal and NarenderRaju, P. (Eds). (2006). Developments in Traditional Dairy Products, Lecture Compendium of the 21st Short Course, CAS in Dairy Technology, NDRI, Karnal.
4. Pal, D. (1997). Technology of the manufacture of rabri and basundi. In Advances in Traditional Dairy Products. Short course, CAS in Dairy Technology, NDRl Deemed University, Karnal.

FDPT 414 Ice-cream and Frozen Desserts 3(2+1)

Objectives

1. To understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
2. To learn about design and working of Ice cream freezers including cleaning and sanitization
3. To acquire knowledge about the physico-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
4. To learn about the defects that appear in ice cream, causative factors and measures to control them

Course Outlines

Theory

History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts. Stabilizers and emulsifiers their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant. Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention. Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes; Manufacture of plain and fruit flavoured ice-cream; Manufacture of chocolate, fruit and nut ice cream; Preparation of sherbets/ices; Preparation of soft served and filled ice-cream; Manufacture of kulfi. Study of continuous and batch type freezers; Manufacture of ice-cream by continuous process; Determination of overrun in ice cream; Visit to an Ice Cream Plant.

Lecture Outlines

Theory

No.	Lecture Outline
	Unit I
1	History, Development and status of ice cream industry
2	Origin and Progress in development of icecream and frozen desserts industry.
3	Status of ice cream industry in India and abroad
4	Definition, classification and composition of Ice cream and other frozen desserts- Nutritional value
	Unit II
5	Ice-cream-Definition- Classification -I of ice cream- Plain, Fruit and Nut, Chocolate, Ice lollies, Candies, Kulfi & Malai-ka-baraf
6	Classification-II-Sherbets and Ices, Mousse, Gelato, Bisque, Custards, Cassetta, Variegated ice cream, Novelties etc.
7	Composition of ice cream (low-fat, good average, premium) and frozen desserts (Sherbets, Ices, Soft serve).
8	FSSAI and other legal standards of Ice-cream and frozen dessert
	Unit III
9	Ingredients in Ice cream and frozen desserts
10	Dairy ingredients in ice cream
11	Non-dairy ingredients in ice cream
12	Stabilizers and Emulsifiers – classification, types, properties and role in quality of ice cream
	Unit IV
13	Stabilizers and Emulsifiers - selection, mechanism of action, influence on mix and ice cream, proprietary stabilizer blends.
14	Technological aspects of ice cream manufacture
15	Preparation of ice cream mix - standardization, blending, homogenization
16	Preparation of ice cream mix - pasteurization, cooling, ageing and flavour addition.
	Unit V
17	Freezing of ice cream mix and control of overrun
18	Thermodynamics of freezing and refrigeration load - Typical freezing curve
19	Calculating freezing point of ice cream mix.
20	Calculating refrigeration load. Refrigeration control and related instrumentation.
	Unit VI
21	Types of ice cream freezers – Batch, Continuous, Soft-serve freezers, homemade freezers-specification-cleaning-sanitization

22 Personnel, equipment and plant hygiene, Cleaning and sanitization of ice cream freezers and related equipment.

23 Physico-chemical properties of ice cream mixes and ice cream

24 Physico-chemical properties of ice cream

Unit VII

25 Effect of processing on physico-chemical properties.

26 Control of whipping ability of mixes.

27 Packaging, hardening, storage and shipping of ice cream

28 Hardening of ice cream – hardening methods, Storage and Shipment of ice cream

Unit VIII

29 Sensory attributes and method of Sensory Evaluation of Ice Cream and frozen desserts

30 Defects in ice cream-– Appearance, Flavour, Body, Texture and package and melting quality - Causes and Prevention

31 Recent advances in ice cream industry-Low-calorie, reduced fat, diabetic and dietetic ice cream and frozen desserts**.**

32 Developments in ice cream Industry (flavourings, colourings, fat replacers, bulking agents

Practical

No.	Practical Outline
1	Study of continuous and batch type freezers
2	Calculation of standardization of ice-cream mixes
3	Preparation of plain ice-cream
4	Preparation of butterscotch ice cream
5	Preparation of fruit flavoured ice-cream
6	Preparation of fruit and nut ice cream
7	Preparation of sherbets/ices
8	Preparation of soft served and filled ice-cream
9	Preparation of kulfi
10	Preparation of ice-cream by continuous process
11	Preparation of Frozen Dessert-Ice pops
12	Preparation of Choco bar
13	Quality evaluation of different ice creams in market
14	Determination of overrun in ice cream
15	Visit to an Ice Cream Plant
16	Practical examination

References

1. Arbuckle, W.S. 1991. Ice Cream. AVI Publ., Co. Inc., West Port, Connecticut.
2. Hall, C.W and Hedric, T.T. 1975. Drying of Milk and Milk Products. AVI Publ. Co. Inc., West Port, Connecticut. p-338.
3. Hui, Y.H. 1993. Dairy Science and Technology Handbook 2- Product Manufacturing. Wiley – VCH Inc., USA.
4. Ice Cream Alliance and Ice Cream Federation. 1992. Code of Practice for the Hygienic manufacture of Ice Cream.
5. NDRI. 1998. Advances in Ice Cream and Frozen Desserts. Lecture compendium, Sixth short course, Dec 15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson, R.K. 1986. Modern Dairy Technology. Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.
7. Robinson, R.K. 2002. Dairy Microbiology Handbook. 3rd edn. John Willey and sons, New York, USA.
8. Sommer, H. H. 1951. The Theory and Practice of Ice Cream Making. 6th edn. Madison, Wisconsin, p 5-10

FDPE 423 Energy Conservation and Management 2(1+1)

Objectives

1. To equip students with the knowledge and skills required to effectively manage and conserve energy resources within the context of dairy and food processing industries
2. Impart knowledge on green technologies

Lecture Outlines

Theory

Introduction: Potential and importance of industrial energy conservation in dairy and food processing; Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE); Electricity Act (2003), Integrated energy policy; Energy management and audit: Definition, energy audit, need, types of energy audit; Energy audit approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Energy balances and computation of efficiencies of equipment; Role of energy inspectors and auditors in energy management; Electrical load management: Demand management, energy management information systems, energy saving controllers and cost saving techniques; Quality of power, power factor and its improvement; Transformers, losses in transformers; Energy savings in transformers; Electric motorselection and application, energy efficient motors; Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy; Bureau of Energy Efficiency (BEE): Power saving guide with star ratings of electrical appliances: Induction motors, air conditioners, refrigerators

and water heaters; Industrial Lighting: Quality of light, types of light sources, energy efficiency, light controls. Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, fluidized bed combustion and multi - fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; steam conservation opportunities; upkeep and maintenance of steam auxiliaries and fittings. Energy conservation in refrigeration and AC systems (HVAC), cooling towers, pumps and pumping systems, fans, blowers, air compressors; Maintenance and up keep of Vacuum lines and compressed air pipe lines; Conservation and reuse of water, water auditing; Energy conservation opportunities in wastewater treatment. Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like thermal processes, evaporation, drying and freezing; Role of steam traps in energy saving; Energy savings methods in hot air generator, thermic fluid heater, steam radiator. Energy conservation in buildings: Concepts of green buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc; Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, fuel and oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits. Cleaner energy sources: Introduction to solar, and biomass energy; Solar thermal and photo-voltaic energy options for food processing industries; Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practical

Study of Energy Conservation Act 2001; Study of schemes of BEE; Study of concepts of energy balance in unit operations and system boundaries; Solving examples on energy balances; Solving problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve; Determination of Load factor of an installation; Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter, Ammeter and Volt meter; Study of performances of a general type of induction motor and an energy efficient induction motor; Study of use of VSD; Study of various types of electrical appliances classified under different BEE Star ratings; Drawing energy balance on a boiler: Collection of data, Analysis of results and determination of efficiency; Exercise on energy audit of a Dairy plant.

Lecture Outlines

Theory

No. Lecture Outline

Unit I

1 Introduction to Energy Conservation: Potential and importance in dairy and food processing; Overview of Energy Conservation Act (2001), Electricity Act (2003), and Bureau of Energy Efficiency (BEE) schemes; Integrated energy policy.

2 Energy Management and Audit: Definition, energy audit need and types of energy audits; Approaches: energy costs, benchmarking, and energy performance; matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution

Unit II

3 Energy Balances and Equipment Efficiency: Computation of efficiencies of equipment; Role of energy inspectors and auditors in energy management

4 Electrical Load Management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques

Unit III

5 Quality of power and Transformers: Power factor and its improvement; losses in transformers; Energy savings in transformers; Electric motor-selection and application

6 Electric Motors and Drives: selection, application and energy-efficient motors; role of Variable Speed Drives (VSD) and Variable Frequency Drives (VFD) in saving electric energy

Unit IV

7 Energy Efficiency of Appliances: Bureau of Energy Efficiency (BEE), Power saving guide with star ratings of electrical appliances: Induction motors, air conditioners, refrigerators and water heaters;

8 Energy Efficiency of Appliances: Industrial lighting- quality of light, types of light sources, energy efficiency, light controls

Unit V

9 Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, fluidized bed combustion and multi - fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; Steam conservation opportunities; Upkeep and maintenance of steam auxiliaries and fittings

10 Energy conservation in refrigeration and AC systems (HVAC), cooling towers, pumps and pumping systems, fans, blowers, air compressors; Maintenance and up keep of vacuum lines and compressed air pipe lines

Unit VI

11 Water and wastewater management: Conservation and reuse of water, water auditing; energy conservation opportunities in wastewater treatment.

12 Energy Conservation in Processing Equipment: Improving efficiency and energy conservation in food processing operations like Thermal processes, Evaporation, Drying and Freezing; Role of steam traps in energy saving; Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator. Energy conservation in building

Unit VII

13 Concepts of Green Buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases of boiler, DG exhaust, hot air from spray dryer and FBD

14 Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, fuel and oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits

Unit VIII

15 Cleaner energy sources: Introduction to Solar and Biomass Energy; Solar thermal and photo-voltaic energy options for food processing industries

16 Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA

Practical

No.	Practical Outline
1	Study of Energy Conservation Act (2001) and BEE schemes
2	Study of concepts of energy balance in Unit Operations and System boundaries
3	Tutorial on energy balance
4	Solving problems on electrical energy use and management
5	Exercises on connected load, maximum demand, demand factor and load curve
6	Determination of Load factor of an installation
7	Study on use of power factor meter and determination of true power and wattles power by using PF meters
8	Study on use of Watt meter, Ammeter and Volt meter
9	Study on performances of general type of induction motor and an energy efficient induction motor
10	Study of use of Variable Speed Drive(VSD)
11	Study of various types of electrical appliances classified under different BEE Star Ratings
12	Drawing Energy Balance on a boiler
13	Collection of data on boiler energy balance, analysis of results and determination of efficiency
14	Exercise on energy audit of a dairy plant.
15	Demonstration of PLC and SCADA for energy monitoring and control devices
16	Practical Examination

References

1. Tufail Ahmad 2012 Dairy Plant Engineering and Management, Kitab Mahal Publisher.
2. JiøiKlemeš, Robin Smith and Jin-Kuk Kim 2008 Handbook of Water and Energy Management in Food Processing, A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition.
3. Lijun Wang 2008 Energy Efficiency and Management in Food Processing Facilities, CRC Press Inc; 1st edition (4 December 2008); Taylor and Francis.
4. Paul O'Callaghan 1993 Energy Management, McGraw- Hill Book Company Europe, Shppenhangers Road, England.

FDPE 424 Applications of Renewable Energy in Food Processing 2(1+1)

Objectives

1. To impart knowledge about the alternative and renewable sources of energy
2. Understanding biogas production and mechanism of biogas plants
3. To understand concept of wind and hydroelectric energy

Course Outlines

Theory

Introduction to energy sources; classification of renewable energy sources, utilization of these sources in food processing sector; Solar radiation, measurement of solar radiation, types of solar collectors and their uses; familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator; utilization of solar thermal energy in food processing; Solar photovoltaic cells, modules, arrays, conversion process of solar energy into electricity, applications in food industry; Biomass and its characterization; briquetting of biomass. Biomass combustion, pyrolysis, gasification and uses of gasifiers in food industry and biodiesel preparation; Importance of biogas technology, production mechanism, types of biogas plants, uses of biogas, handling and utilization of digested slurry. Use of food waste for biogas generation and its applications; Brief introduction to wind energy, hydroelectric energy, ocean energy.

Practical

Study of solar radiation measuring instruments; Study of solar cooker; Study of solar water heater; Study of solar dryer; Study of solar PV system; Estimation of calorific value of biomass; Estimation of moisture content of biomass; Estimation of ash content of biomass; Estimation of fixed carbon and volatile matter of biomass; Study of briquetting machine; Demonstration of up draft gasifier; Demonstration of down draft gasifier; Demonstration of working of a fixed dome type biogas plants; Demonstration of working of a floating drum

type biogas plants; Demonstration of biodiesel preparation; Demonstration of wind measuring instruments.

Lecture Outlines

Theory

No.	Lecture Outline
	Unit I
1	Introduction to energy sources - conventional energy sources and renewable energy sources; classification of renewable energy sources, advantages and disadvantages
2	Utilization of renewable energy sources in food processing sector
	Unit II
3	Solar radiation- beam and diffuse solar radiation, measurement of solar radiation
4	Types of solar collectors- Solar flat plate and focusing type solar collectors and solar air heater and their uses
	Unit III
5	Familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator
6	Utilization of solar thermal energy in food processing- Solar photovoltaic cells, modules, arrays, conversion process of solar energy into electricity, applications in food industry
	Unit IV
7	Biomass and its importance and characterization; briquetting of biomass advantages of briquetting of biomass
8	Processes of briquetting of biomass- types of briquetting machines
	Unit V
9	Biomass combustion -parameters affecting combustion, principles of combustion, pyrolysis, gasification
10	Uses of gasifiers in food industry- fixed bed, down draft, cross draft, fluidized bed gasifiers
	Unit VI
11	Biodiesel preparation- principle, transesterification process, process for production of biodiesel from Jatropha seeds
12	Biogas – importance and principles of biogas production, production mechanism, types of biogas plants- KVIC, Janata type and Deenabandu biogas plants, uses of biogas, Handling and utilization of digested slurry
	Unit VII
13	Use of food waste for biogas generation and its applications

14 Brief introduction to wind energy- nature of the wind- horizontal and vertical axis wind mills, hydroelectric energy, ocean energy

Unit VIII

15 Brief introduction hydroelectric energy- nature of small hydro development, classification, components of a hydroelectric scheme, turbines

16 Brief introduction of Ocean energy – Ocean Thermal Energy Conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, closed OTEC system, hybrid cycle

Practical

No.	Practical Outline
1	Study of solar radiation measuring instruments
2	Study of solar cooker
3	Study of solar water heater
4	Study of solar dryer
5	Study of solar PV system
6	Estimation of calorific value of biomass
7	Estimation of moisture content and ash content of biomass
8	Estimation of fixed carbon and volatile matter of biomass
9	Study of briquetting machine
10	Study of up draft gasifier
11	Study of down draft gasifier
12	Study of working of a fixed dome type biogas plant
13	Study of working of a floating drum type biogas plant
14	Study of biodiesel preparation;
15	Study of wind measuring instruments.
16	Practical Examination

References

1. Khandelwal, K.C. and S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
2. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
3. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non-Conventional Energy Sources, Himanshu Publications.
5. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.
6. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.

FDPE 425 Food Plant Design and layout 3(2+1)

Objectives

1. Understand key principles of food plant design and layout
2. Learn about industry-specific regulations safety standards, critical thinking and problem-solving skills in food industries
3. To study on CIP, energy audit, water conversation aspects adopted in food industries.

Course Outlines

Theory

Overall design of food processing plant; Plant location, levels of plant location, factors affecting plant location, Problems and general design considerations (technical, economic, legal, safety and hygiene); Preparation of a plant layout: Plant layout problem, importance, objectives, classical types of layouts; Evaluation of plant layout; Advantages of good layout; Organizing for plant layout, data forms; Development and presentation of layout: Development of the pilot layout, constructing the detailed layout - Functional design: Setting of different sections in a plant, layout installations; Quantitative analysis of plant layout: subjective, quantitative, semi-quantitative techniques, equal weights method and weight-cumrating methods; Composite measure methods and location, Break-even-analysis. Engineering economy; methods of economic evaluation of engineering alternatives undiscounted cash flow methods, payback period method discounted cash flow method, net present value, equivalent annual rate of return methods, cost-benefit analysis and social costs. Linear programming; salient features – formulation of linear programming model, advantages and limitations Network analysis, PERT and CPM, inventory management, layout of effluent treatment plant; Common problems in plant layout and process scheduling; Equipment selection and capacity determination, arrangement of process and service equipment; Practical layouts; Common materials of construction of food plant, buildings; Maintenance of food plant buildings, illumination and ventilation, cleaning and sanitization, painting and colour coding, fly and insect control; Feasibility study: Steps involved in feasibility study, collection of information, information flow diagrams, preparation of feasibility report; Plant size: Economic plant size, factors affecting the plant size (technical and economical), raw material availability, market demand, competition in the market, return on investment, etc.; Process design: 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 including their design and computer aided development of flow charts; Selection of equipment: Considerations involved in equipment selection, economic analysis of equipment alternatives using optimization techniques and cash flows, economic decision on spare equipment; Equipment symbols,

flow sheet symbols, electric symbols, graphic symbols for piping systems, standards Plant surroundings: Requirements of the steam, refrigeration, water, electricity, waste disposal, lighting, ventilation, drainage, CIP system, dust removal, fire protection, etc.; Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring; Workers safety and health aspects: Falling hazards and safeguards, electric hazards, heat exposure, dust protection, noise control, protection against chemicals, fire safety, fumes, moist conditions, personnel hygiene, sanitary requirements and standards; Insect, rodent and bird control; Building and building materials: Requirements in respect of building type, wall, ceiling and floor construction, building height and building materials; Utilities and services Introduction: Classification of various utilities and services in food industry; Water supply system: Operational aspects of pumps, piping system for fresh water, chilled water, fittings and control; water requirement for cleaning and processing, water quality, water purification and softening; water use in food processing: Different types of water requirements in food processing plants, types of water use, waste water sources, water wastage minimization, water loadings per unit mass of raw material; Water conservation: Water and waste water management, economic use of water, water filtration and recirculation; Steam uses in food industry: Temperature, pressure and quantity of steam required in various food processing operations; Steam generation system: Components of a boiler system, fuels used in boilers, energy analysis for a steam generation system, heat loss from boiler system, boiler design consideration; Energy conservation technologies for steam generation system, energy saving through optimal design and operation of boiler, energy recovery from flue gas, energy recovery from blow down water, maintenance of boiler; Steam distribution system: Components of steam distribution, heat loss and energy efficiency of a steam distribution system; Energy conservation technologies for steam distribution system: Steam trap maintenance, condensate recovery, repairing of steam leaks, insulation improvements; economical analysis of energy: Efficiency improvement, cogeneration; electric energy uses in food industry

Practical

Preparation of project report. Preparation of feasibility report; Layout of food storage wares and go-downs; Layout and design of cold storage; Layout of pre-processing house; Layout of milk and milk product plants; Low shelf-life product plant; Bakery and related product plant; Fruits processing plants; Vegetable processing plants; Layout of multi- product and composite food plants; Evaluation of given layout; Study of waste disposal and management process in the food processing plants. Study of different types piping layout, fittings, control, process of regular check-ups and maintenance. Study of different types steam distribution systems, maintenance and safety measures. Study on tools and software for food plant design (AutoCAD, SketchUp) to create layouts. Study on regulatory requirements and compliance of key regulations (GMP, HACCP, FDA standards). Visit to food industry to study the plant layout

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Overall design of food processing plant; Plant location, levels of plant location factors affecting plant location
2	Preparation of a plant layout: Plant layout problem, importance, objectives, classical types of layouts
3	Evaluation of plant layout: Advantages of good layout; Organizing for plant layout, Data forms
4	Development and presentation of layout: Development of the pilot layout, constructing the detailed layout
Unit II	
5	Functional design: Setting of different sections in a plant and layout installations
6	Quantitative analysis for plant layout: Subjective, quantitative, semi- quantitative techniques, equal weights method and weight-cum-rating methods, Composite measure methods and location Break-even-analysis
7	Engineering economy; Methods of economic evaluation of engineering alternatives undiscounted cash flow methods, payback period method, discounted cash flow method net present value, equivalent annual rate of return methods, cost-benefit analysis and social costs
8	Linear programming; Salient features formulation of linear programming model, advantages and limitations, Network analysis, PERT and CPM, inventory management
Unit III	
9	Layout of effluent treatment plant: Common problems in plant layout and process scheduling
10	Equipment selection and capacity determination, arrangement of process and service equipment
11	Practical layouts, Common materials of construction of food plant and building
12	Maintenance of food plant buildings, illumination and ventilation, cleaning and sanitization, painting and colour coding, fly and insect control
Unit IV	
13	Feasibility study: Steps involved in feasibility study, collection of the information, information flow diagrams, preparation of feasibility report
14	Plant size: Economic plant size, factors affecting the plant size (technical and economical), raw material availability, market demand, competition in the market, return on investment
15	Process design: Product specifications, least cost mix of raw materials, process design, process selection considering technical, economic and social aspects

16 Process planning and scheduling, flow sheeting, flow diagrams and process flow charts including their design, computer aided development of flow charts

Unit V

17 Selection of equipment: Considerations involved in equipment selection, economic analysis of equipment alternatives using optimization techniques and cash flows, economic decision on spare equipment

18 Equipment symbols, flow sheet symbols, electric symbols, graphic symbols for piping systems and standards

19 Plant surroundings: Requirements of the steam, refrigeration, water, electricity, waste disposal, lighting, ventilation, drainage, CIP system, dust removal, fire protection

20 Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring

Unit VI

21 Worker's safety and personnel hygiene, and health aspects: Falling hazards and safeguards, electric hazards, heat exposure

22 Controls: dust protection, noise control, protection against chemicals, fire safety, fumes, moist conditions, sanitary requirements and standards; Insect, rodent and bird control

23 Building and building materials: Requirements in respect of building type, wall, ceiling and floor construction, building height and building materials

24 Utilities and services Introduction; classification of various utilities and services in food industry

Unit VII

25 Water supply system: Operational aspects of pumps, piping system for fresh water, chilled water, fittings and control; water requirement for cleaning and processing, water quality, water purification and softening

26 Water use in food processing: Different types of water requirements in food processing plants, types of water use

27 Waste water sources, water wastage minimization, water loadings per unit mass of raw material; Water conservation: Water and waste water management, economic use of water, water filtration and recirculation

28 Steam uses in food industry: Temperature, pressure and quantity of steam required in various food processing operations

Unit VIII

29 Steam generation system: Components of a boiler system, fuels used in boilers, energy analysis for a steam generation system, heat loss from boiler system, boiler design consideration

30 Energy conservation technologies for steam generation system, energy saving through optimal design and operation of boiler, energy recovery from flue gas, energy recovery from blow down water, maintenance of boiler

31 Steam trap maintenance, condensate recovery, repairing of steam leaks, insulation improvements; Economical analysis of energy efficiency improvement and cogeneration

32 Electric energy uses in food industry

Practical

No.	Practical Outline
1	Preparation of project report
2	Preparation of feasibility report
3	Layout of food storage wares and go-downs
4	Layout and design of cold storage
5	Layout of milk and milk product plants
6	Layout of Fruits and Vegetables processing plants
7	Layout of Bakery and related product plant
8	Layout of multi-product and composite food plants
9	Evaluation of given layout
10	Study of waste disposal and management process in the food processing plants
11	Study of different types of piping layout, fittings, control, process of regular check-ups and maintenance
12	Study of different types steam distribution systems, maintenance and safety measures
13	Study on tools and software for food plant design (AutoCAD, SketchUp) to create layouts
14	Study on regulatory requirements and compliance of key regulations (GMP, HACCP, FDA standards)
15	Visit to food industry for Study of Plant Layout
16	Practical Examination

References

1. Tufail Ahmad. 2003. Dairy Plant Engineering and Management. KitabMahal, Allahabad.
2. Max S. Peters and Klas D. Timmerhaus.1991. Plant Design and Economics for Chemical Engineers, 4th. Ed. McGraw-Hill, Inc., New York.
3. Ed Bausbacher and Roger Hunt. 1993. Process Plant Layout and Piping Design. P.T.R. Prentice-Hall, Inc., New Jersey.
4. Willia D. Baasel.1989. Preliminary Chemical Engineering Plant Design, 2nd Ed.. Elsevier, New York
5. Energy Efficiency and Management in Food Processing Facilities by Lijun Wang. Published by CRC Press, 2008
6. “Practical Design, Construction, and Operation of Food Facilities” - This book by J. Peter Clark

FDPT 415 Waste and By-Products Utilization 3(2+1)

Objectives

1. To understand the nature of agricultural wastes and their impact on the environment.
2. To know physical, chemical and biological basis of agricultural waste treatment.
3. To analyze and design systems for the collection, handling, treatment and utilization of wastes.
4. To understand the waste treatment processes.

Course Outlines

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from food industry, rice mill,sugarcane industry, oil mill etc. Concept, scope and maintenance of waste management and effluent treatment; Waste parameters 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 by-products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; biofuels and ethanol, packaging material through recycling. Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting. Pre-treatment of waste: sedimentation, coagulation, flocculation and flotation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal. Assessment, treatment and disposal of solid waste; Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water. Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash. Study about briquetting of agricultural residues. Estimation of excess air for better combustion of briquettes. Study of extraction of oil from rice bran. Study on bioconversion of agricultural wastes. Recovery of germ and germ oil from by-products of cereals. Visit to various industries using waste and food by-products.

Lecture Outlines

Theory

No.	Lecture Outline
Unit I	
1	Types and formation of by-products and waste
2	Magnitude of waste generation in different food processing industries
3	Uses of different agricultural by-products from food industry, rice mill, dhal mill and sugarcane industry
4	Uses of different agricultural by-products from food industry, dairy plants, oil mills, Fruits and vegetable processing plants etc.
Unit II	
5	Concept, scope and maintenance of Waste management
6	Concept, scope and maintenance of Effluent Treatment Plant
7	Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD)
8	Waste parameters and their importance in waste management- fat, oil and grease content, metal content
Unit III	
9	Forms of phosphorous and sulphur in waste waters
10	Microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues
11	Waste utilization in various industries, furnaces run on agricultural wastes and by products
12	Waste utilization in various industries, boilers run on agricultural wastes and by-products
Unit IV	
13	Briquetting of biomass as fuel: different types of briquetting machines
14	Production of charcoal briquette
15	Generation of electricity using surplus biomass
16	Producer gas generation and utilization
Unit V	
17	Biofuels and ethanol: types of biofuel
18	Packaging material through recycling
19	Waste treatment and disposal: Design and construction of family size biogas plants
20	Operation and management of institutional community and family size biogas plants
Unit VI	
21	Design and construction of vermi-composting unit

22 Operation and management of vermi-composting unit

23 Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation

24 Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches

Unit VII

25 Secondary treatments: biological and chemical oxygen demand for different food plant waste- activated sludge process

26 Secondary treatments: rotating biological contractors, lagoons

27 Tertiary treatments: Advanced waste water treatment process- sand, coal

28 Tertiary treatments: Activated carbon filters

Unit VIII

29 Tertiary treatments: Phosphorous, Sulphur, nitrogen and heavy metals removal

30 Effluent Treatment Plants

31 Assessment, treatment and disposal of solid waste

32 Environmental performance of food industry to comply with ISO-14001 standards

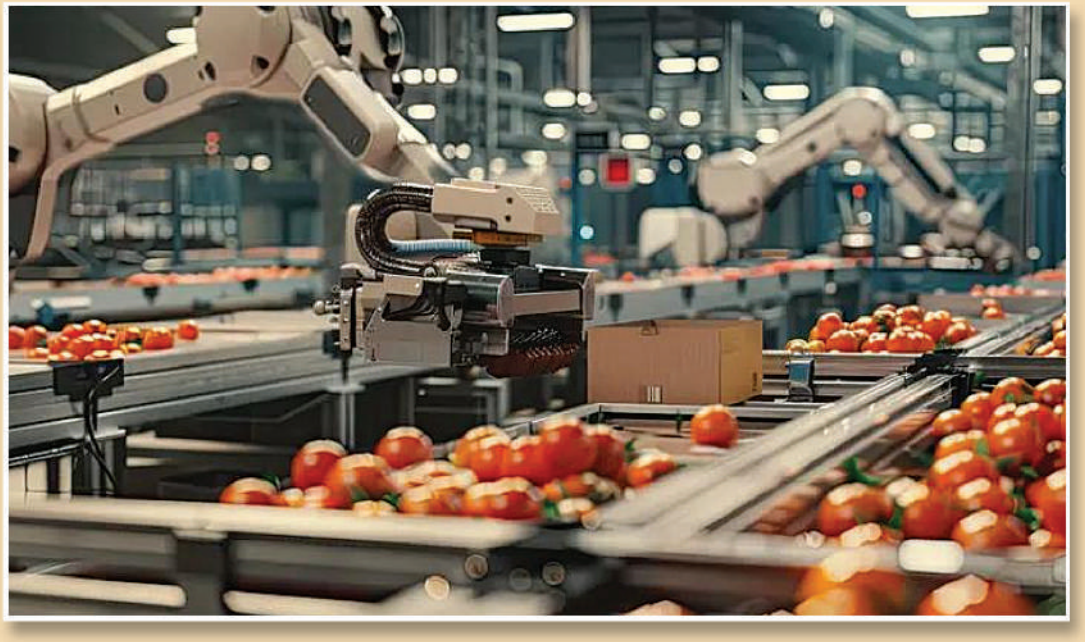
Practical

No.	Practical outline
1	Determination of temperature and pH of waste water
2	Determination of turbidity of waste water
3	Determination of solids content of waste water
4	Determination of BOD of waste water
5	Determination of COD of waste water
6	Determination of ash content of agricultural wastes
7	Determination of un-burnt carbon in ash
8	Study about briquetting of agricultural residues
9	Estimation of excess air for better combustion of briquettes
10	Extraction of oil from rice bran
11	Study on bioconversion of agricultural wastes
12	Recovery of germ from by-products of cereals
13	Recovery of germ oil from by-products of cereals
14	Visit to effluent treatment plant
15	Visit to waste recycling plant
16	Practical Examination

References

1. Bhatia S C. 2001. *Environmental Pollution and Control in Chemical Process Industries*. Khanna Publishers, New Delhi.
2. Garg S K. 1998. *Environmental Engineering* (Vol. II) – *Sewage Disposal and Air Pollution Engineering*. Khanna Publishers, New Delhi
3. Joshi V K and Sharma S K. 2011. *Food Processing Waste Management: Treatment and Utilization Technology*. New India Publishing Agency.
4. Markel I A. 1981. *Managing Livestock Waste.* AVI Publishing Co.
5. Pantastico E C B. 1975. *Post-harvest Physiology, Handling and Utilization of Tropical and Sub-Tropical Fruits and Vegetables.* AVI Pub. Co.
6. Prashar A and Bansal P. 2008. *Industrial Safety and Environment*. S.K. Kataria and Sons, New Delhi.
7. Shewfelt R L and Prussi S E. 1992. *Post-Harvest Handling - A Systems approach*. Academic Press Inc.
8. USDA 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.
9. Weichmann J. 1987. *Post-Harvest Physiology of Vegetables*. Marcel and Dekker Verlag.
10. Vasso O and Winfried R (Eds). 2007. *Utilization of By-products and Treatment of Waste in the Food Industry*. Springer Science and Business Media, LLC 233 New York.

Continuous industrial fryer



Robotic sorter for tomatoes

Dr. N.T.R. College of Food Science and Technology, Bapatla

College of Food Science and Technology, Pulivendula

Contact

Dean of Agricultural Engineering and Technology

Acharya N. G. Ranga Agricultural University

Lam, Guntur - 522 034

Email ID : deanaet@angrau.ac.in; Website: www.angrau.ac.in