



# **RAJALAKSHMI ENGINEERING COLLEGE**

An AUTONOMOUS Institution  
Affiliated to ANNA UNIVERSITY, Chennai



## **CHOICE BASED CREDIT SYSTEM**

## **CURRICULUM AND SYLLABUS**

**(2018 -2022 Batch)**

## **B.TECH. FOOD TECHNOLOGY REGULATION – 2017**

**CHOICE BASED CREDIT SYSTEM**

**CURRICULUM AND SYLLABUS**

**B.TECH. FOOD TECHNOLOGY**

**REGULATION 2017**

**VISION**

To develop food technologists with academic excellence focused on education, research and development with the technical knowledge on value addition, food nutrition, food quality and safety to cater the needs of industry as well as society.

**MISSION**

- To impart quality technical education in the different areas of Food technology.
- To provide a platform for overall development of the students, to be more creative, innovative and globally competent ethical professionals.
- To promote research and develop technologies for the sustenance and wellbeing of the society.

## **1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

The Food Technology curriculum is designed to prepare graduates having knowledge with high ethical values and industrial preparedness

- To understand and apply the concepts of basic sciences, Engineering and technology towards their application in the area of Food Technology.
- Identification and analysis to solve problems for the development of products, processes, techniques to meet the demands of the society.
- To apply the learnt theory and practical skills in Food Technology for industry, R&D and entrepreneurship.
- To learn professional and ethical attitude especially its impact on safety, Health and environment
- Build an environment that is conducive to higher academic pursuit and nurture creative and innovative thoughts.

## 2. PROGRAMME OUTCOMES (POs):

After completion of four years of study, the Food Technology Graduates will be able to:

PO	Graduate Attribute	Programme Outcome
1	Engineering Knowledge	Apply knowledge of mathematics, basic science and engineering.
2	Problem Analysis	Identify, formulate and solve problems using Technology.
3	Design/ development of solutions	Design a system or process for improvement of performance, satisfying the constraints.
4	Conduct investigations of complex problems	Conduct experiments & collect, analyze and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8	Ethics	Interact with industry, business and society in a professional and ethical manner.
9	Individual and team work	Ability to work in a multidisciplinary team.
10	Communication	Proficiency in oral and written communication.
11	Project management and finance	Implementation of cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

### 3. PROGRAMME SPECIFIC OUTCOMES (PSOS)

By the completion of Food Technology B. Tech program, the student will

1. Develop theoretical and practical knowledge; develop effective communication and cognitive skills.
2. Develop focus in the Food Technology and apply critical thinking and problem-solving skills to address current challenges in the food industry.
3. Understand the importance of responsibility, dependability, punctuality, courtesy, sensitivity, respect for others and effort in the work place.
4. Commit to the highest standards of professional integrity and ethical values

### 4.MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OBJECTIVES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>I</b>	√	√			√							√
<b>II</b>		√	√	√	√				√	√		
<b>III</b>		√	√	√		√		√	√	√	√	
<b>IV</b>						√	√	√				
<b>V</b>		√				√	√				√	

**CURRICULUM AND SYLLABUS**  
**B.TECH. FOOD TECHNOLOGY REGULATION 2017**  
**BATCH: 2018-2022**

**SEMESTER I**

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	HS17151	Communicative English	HS	3	3	0	0	3
2	MA17151	Engineering Mathematics–I	BS	5	3	2	0	4
3	PH17151	Engineering Physics	BS	3	3	0	0	3
4	CY17151	Engineering Chemistry	BS	3	3	0	0	3
5	GE17151	Problem Solving and python Programming	ES	3	3	0	0	3
6	GE17152	Engineering Graphics	ES	6	2	0	4	4
<b>PRACTICALS</b>								
7	GE17161	Problem Solving and python Programming Laboratory	ES	4	0	0	4	2
8	GE17162	Physics and Chemistry Laboratory	BS	4	0	0	4	2
<b>TOTAL</b>				<b>31</b>	<b>17</b>	<b>2</b>	<b>12</b>	<b>24</b>

**SEMESTER II**

Sl. No	COURS E CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	HS17251	Technical English	HS	3	3	0	0	3
	HS17252	Professional English Communication						
2	MA17251	Engineering Mathematics–II	BS	5	3	2	0	4
3	PH17253	Physics of Materials	BS	3	3	0	0	3

4	EE17252	Basic Electrical, Electronics and Instrumentation Engineering	ES	4	2	2	0	3
5	FT17201	Microbiology	BS	3	3	0	0	3
6	FT17202	Food Chemistry	PC	3	3	0	0	3
<b>PRACTICALS</b>								
7	GE17261	Engineering Practices Lab	ES	4	0	0	4	2
8	FT17211	Food chemistry Lab	PC	4	0	0	4	2
<b>TOTAL</b>				<b>29</b>	<b>17</b>	<b>4</b>	<b>8</b>	<b>23</b>

### SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	MA17351	Transforms and Partial Differential Equation	BS	4	3	1	0	4
2	FT17301	Introduction to Food Processing	PC	3	3	0	0	3
3	FT17302	Food Process Calculations	PC	5	3	2	0	4
4	FT17303	Food Microbiology	PC	3	3	0	0	3
5	FT17304	Fluid Mechanics	PC	4	4	1	0	4
6	FT17305	Human Nutrition and Dietetics	PC	3	3	0	0	3
<b>PRACTICALS</b>								
7	FT17311	Food Microbiology Laboratory	PC	4	0	0	4	2
8	FT17312	Clinical Nutrition Lab	PC	4	0	0	4	2
9	HS17361	Interpersonal Skills/Listening and Speaking	EEC	2	0	0	2	1
<b>TOTAL</b>				<b>34</b>	<b>18</b>	<b>6</b>	<b>10</b>	<b>26</b>

### SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	MA17353	Probability and Statistics	BS	4	3	1	0	4
2	FT17401	Food Analysis	PC	3	3	0	0	3
3	FT17402	Fundamentals of Heat and Mass Transfer	PC	3	3	0	0	3
4	CY17251	Environmental Science and Engineering	BS	3	3	0	0	3
5	FT17403	Food Additives	PC	3	3	0	0	3
6	FT17404	Unit Operations for Food Industries	PC	3	3	0	0	3
<b>PRACTICALS</b>								
7	FT17411	Food Analysis Laboratory	PC	4	0	0	4	2
8	FT17412	Unit Operations Laboratory	PC	4	0	0	4	2
9	HS17461	Advanced Reading and Writing	EEC	2	0	0	2	1
<b>TOTAL</b>				<b>32</b>	<b>18</b>	<b>4</b>	<b>10</b>	<b>25</b>

### SEMESTER V

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	FT17501	Thermodynamics	PC	4	3	1	0	4
2	FT17502	Food Processing and Preservation	PC	4	3	1	0	4
3	FT17503	Baking and Confectionary Technology	PC	3	3	0	0	3
4	FT17504	Professional Ethics for Food Technologists	PC	3	3	0	0	3
5		Professional Elective I	PE	3	3	0	0	3
6		Open Elective I	OE	3	3	0	0	3



<b>PRACTICALS</b>								
7	FT17511	Food Processing and Preservation Laboratory	PC	4	0	0	4	2
8	FT17512	Baking and Confectionary Technology Laboratory	PC	4	0	0	4	2
<b>TOTAL</b>				<b>27</b>	<b>18</b>	<b>2</b>	<b>8</b>	<b>24</b>

### SEMESTER VI

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	FT17601	Food Process Engineering and Economics	PC	3	3	0	0	3
2	FT17602	Dairy Process Technology	PC	3	3	0	0	3
3	FT17603	Fruit and Vegetable Processing Technology	PC	3	3	0	0	3
4		Professional Elective II	PE	3	3	0	0	3
5		Professional Electives III	PE	3	3	0	0	3
6		Open Elective II*	OE	3	3	0	0	3
<b>PRACTICALS</b>								
7	FT17611	Fruit and Vegetable Processing Technology Laboratory	PC	4	0	0	4	2
8	FT17612	Dairy Process Technology Laboratory	PC	4	0	0	4	2
<b>TOTAL</b>				<b>27</b>	<b>18</b>	<b>0</b>	<b>8</b>	<b>22</b>

**SEMESTER VII**

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1	FT17701	Food Safety, Quality and Regulation	PC	3	3	0	0	3
2	FT17702	Food Packaging Technology	PC	3	3	0	0	3
3	FT17703	Refrigeration and Cold Chain Management	PC	3	3	0	0	3
4		Professional Elective IV	PE	3	3	0	0	3
5		Professional Elective V	PE	3	3	0	0	3
6		Professional Electives VI	PE	3	3	0	0	3
<b>PRACTICALS</b>								
7	FT17711	Testing of Packaging Materials Laboratory	PC	4	0	0	4	2
8	FT17712	Industry Training (Two weeks training during vacation)	EEC	1	0	0	0	1
9	FT17713	Mini project	EEC	2	0	0	2	1
<b>TOTAL</b>				<b>25</b>	<b>18</b>	<b>0</b>	<b>6</b>	<b>22</b>

**SEMESTER VIII**

Sl. No	COURS E CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>PRACTICALS</b>								
1	FT17811	Project Work	EEC	30	0	0	20	15
<b>TOTAL</b>				<b>30</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>15</b>

**TOTAL CREDITS: 181**

**PROFESSIONAL ELECTIVES (PE)**

**PROFESSIONAL ELECTIVE – I (SEMESTER V)**

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	FT17E51	Biology and Chemistry of Food Flavors	PE	3	3	0	0	3
2.	FT17E52	Pulse and Oil Seed Technology	PE	3	3	0	0	3
3.	FT17E53	Traditional Foods	PE	3	3	0	0	3
4.	FT17E54	Beverage Technology	PE	3	3	0	0	3
5.	FT17E55	Biochemical Engineering	PE	4	3	0	2	4

**PROFESSIONAL ELECTIVE – II, III (SEMESTER VI)**

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	FT17E61	Functional Foods and Nutraceuticals	PE	3	3	0	0	3
2.	FT17E62	Food Toxicology and Allergy	PE	3	3	0	0	3
3.	FT17E63	Spices and Plantation Technology	PE	3	3	0	0	3
4.	FT17E64	Food Process Equipment Design	PE	3	3	0	0	3
5.	FT17E65	Cereal Technology	PE	3	3	0	0	3
6.	FT17E66	Instrumentation and Process Control in Food Industries	PE	3	3	0	0	3
7.	BT17E63	Biological Spectroscopy	PE	3	3	0	0	3
8.	FT17E67	Meat, Fish and Poultry Processing Technology	PE	3	3	0	0	3
9.	GE17451	Total Quality Management	PE	3	3	0	0	3
11	FT17E69	Specialty Foods	PE	3	3	0	0	3
12	GE17E52	Entrepreneurship Development	PE	3	3	0	0	3

**PROFESSIONAL ELECTIVE – IV, V & VI (SEMESTER VII)**

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	FT17E71	Post-Harvest Technology	PE	3	3	0	0	3
2.	FT17E72	Milling Technology	PE	3	3	0	0	3
3.	FT17E73	Creativity, Innovation and New Food Product Development	PE	3	3	0	0	3
4.	BT17701	Downstream Processing	PE	3	3	0	0	3
5.	FT17E74	Nanotechnology in Food Applications	PE	3	3	0	0	3
6.	FT17E75	Management of Food Waste	PE	3	3	0	0	3
7.	FT17E76	Genetic Engineering and Genetically Modified Foods	PE	3	3	0	0	3
8.	FT17E77	Storage Engineering	PE	3	3	0	0	3
9.	FT17E78	Emerging Technologies in Food Processing	PE	3	3	0	0	3
10	FT17E68	Food Plant Design	PE	3	3	0	0	3
11	FT17E79	Comprehension in Food Technology	PE	3	3	0	0	3

**OPEN ELECTIVE SUBJECTS FOR FOOD TECHNOLOGY STUDENTS**

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	OBM1701	Anatomy and Physiology for Engineers	OE	3	3	0	0	3
2.	OBM1702	Biomaterials and Artificial Organs	OE	3	3	0	0	3
3.	OBM1703	Fundamentals of Medical Instrumentation	OE	3	3	0	0	3
4.	OBM1704	Engineering Mechanics for Medical Applications	OE	3	3	0	0	3
5.	OCH1701	Introduction to Fertilizer Technology	OE	3	3	0	0	3
6.	OCH1706	Recent trends in water treatment	OE	3	3	0	0	3
7.	OCE1705	Basics of Architecture	OE	3	3	0	0	3
8.	OCE1706	Global Warming and Climate Change	OE	3	3	0	0	3
9.	OCS1705	IoT and its Applications	OE	3	3	0	0	3
10.	OCS1706	Programming in C	OE	4	2	0	2	3
11.	OCS1707	Programming in C++	OE	4	2	0	2	3

12.	OCS1708	Java Programming	OE	4	2	0	2	3
13.	OCS1709	Computer Programming	OE	4	2	0	2	3
14.	OEC1701	MEMS and its Applications	OE	3	3	0	0	3
15.	OIT1704	Computer Vision	OE	3	3	0	0	3
16.	OIT1706	Machine Learning and R Programming	OE	3	3	0	0	3
17.	OMT1703	Bio-mechatronics	OE	3	3	0	0	3
18.	OPH1701	Materials Synthesis and Characterization Techniques	OE	3	3	0	0	3
19.	OPH1702	Nanophysics	OE	3	3	0	0	3
20.	OCY1701	Green Chemistry in Energy and Environment	OE	3	3	0	0	3
21.	OCY1702	Interface Chemistry and Engineering	OE	3	3	0	0	3
22.	OGE1701	Human Rights	OE	3	3	0	0	3
23.	OGE1702	Foreign Language-Japanese	OE	3	3	0	0	3
24.	OGE1703	Foreign Language-German	OE	3	3	0	0	3
25.	OGE1704	Foreign Language-French	OE	3	3	0	0	3

### **SUMMARY**

S.No	SUBJECT AREA	CREDITS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1.	HS	3	3	-	-	-	-	-	-	6
2.	BS	12	10	4	7	-	-	-	-	33
3.	ES	9	5	-	-	-	-	-	-	14
4.	PC	-	5	21	17	18	13	11	-	85
5.	PE	-		-	-	3	6	9	-	18
6.	OE	-		-	-	3	3		-	6
7.	EEC	-		1	1	-		2	15	19
<b>Total</b>		<b>24</b>	<b>23</b>	<b>26</b>	<b>25</b>	<b>24</b>	<b>22</b>	<b>22</b>	<b>15</b>	<b>181</b>

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
HS 17151	<b>COMMUNICATIVE ENGLISH</b> (Common to all branches of B.E/B.Tech. programmes)	HS	3	0	0	3

<b>Objectives:</b>						
●	To develop the basic reading and writing skills of first year engineering and technology students.					
●	To help learners develop their listening skills, which will enable them listen to lectures and comprehend them by asking questions; seeking clarifications.					
●	To help learners develop their speaking skills and speak fluency in real contexts.					
●	To help learners develop vocabulary of a general kind by developing their reading skills.					

<b>UNIT-I</b>	<b>SHARING INFORMATION RELATED TO ONESELF/FAMILY &amp; FRIENDS</b>	<b>9</b>
Reading-short comprehension passages, practice in skimming-scanning and predicting, Writing-Completing sentences-developing hints. Listening-short texts- short formal and informal conversations. Speaking- introducing oneself- exchanging personal information- language development- Wh questions- asking and answering yes or no questions. Subject –verb agreement- regular and irregular verbs. Vocabulary development- prefixes, suffixes-articles.		
<b>UNIT-II</b>	<b>GENERAL READING AND FREE WRITING</b>	<b>9</b>
Reading-comprehension-pre-reading-post-reading-comprehension questions (multiple choice questions and/ or short questions/ open-ended questions)- inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short listening texts)- register. Writing – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures, listening-telephonic conversations, speaking- sharing information of a personal kind- greeting-taking leave, language development-prepositions, conjunctions, vocabulary development –guessing meanings of words in context.		
<b>UNIT-III</b>	<b>GRAMMER AND LANGUAGE DEVELOPMENT</b>	<b>9</b>
Reading – short texts and longer passages (close reading). Writing –understanding text structure- use of reference words and discourse markers- coherence-jumbled sentences, Listening-listening to longer texts and filling up the table- product description-narratives from different sources. Speaking-asking about routine actions and expressing opinions. Language development- degrees of comparison-pronouns-direct vs indirect questions. Vocabulary development-single word substitutes-adverbs.		
<b>UNIT-IV</b>	<b>READING AND LANGUAGE DEVELOPMENT</b>	<b>9</b>
Reading-short texts and longer passages (close reading). Writing- Letter writing-informal or personal letters – emails – conventions of personal emails. Listening-listening to longer texts and filling up the table- product description- narratives from different sources. Speaking- speaking about oneself-speaking about one's friend. Language development- Tenses- simple present- simple past – present continuous and past continuous. Vocabulary development- synonyms-antonyms-phrasal verbs.		

<b>UNIT-V</b>	<b>EXTENDED WRITING</b>	<b>9</b>
Reading- longer texts- close reading. Writing – brainstorming-writing short essays- developing an outline – identifying main and subordinate ideas- dialogue. Listening- listening to talks- conversations. speaking- participating in conversations- short group conversations. Language development-modal verbs- present/past perfect tense. Vocabulary development –functional uses of tenses.		
		<b>Total Contact Hours : 45</b>

<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	Read articles of general kind in magazines and newspapers
●	Participate effectively in informal conversations; introduce themselves and their friends and express opinions
●	Comprehend conversations and short talks delivered in English
●	Express ideas about oneself freely.
●	Write short essays of a general kind and personal letters and emails in English

<b>Text Book (s):</b>	
<b>1</b>	Board of Editors. Using English, A course book for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad: 2015
<b>2</b>	Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Bailey, Stephen, "Academic Writing: A practical; guide for students". New York:Rutledge,2011.
<b>2</b>	Means, L. Thomas and Elaine Langlois., "English & Communication for Colleges"., Cengage Learning, USA:2007
<b>3</b>	Redston, Chris & Gillies Cunningham , "Face2Face (Pre-intermediate Student's Book & Workbook)", Cambridge University Press, New Delhi: 2005
<b>4</b>	Comfort, Jeremy, <i>et al.</i> , "Speaking Effectively: Developing Speaking Skills for Business English". Cambridge University Press, Cambridge: Reprint 2011.
<b>5</b>	Dutta P Kiranmai and RajeevanGeeta., "Basic Communication Skills", Foundation Books:2013

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	2	3	1	-	-	-	-	-
CO2	-	-	-	1	-	1	-	-	-	3	1	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-
CO5	-	-	-	-	-	1	-	-	2	3	1	-	-	-	-	-
Average	-	-	-	1	-	1	-	-	1.6	3	1	-	-	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
MA 17151	<b>ENGINEERING MATHEMATICS-I</b> (Common to all branches of B.E/B.Tech. programmes)	BS	3	1	0	4

Objectives:	
●	To learn the basics and concepts of traditional calculus gain knowledge in using matrix algebra techniques.
●	To provide the basic tools of calculus mainly for purpose of modelling Engineering problems mathematically and obtaining the solutions.
●	To understand the concepts of single variable and multivariable calculus that plays an important role in the field of science, engineering and technology

<b>UNIT-I</b>	<b>MATRICES</b>	<b>12</b>
Eigen values and Eigen vectors of real matrix – Characteristic Equation - Properties of Eigen values and Eigen vectors - Cayley – Hamilton theorem - Diagonalization of matrices – Reduction of quadratic form to canonical form by orthogonal transformation - Nature of quadratic forms.		
<b>UNIT-II</b>	<b>DIFFERENTIAL CALCULUS</b>	<b>12</b>
Representation of functions – Limit of functions – Continuity – Derivatives – Differentiation rules – Maxima and Minima of functions of one variable.		
<b>UNIT-III</b>	<b>FUNCTIONS OF SEVERAL VARIABLES</b>	<b>12</b>
Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables – Maxima and minima of functions of two variables – Lagrange’s method of undetermined multipliers.		
<b>UNIT-IV</b>	<b>INTEGRAL CALCULUS</b>	<b>12</b>
Definite and Indefinite integrals- Substitution rule- Techniques of Integration- Integration by parts- Bernoulli’s formula, Trigonometric integrals, Trigonometric substitutions, integration of rational functions by partial fraction, integration of irrational functions- improper integrals.		
<b>UNIT-V</b>	<b>MULTIPLE INTEGRAL</b>	<b>12</b>
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.		



	<b>Total Contact Hours</b>	<b>:</b>	<b>60</b>
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**Course Outcomes:**

On completion of course students will be able to

●	Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, positive definite matrices and similar matrices for solving problems.
●	Use the techniques of differentiation to differentiate functions and to apply the concept of differentiation to solve the problems of maxima and minima.
●	To apply the concept of partial differentiation for functions two or more variables and use different techniques for solving problems.
●	Solve the problems involving integration using different methods such as substitution, partial fractions by parts.
●	Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.

**Text Books:**

<b>1</b>	Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
<b>2</b>	James Stewart, “Calculus: Early Transcendentals”, Cengage Learning, 7 <sup>th</sup> Edition, New Delhi, 2015.

**Reference Books / Web links:**

<b>1</b>	Anton, H., Bivens, I., and Davis, S., "Calculus", Wiley, 10 <sup>th</sup> edition, 2016.
<b>2</b>	Jain R.K and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 3 <sup>rd</sup> Edition, 2007.
<b>3</b>	Narayanan, S. and Manicavachagom Pillai, T. k., “Calculus” Volume I and II, S.Viswanathan Publishers Pvt. Ltd., Chennai, 2007
<b>4</b>	Srimantha Pal and Bhunia, S.C, “Engineering mathematics” Oxford University Press, 2015.
<b>5</b>	Weir, M.D and Joel Hass, “Thomas Calculus”, 12 <sup>th</sup> Edition, Pearson India, 2016
<b>6</b>	T Veerarajan, Engineering Mathematics –I, McGraw -Hill Education, 2014

PO/PS O CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PS O4
CO 1	3	2	1	-	-	-	-	-	-	-	1	-	1	-	-	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-
CO 5	2	2	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Average	2.2	2	1	-	-	-	-	-	-	-	1	1	1	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
PH 17151	<b>ENGINEERING PHYSICS</b> (Common to all branches of B.E/B.Tech. programmes)	BS	3	0	0	3

**Objectives:**

- Enhance the fundamental knowledge in Physics and its application relevant to various streams of Engineering and technology

<b>UNIT-I</b>	<b>PROPERTIES OF MATTER</b>	<b>9</b>
Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams –area moment of inertia - bending moment – cantilever - applications – uniform and non-uniform bending- I-shaped girders - stress due to bending in beams.		
<b>UNIT-II</b>	<b>WAVES AND OPTICS</b>	<b>9</b>
Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation Lasers: Population of energy levels, Einstein’s A and B coefficients derivation- resonant cavity, optical amplification (qualitative)- CO <sub>2</sub> laser- semiconductor lasers: homojunction and heterojunction – Fibre optics: Principle, numerical aperture and acceptance angle – types of optical fibres ( material, refractive index and mode)- losses associated with optical fibres- fiber optic sensors: pressure and displacement.		
<b>UNIT-III</b>	<b>THERMAL PHYSICS</b>	<b>9</b>
Transfer of heat energy – thermal expansion of solids and liquids – expansion joints – bimetallic strips– thermal conduction, convection and radiation – rectilinear heat flow – thermal conductivity- Frobe’s and Lee disc method: theory and experiment – Conduction through compound media (series and Parallel) – thermal insulation- applications: heat exchangers, refrigerators, Ovens and solar water heaters.		
<b>UNIT-IV</b>	<b>QUANTUM PHYSICS</b>	<b>9</b>
Black body radiation- Planck’s theory (derivation) -Compton effect: theory and experimental verification- wave particle duality - electron diffraction- concept of wave function and its physical significance- Schrodinger’s wave equation- time independent and time dependent equations - particle in a one-dimensional rigid box - tunnelling (qualitative) - electron microscope - scanning tunnelling microscope.		
<b>UNIT-V</b>	<b>CRYSTAL PHYSICS</b>	<b>9</b>
Single crystalline, polycrystalline and amorphous materials- single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices- inter planar distances - reciprocal lattice- coordination number and packing factor for SC, BCC, FCC and HCP-Polymorphism and allotropy: diamond		

and graphite structures - crystal imperfections: point defects, line defects - Burger vectors, stacking faults- role of imperfections in plastic deformations- growth of single crystals: solution and melt growth techniques.

**Contact Hours** : **45**

### Course Outcomes:

On completion of the course, students will be able to

- Apply the knowledge of basic properties of matter and its application in Engineering and Technology
- Use the concepts of waves and optical devices and their applications in fibre optics.
- Use the thermal properties of materials and their applications in heat exchangers
- Use the advanced physics concepts of quantum theory and its applications in electron microscope and material sciences.
- Apply the basic knowledge of crystallography in materials preparation and device fabrication.

### Text Books:

- 1 Bhattacharya, D.K., & Poonam, T., “Engineering Physics”, Oxford University Press 2015.
- 2 Gaur, R.K. & Gupta, S.L. “Engineering Physics”, Dhanpat Rai Publishers, 2012.
- 3 Pandey, B.K., & Chaturvedi, S., “Engineering Physics”, Cengage Learning India, 2012.

### Reference Books / Web links:

- 1 Halliday, D., Resnick, R., & Walker, J., “Principles of Physics”, Wiley, 2015.
- 2 Serway, R.A. & Jewett, J.W., “Physics for Scientists and Engineers”, Cengage Learning, 2010
- 3 Tipler, P.A. & Mosca, G., “Physics for Scientists and Engineers with modern physics”, W.H.Freeman, 2007
- 4 Arthur Besier and S. RaiChoudary, “Concepts of Modern physics (SIE)”, 7<sup>th</sup> Edition, McGraw-Hill Education, 1994.
- 5 R.Murugeshan and Kiruthiga Sivaprasath, “Modern physics”, S.Chand, 2015.

PO/PS O CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO 1	3	2	1	-	-	-	-	-	-	-	1	-	1	-	-	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-
CO 5	2	2	-	-	-	-	--	-	-	-	-	1	1	-	-	-
Average	2.2	2	1	-	-	-	-	-	-	-	1	1	1	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
CY 17151	ENGINEERING CHEMISTRY (Common to all branches of B.E/B.Tech. programmes)	BS	3	0	0	3

<b>Objectives:</b>	
●	To acquire knowledge on characteristics of boiler feed water and water treatment techniques
●	To develop an understanding on surface chemistry and its application
●	To develop an understanding on basic concepts of phase rule and its application towards alloying
●	To acquire knowledge on different types of fuels and its characteristics
●	To obtain knowledge on batteries and fuel cell.

<b>UNIT-I</b>	<b>WATER AND ITS TREATMENT</b>	<b>9</b>
Hardness of water –types- expression of hardness- units- boiler troubles (scale and sludge) -treatment of boiler feed water- internal treatment (Phosphate, colloidal, sodium aluminate and calgon conditioning)- External treatment - ion exchange process, zeolite process - potable water treatment - break point chlorination - desalination of brackish water - Reverse osmosis - UASB process (Upflow Anaerobic Sludge Blanket)		
<b>UNIT-II</b>	<b>SURFACE CHEMISTRY AND CATALYSIS</b>	<b>9</b>
Adsorption- types of adsorption - adsorption of gases on solid - adsorption of solute from solutions - types of isotherms-Freundlich adsorption isotherm -Langmuir adsorption isotherm – Contact theory – Preparation and applications of activated carbon (Up flow and down flow process)- applications of adsorption on pollution abatement.  Catalysis - general characteristics -types of catalysis –Criteria- autocatalysis- catalytic poisoning and catalytic promoters- acid -base catalysis – applications (catalytic convertor)- enzyme catalysis - Michaelis - Menton equation.		
<b>UNIT-III</b>	<b>PHASE RULE, ALLOYS AND COMPOSITES</b>	<b>9</b>
Phase rule: Introduction, definition of terms with examples, One Component System- water system – Reduced phase rule – thermal analysis and cooling curves- Two Component Systems- lead-silver system- Pattinson process. Alloys: Introduction- Definition- Properties of alloys- Significance of alloying, Functions and effect of alloying elements- Nichrome and Stainless steel (18/8)– heat treatment of steel.  Composites- polymer matrix composites- metal matrix composites- ceramic matrix composites.		
<b>UNIT-IV</b>	<b>FUELS AND COMBUSTION</b>	<b>9</b>
Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range.		
<b>UNIT-V</b>	<b>ENERGY SOURCES AND STORAGE DEVICES</b>	<b>9</b>
Batteries-Components- Characteristics- Voltage, current, capacity, electrical storage density, energy density, discharge rate- Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, Ni- Cd		

battery, lithium-ion-battery). fuel cells – H<sub>2</sub>-O<sub>2</sub> fuel cell, Methanol oxygen fuel cell, Proton exchange membrane fuel cell- SOFC and Biofuel cells.

**Contact Hours : 45**

### Course Outcomes:

On completion of the course, students will be able to

- Get familiarized on water treatment techniques
- Apply adsorption phenomena on various fields
- Analyse alloying composition based on phase rule concept
- Apply the role of fuels in day today applications
- Design the batteries and fuel cells.

### Text Books:

- 1 P. C. Jain and Monika Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
- 2 S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India Pvt., Ltd., New Delhi, 2013.

### Reference Books / Web links:

- 1 Friedrich Emich, “Engineering Chemistry”, Scientific International Pvt. Ltd., New Delhi, 2014. 2. 3.
- 2 Prasanta Rath, “Engineering Chemistry”, Cengage Learning India Pvt. Ltd., Delhi, 2015.
- 3 Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, 2015.
- 4 S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	P S O 3	PS O4
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	1	1	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
AVG.	2.4	1.6	1.5	-	-	-	-	-	-	-	-	1	1	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
GE 17151	PROBLEM SOLVING AND PYTHON PROGRAMMING	ES	3	0	0	3

<b>Objectives:</b>	
●	Develop an understanding of algorithmic problem solving.
●	Develop Python programs with conditionals and loops
●	Define Python functions and call them
●	Use Python data structures — lists, tuples, dictionaries.
●	Do input/output with files in Python.

<b>UNIT-I</b>	<b>ALGORITHMIC PROBLEM SOLVING</b>	<b>9</b>
Introduction to computers- Characteristics – basic organization of a computer- Algorithms- building blocks of algorithms (instructions/statements, state, control flow, functions)- notation (pseudo code, flow chart, programming language)- algorithmic problem solving- simple strategies for developing algorithms (iteration, recursion).		
<b>UNIT-II</b>	<b>DATA, EXPRESSIONS, STATEMENTS AND CONTROL FLOW</b>	<b>9</b>
Python interpreter and interactive mode- values and types- data types – variables – keywords- expressions and statements- Python I/O- operators- precedence of operators, comments. Conditionals: Conditional (if)- alternative (if-else)- chained conditional (if-elif-else)- nested conditional. Iteration: while- for- break- continue- pass. Illustrative programs: exchange the values of two variables- circulate the values of two variables- test for leap year.		
<b>UNIT-III</b>	<b>FUNCTIONS</b>	<b>9</b>
Function calls- type conversion- math function –composition- definition and use- flow of execution- parameters and arguments. Fruitful functions: return values-parameters, local and global scope, recursion. Strings: string slices- immutability - string functions and methods- string comparison. Illustrative programs: square root, GCD, exponentiation- sum an array of numbers-linear search-binary search.		
<b>UNIT-IV</b>	<b>COMPOUND DATA: LISTS, TUPLES, DICTIONARIES</b>	<b>9</b>
Lists: list operations- list slices- list methods- list loop- mutability- aliasing- cloning lists- list parameters. Tuples: immutable- tuple assignment, tuple as return value. Dictionaries: operations and methods- dictionaries and tuples – dictionaries and lists. Advanced list processing - list comprehension. Illustrative programs: Sorting.		
<b>UNIT-V</b>	<b>FILES, MODULES, PACKAGES</b>	<b>9</b>
Files and exception: file operation - text files- reading and writing files- format operator- command line arguments- errors and exceptions- handling exceptions- writing modules- packages. Illustrative programs: word count- copy file- case studies.		
		<b>Contact Hours : 45</b>

<b>Course Outcomes:</b>	
On completion of the course, students will be able to	
●	Develop algorithmic solutions to simple computational problems

●	Structure simple Python programs for solving problems
●	Decompose a Python program into functions.
●	Represent compound data using Python lists, tuples, dictionaries.
●	Read and write data from/to files in Python Programs.

**Text Books:**

1	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 ( <a href="http://greenteapress.com/wp/thinkpython/">http://greenteapress.com/wp/thinkpython/</a> )
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**Reference Books / Web links:**

1	Anita Goel, Ajay Mittal, Computer Fundamentals and programming in C, Pearson India Publisher, 1 <sup>st</sup> edition, 2013.
2	John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013
3	Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
4	Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.
5	Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012
6	Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.
7	The Python Tutorial, <a href="https://docs.python.org/2.7/tutorial/">https://docs.python.org/2.7/tutorial/</a>

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE 17152	<b>Engineering Graphics</b> (Common to all branches of B.E/B.Tech. programmes)	ES	2	0	4	4

**Objectives:**

●	Develop in students, graphic skills for communication of concepts, ideas and design of engineering products
●	Expose them to existing national standards related to technical drawings.
●	Study different type of projections and practice them on free hand sketching

**CONCEPTS AND CONVENTIONS (Not for Examination)****1**

Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning.

<b>UNIT-I</b>	<b>PLANE CURVES AND FREE HAND SKETCH</b>	<b>11</b>
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Basic Geometrical constructions, Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle- drawing of tangents and normal to the above curves- Construction of helical curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects		
<b>UNIT-II</b>	<b>PROJECTION OF POINTS, LINES AND PLANE SURFACE</b>	<b>12</b>
Orthographic projection- Principles-Principal planes- projection of points. First angle projection - Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
<b>UNIT-III</b>	<b>PROJECTION OF SOLIDS</b>	<b>12</b>
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.		
<b>UNIT-IV</b>	<b>PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES</b>	<b>12</b>
Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of the section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surface of solids with cut-outs and holes.		
<b>UNIT-V</b>	<b>ISOMETRIC AND PERSPECTIVE PROJECTIONS</b>	<b>12</b>
Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones- combination of two solid objects in simple vertical positions- Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.		
<b>Total Contact Hours</b>		<b>: 60</b>

<b>Course Outcomes:</b> After learning the course, the students should be able	
●	Draw a basic geometrical constructions of plane curves and free hand sketching of multiple views from pictorial objects.
●	Draw the orthographic projection of points, lines and planes
●	Draw the projection of solids
●	Draw the projection of Sectioned solids and development of surfaces of solids
●	Draw the true shape of the sectioned solid and development of surfaces
●	Draw the isometric and perspective sections of simple solids.

<b>Text Book (s):</b>	
<b>1</b>	Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50 <sup>th</sup> Edition, 2010.
<b>2</b>	Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2017.



<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill Publishing Company Limited, New Delhi, 2018.
<b>2</b>	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
<b>3</b>	Luzzader, Waren,J. and Duff, John M., “Fundamantals of Engineering Drawing with an introduction to interactive Computer Graphics for Design and Production”, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., New Dehi, 2005.
<b>4</b>	Venugopal K. and PrabhuRaja V., “Engineering Graphics”, New Age International (P)Limited, 2008.
<b>5</b>	Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2 <sup>nd</sup> Edition, 2009.

<b>Publication of Bureau of Indian Standards</b>	
<b>1</b>	IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
<b>2</b>	IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
<b>3</b>	IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
<b>4</b>	IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
<b>5</b>	IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

<b>Special Points Applicable to End Semester Examination on Engineering Graphics</b>	
<b>1</b>	There will be five questions, each of either or type covering all units of the syllabus
<b>2</b>	All questions will carry equal marks of 20 each making a total of 100.
<b>3</b>	The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size
<b>4</b>	The examination will be conducted in appropriate sessions on the same day

PO\PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	-	-	-	-	-	-	-	-	1	-	2	2	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	1	-	2	2	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	1	-	2	2	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	1	-	2	2	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	1	-	2	1	-	-	-
AVG	2	-	-	-	-	-	-	-	-	1	-	2	1.8	-	-	-

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE 17161	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	ES	0	0	4	2

**Objectives:**

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The student will be able to:	
●	Be familiarize with the use of office package, exposed to presentation and visualization tools.
●	Implement python programs with conditionals and loops
●	Use functions for structuring python programs.
●	Represent compound data using python lists, tuples and dictionaries
●	Read and Write data from/to files in python.

List of Experiments			
1	Search, generate, manipulate data using Open Office		
2	Presentation and Visualization- graphs, charts, 2D, 3D		
3	Problem solving using algorithms and flowcharts		
4	Compute GCD of two numbers		
5	Find the square root of a number (Newton's method)		
6	Exponentiation (power of a number)		
7	Linear search and Binary search		
8	First n prime numbers		
9	Find the maximum of a list of numbers		
10	Sorting		
11	Remove all the duplicates in a list		
12	Multiply Matrices		
13	Programs that take command line arguments (word count)		
14	Find the most frequent words in a text read from a file		
15	Mini Project		
			Total Contact Hours : 60

<b>Platform needed:</b>	
Hardware	PC with 8 GB RAM, i3 Processor
Software	Python 3 interpreter for Windows/Linux

<b>Course Outcomes:</b>	
<b>The students will be able to</b>	
•	Develop the documentation , presentation and visualization charts
•	Implement python programs with conditionals and loops
•	Develop python programs stepwise by defining functions and calling them.
•	Use python lists, tuples and dictionaries for representing compounded data
•	Read and Write data from/to files in Python.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
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GE 17162	PHYSICS AND CHEMISTRY LABORATORY	PC	0	0	4	2
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<b>Objectives:</b>	
<b>The student will be able to:</b>	
●	To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

<b>List of Experiments: PHYSICS LABORATORY (Any 5 Experiments)</b>			
1	Determination of rigidity modulus – Torsion pendulum		
2	Determination of Young's modulus by non-uniform bending method		
3	(a) Determination of wavelength, and particle size using Laser (b) Determination of acceptance angle in an optical fiber.		
4	Determination of thermal conductivity of a bad conductor – Lee's Disc method		
5	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer		
6	Determination of wavelength of mercury spectrum – spectrometer grating		
7	Determination of thickness of a thin wire – Air wedge method		
<b>Total Contact Hours</b>			<b>: 30</b>

<b>Course Outcomes:</b>	
<b>The students will be able to</b>	
●	Apply the principle of elasticity viz Young's Modulus & rigidity modulus of engineering materials.
●	Apply the principle of elasticity in determining the compressibility of liquids using ultrasonic waves
●	Apply the principle of optics in fiber optical communication.
●	Apply thermal properties of various insulating materials in Engineering applications.
●	Use the basic instruments like Vernier calliper, micro meter and microscope for various basic measurements.

### CHEMISTRY LABORATORY:

<b>Objectives:</b>	
<b>The student will be able to:</b>	
●	To acquire practical skills in the determination of water quality parameters.
●	To gain knowledge about spectrophotometer and flame photometer
●	To acquire knowledge on the determination of corrosion rate

<b>List of Experiments: CHEMISTRY LABORATORY (Any 7 Experiments)</b>	
1	Estimation of HCl using Na <sub>2</sub> CO <sub>3</sub> as primary standard and Determination of alkalinity in water sample.
2	Determination of total, temporary & permanent hardness of water by EDTA method.
3	Determination of DO content of water sample by Winkler's method.

<b>4</b>	Determination of chloride content of water sample by argentometric method.
<b>5</b>	Determination of strength of given hydrochloric acid using pH meter.
<b>6</b>	Estimation of iron content of the given solution using potentiometer.
<b>7</b>	Conductometric titration of strong acid vs strong base.
<b>8</b>	Determination of strength of acids in a mixture of acids using conductivity meter.
<b>9</b>	Estimation of copper content of the given solution by Iodometry
<b>10</b>	Estimation of iron content of the water sample using spectrophotometer (1,10- Phenanthroline/thiocyanate method).
<b>11</b>	Estimation of sodium and potassium present in water using flame photometer.
<b>12</b>	Corrosion experiment-weight loss method.
<b>Total Contact Hours : 30</b>	

**Course Outcomes:**

**The students will be able to**

- |   |   |
|---|---|
| ● | Apply the quantitative chemical analysis of water quality related parameters. |
| ● | Analyze the characteristics of water.   |
| ● | Measure the corrosion rate in metals  |
| ● | Apply the instrumentation skills in analysing metallic elements in water      |
| ● | Analyze quantitatively the strength of acids and bases in water.              |

**Text Books:**

- |    |  |
|----|--|
| 1. | Vogel's Textbook of Quantitative Chemical Analysis (8TH edition, 2014) |
|----|--|

Subject Code	Subject Name	Category	L	T	P	C
HS 17251	TECHNICAL ENGLISH	HS	3	0	0	3

### Objectives:

- |   |   |
|---|---|
| ● | Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.       |
| ● | Foster their ability to write convincing job applications and effective reports                                       |
| ● | Develop their speaking skills to make technical presentations , participate in group discussions.                     |
| ● | Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation. |

<b>UNIT-I</b>	<b>INTRODUCTION TECHNICAL ENGLISH</b>	<b>9</b>
Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- Speaking –Asking for and giving directions- Reading – reading short technical texts from journals- newspapers- Writing- purpose statements – extended definitions – issue- writing instructions – Checklists-		

Recommendations-Vocabulary Development- technical vocabulary Language Development –subject verb agreement - compound words.			
<b>UNIT-II</b>	<b>READING AND STUDY SKILLS</b>	<b>9</b>	
Listening- Listening to longer technical talks and completing exercises based on them-Speaking – describing a process-Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing- Writing- interpreting charts, graphs- Vocabulary Development -vocabulary used in formal letters/emails and reports Language Development- impersonal passive voice, numerical adjectives.			
<b>UNIT-III</b>	<b>TECHNICAL WRITING AND GRAMMAR</b>	<b>9</b>	
Listening- Listening to classroom lectures/ talks on engineering/technology -Speaking – introduction to technical presentations- Reading – longer texts both general and technical, practice in speed reading; Writing- Describing a process, use of sequence words- Vocabulary Development- sequence words- Misspelled words. Language Development- embedded sentences			
<b>UNIT-IV</b>	<b>REPORT WRITING</b>	<b>9</b>	
Listening- Listening to documentaries and making notes. Speaking – mechanics of presentations- Reading – reading for detailed comprehension- Writing- email etiquette- job application – cover letter –Résumé preparation (via email and hard copy)- analytical essays and issue based essays--Vocabulary Development- finding suitable synonyms-paraphrasing-. Language Development- clauses- if conditionals.			
<b>UNIT-V</b>	<b>GROUP DISCUSSION AND JOB APPLICATIONS</b>	<b>9</b>	
Listening- TED/Ink talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey- Vocabulary Development- verbal analogies Language Development- reported speech			
		<b>Total Contact Hours</b>	<b>: 45</b>

<b>Course Outcomes:</b>	
<b>On completion of course students will be able to</b>	
●	Read technical texts and write area- specific texts effortlessly.
●	Listen and comprehend lectures and talks in their area of specialisation successfully.
●	Speak appropriately and effectively in varied formal and informal contexts
●	Write reports and winning job applications.
●	Write error free language

<b>Text Books:</b>	
1	Board of editors., “Fluency in English - A Course book for Engineering and Technology”. Orient Blackswan, Hyderabad: 2016.
2	Sudharshana.N. P and Saveetha. C., “English for Technical Communication”, Cambridge University Press: New Delhi, 2016.

<b>Reference Books / Web links:</b>	
1	Booth-L. Diana, “Project Work”, Oxford University Press, Oxford: 2014.
2	Grussendorf, Marion, “English for Presentations”, Oxford University Press, Oxford: 2007
3	Kumar, Suresh. E., “Engineering English”. Orient Blackswan: Hyderabad,2015.

4	Means, L. Thomas and Elaine Langlois, "English & Communication for Colleges", Cengage Learning, USA: 2007
5	Raman, Meenakshi and Sharma, Sangeetha, "Technical Communication Principles and Practice", Oxford University Press: New Delhi, 2014.

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	2	3	1	-	-	-	-	-
CO2	-	-	-	1	-	1	-	-	-	3	1	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-
CO5	-	-	-	-	-	1	-	-	2	3	1	-	-	-	-	-
Average	-	-	-	1	-	1	-	-	1.6	3	1	-	-	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
HS 17252	PROFESSIONAL ENGLISH COMMUNICATION	BS	3	0	0	3

Objectives:	
●	To prepare the students to be competent in a global business environment
●	To think accurately, clearly and deeply in communicative contexts.
●	To improve career opportunities-get English language skills that are needed to be successful.

UNIT-I	CRITICAL/INFORMATIONAL LISTENING	9
Short conversations or Monologues- Listening for specific information- Conversations or Monologues with factual information- listen to fill up missing information- business related discussions or interview (two or more speakers)		
UNIT-II	CONVERSATIONAL/PRESENTATION SKILLS	9
Speak about oneself- Face-to-face speaking for real life context- pick and talk- personal opinion on business related topics- mini presentations on a business theme- discussion with another candidate on business related topics.		
UNIT-III	INTENSIVE/EXTENSIVE READING AND INTERPRETING	9
Short texts (Signs, messages, emails, labels and notes)- Short description – graph or chart. Reading to find factual information- decision making from a written text- a leaflet or a newspaper- magazine or article- reading to understand correct grammar, Contextually- reading to understand the structure of a text- read and transfer information from memos, advertisements, notices.		
UNIT-IV	FORMAL COMMUNICATION	9

Business Correspondence- writing business letters to people outside the company. Internal Company Communication- a note, a message, a memo or an email.			
UNIT-V	VERBAL ABILITY/FUNCTIONAL GRAMMAR		9
Grammar- tenses- concord- prepositions-articles-punctuations. Vocabulary-advanced vocabulary- synonyms and antonyms. Sentence correction- sentence completion-cloze passage- verbal reasoning: analogies, meaning- usage match.			
		Total Contact Hours	: 45

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Listen to, understand and give opinion in meetings
●	Apply for new jobs and develop their career
●	Write short business messages and reports
●	Use language in both official and unofficial contexts.
●	Speak effectively in business communication.

<b>Text Books:</b>	
1	Board of editors., “Sure Outcomes. A communication skills course for Undergraduate Engineers and Technologists”, Orient Blackswan, Hyderabad: 2013.

<b>Reference Books / Web links:</b>	
1	Hartley, Mary., “The Power of Listening” Jaico publishing House, 1 <sup>st</sup> edition, 2015
2	Chambers, Harry, “Effective Communication Skills for Scientific and Technical Professionals” Persues Publishing, Cambridge, Massachusetts, 2000.
3	Lesikar V. Raymond, Flatley E. Marie, Rentz, Kathryn and Pande, Neerja. “ Business Communication” 11 <sup>th</sup> edition, Tata McGraw Hill Education Private Limited.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	
CO1	-	-	-	-	-	-	-	-	2	3	1	-	-	-	-	-	
CO2	-	-	-	1	-	1	-	-	-	3	1	-	-	-	-	-	
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	
CO4	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	
CO5	-	-	-	-	-	1	-	-	2	3	1	-	-	-	-	-	
Average	-	-	-	1	-	1	-	-	1.6	3	1	-	-	-	-	-	
Subject Code	Subject Name										Category	L	T	P	C		
MA 17251	ENGINEERING MATHEMATICS – II (Common to all branches of B.E/B.Tech. programmes)										BS	3	1	0	4		

<b>Objectives:</b>	
●	To handle practical problems arising in the field of engineering laboratory
●	To solve the problems using the concept of Differential equation, Vector calculus, Complex analysis, Laplace transforms.

<b>UNIT-I</b>	<b>DIFFERENTIAL EQUATIONS</b>	<b>12</b>
Higher order Linear differential equations with constant coefficients- Method of variation of parameters - Homogenous equation of Euler's and Legendre's type - System of simultaneous linear differential equations with constant coefficients- Method of undetermined coefficients.		
<b>UNIT-II</b>	<b>VECTOR CALCULUS</b>	<b>12</b>
Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals. (cubes and parallelepipeds)		
<b>UNIT-III</b>	<b>ANALYTIC FUNCTIONS</b>	<b>12</b>
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = Z + C$ , $CZ$ , $1/Z$ , $Z^2$ - Bilinear transformation.		
<b>UNIT-IV</b>	<b>COMPLEX INTEGRATION</b>	<b>12</b>
Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi-circular contour.		
<b>UNIT-V</b>	<b>LAPLACE TRANSFORMS</b>	<b>12</b>
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.		
		<b>Total Contact Hours : 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Apply various techniques in solving differential equation
●	Use the concept of Gradient, divergence and curl of a vector point function and related identities in different areas of engineering.
●	Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
●	Use the concept of Analytic functions, conformal mapping and complex integration for solving problems.
●	Use Laplace transform and inverse transform techniques to solve differential equations



<b>Text Books:</b>	
1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

<b>Reference Books / Web links:</b>	
1	Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7th Edition, 2009.
2	Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3	O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4	Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4 th Edition, New Delhi, 2014.
5	Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
6	T Veerarajan, "Engineering Mathematics I & II", McGraw-Hill Education, 3 <sup>rd</sup> Edition, 2012.

PO/PS O CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PS O4
CO 1	3	2	1	-	-	-	-	-	-	-	1	-	1	-	-	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-
CO 5	2	2	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Average	2.2	2	1	-	-	-	-	-	-	-	1	1	1	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
PH 17253	<b>PHYSICS OF MATERIALS</b> (Common to all branches of B.E/B.Tech. programmes)	BS	3	0	0	3

<b>Objectives:</b>	
●	To introduce and study the synthesis and characterisation of materials
●	To study the properties of conducting materials, superconductors, insulators, magnetic materials, ceramics and new materials

<b>UNIT-I</b>	<b>PREPARATION AND PROCESSING OF MATERIALS</b>	<b>9</b>
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Phases - phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions – diffusion Fick’s law- nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD method – Sol-gel method- heat treatment and hardening process.			
UNIT-II	PROPERTIES OF CONDUCTING MATERIALS AND SUPER CONDUCTING MATERIALS		9
Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law – electrons in metals: particle in a three-dimensional box – density of energy states – effect of temperature on Fermi energy- carrier concentration in metal. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High Tc superconductors – Magnetic levitation and SQUIDS.			
UNIT-III	ELECTRONIC MATERIALS		9
Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) –Concept of effective mass of electron and hole- carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration –Compound semiconductors- Hall effect – determination of Hall coefficient – LED - Solar cells.			
UNIT-IV	INSULATING AND MAGNETIC MATERIALS		9
Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant magnetoresistance materials.			
UNIT-V	CERAMIC AND NEW MATERIALS		9
Ceramics: types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals-Metallic glasses – Shape memory alloys: Copper, Nickel and Titanium based alloys – Relaxor-Ferroelctric materials- Electro and Magneto rheological fluids- Sensors and Actuators- polymer semiconductor- photo conducting polymers- Bio-sensors- Bio materials- hydroxylapatite- PMAA- Silicone.			
Total Contact Hours			: 45

**Course Outcomes:**

On completion of course students will be able to

- Prepare and characterize the structure of various crystals
- Analyse conducting properties of metals and superconductors
- Analyse physical properties of semiconductors in electronic devices
- Analyse the properties of insulating and magnetic materials
- Analyze the usage of new engineering materials

<b>Text Books:</b>	
1	Raghavan, V. “Materials Science and Engineering: A First course”. PHI Learning, 2015.
2	Palanisamy., P.K., “Materials Science”, Scitech., 2003

<b>Reference Books / Web links:</b>	
1	Kumar.J., MoorthyBabu.S and Vasudevan.S., “Engineering Physics”, Vijay Nicole Imprints, 2006.
2	Calister, W.D., “Materials Science and Engineering an Introduction”, John Wiley, 2003.
3	Raghavan,V., “Physical Metallurgy”, Prentice Hall of India, 2002.
4	S.O.Pillai, “Solid state physics”, New Age International, 2015.
5	Charles Kittel, “Introduction to Solid state Physics”, 8 <sup>th</sup> Edition, Willey India Pvt. Ltd., 2005.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	2	-	-	1	1	-	-	-	-	-	-	1	-	-
AVG	2.4	1.6	1.4	-	-	1	1	-	-	-	-	-	-	1	-	-

Subject Code	Subject Name	Category	L	T	P	C
EE 17252	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING	ES	3	0	0	3

<b>Objectives:</b>	
<b>To impart knowledge on</b>	
●	DC Circuits
●	AC circuits
●	Principle of operations of various electrical machines
●	Working principle of different types of electronic devices
●	Basic principle of operations of measuring instruments

UNIT-I	DC Circuits	9
Basic circuit components -Ohms Law -Kirchhoff's Law- Instantaneous power -Inductors –Capacitors- Independent and Dependent sources- steady state solution of DC circuits- Nodal analysis, Mesh analysis- Thevinin's theorem- Norton's theorem, Maximum power transfer theorem- Linearity and superposition theorem.		
UNIT-II	AC Circuits	9
Introduction to AC circuits- waveforms and RMS value- power and power factor- single phase and three phase balanced circuits- three phase loads- housing wiring, industrial wiring- materials of wiring.		

<b>UNIT-III</b>	<b>Electrical MACHINES</b>	<b>9</b>
Construction, Principles of operation and characteristics of; DC machines, Transformers (single and three phase), Synchronous machines, three phase and single phase induction motors.		
<b>UNIT-IV</b>	<b>ELECTRONIC DEVICES &amp; CIRCUITS</b>	<b>9</b>
Types of Materials – Silicon & Germanium- N type and P type materials – PN Junction –Forward and Reverse Bias –Semiconductor Diodes –Bipolar Junction Transistor – Characteristics –Field Effect Transistors – Transistor Biasing –Introduction to operational Amplifier –Inverting Amplifier –Non Inverting Amplifier- DAC-ADC		
<b>UNIT-V</b>	<b>MEASUREMENTS &amp; INSTRUMENTATION</b>	<b>9</b>
Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Thermoelectric, piezoelectric, photoelectric, Hall effect - Classification of instruments- Types of indicating instruments- multimeters- oscilloscopes- three phase power measurements- instrument transformers (CT and PT)		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Understand the DC circuits
- Analyse the AC circuits
- Understand the working principle of electrical machines
- Comprehend the concepts of various electronic devices
- Choose appropriate instruments for electrical measurement for a specific application

**Text Book (s):**

<b>1</b>	Leonard S Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2013
<b>2</b>	D P Kothari and I.J Nagarath, “Basic Electrical and Electronics Engineering”, McGraw Hill Education(India) Private Limited, Third Reprint ,2016
<b>3</b>	Thereja .B.L., “Fundamentals of Electrical Engineering and Electronics”, S. Chand & Co. Ltd., 2008

**Reference Books(s) / Web links:**

<b>1</b>	Del Toro, “Electrical Engineering Fundamentals”, Pearson Education, New Delhi, 2007
<b>2</b>	John Bird, “Electrical Circuit Theory and Technology”, Elsevier, First Indian Edition, 2006
<b>3</b>	Allan S Moris, “Measurement and Instrumentation Principles”, Elseveir, First Indian Edition, 2006
<b>4</b>	Rajendra Prasad, “Fundamentals of Electrical Engineering”, Prentice Hall of India, 2006
<b>5</b>	A.E.Fitzgerald, David E Higginbotham and Arvin Gabel, “Basic Electrical Engineering”, McGraw Hill Education(India) Private Limited, 2009
<b>6</b>	N K De, Dipu Sarkar, “Basic Electrical Engineering”, Universities Press (India) Private Limited 2016.

Subject Code	Subject Name	Category	L	T	P	C
FT 17201	MICROBIOLOGY	BS	3	0	0	3

PO\PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	3	3	1	1	-	-	-	-	2	2	-	1	-
CO 2	3	3	2	3	3	1	1	-	-	-	-	-	2	1	1	-
CO 3	3	3	2	3	3	2	2	-	1	-	-	2	2	1	1	-
CO 4	3	3	2	3	3	2	2	-	-	-	2	2	2	2	-	-
CO 5	3	3	2	3	3	1	2	1	1	1	2	2	2	2	-	-
Average	3	3	2	3	3	1.4	1.6	1	1	1	2	2	2	1.5	1	-

**Objectives:**

- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes. ●
- To provide the students the fundamentals of microbiology, the scope of microbiology and solve the problems in microbial infection and their control.

<b>UNIT-I</b>	<b>INTRODUCTION TO MICROBIOLOGY</b>	<b>9</b>
History (Scientists and discoveries) and scope of microbiology (Primary and secondary metabolites), classification and nomenclature of microorganisms, microscopic examination of microorganisms: light, fluorescent, dark field, phase contrast and electron microscopy. Stains and staining techniques- Definition of auxochrome, chromophores, dyes, classification of stains, Theories of staining: Mechanism of gram staining, acid fast, negative staining, capsular staining, flagella staining, endospore staining.		
<b>UNIT-II</b>	<b>MICROBES- STRUCTURE AND MULTIPLICATION</b>	<b>9</b>
Structural organization and multiplication of bacteria, viruses (TMV, Hepatitis B), algae (cyanophyta, rhodophyta) and fungi (Neurospora), life history of actinomycetes (Streptomyces), yeast (Saccharomyces), mycoplasma (M. pneumoniae) and bacteriophages (T4 phage, Phage).		
<b>UNIT-III</b>	<b>MICROBIAL NUTRITION, GROWTH AND METABOLISM</b>	<b>9</b>
Nutritional classification of bacteria based on carbon, energy, and electron sources. Definition of growth, balanced and unbalanced growth, growth curve and different methods to quantify bacterial growth (counting chamber, viable count method, counting without equipment), different media used for bacterial culture (defined, complex, selective, differential, enriched), Mathematics of growth- Generation time, specific growth rate.		
<b>UNIT-IV</b>	<b>CONTROL OF MICROORGANISMS</b>	<b>9</b>

Physical and chemical control of microorganisms; Definition of sterilization, dry and moist heat, pasteurization, tyndallisation; radiation, ultra-sonication, filtration. Disinfection, sanitization, antiseptics, sterilants, fumigation. Determination of phenol coefficient of disinfectant, host-microbe interactions; anti-bacterial, antifungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.				
UNIT-V	INDUSTRIAL MICROBIOLOGY AND MICROBIAL ECOLOGY			9
Microbes involved in preservation (Lactobacillus, bacteriocins), spoilage of food and food borne pathogens (E. coli, S. aureus, Bacillus, Clostridium), Industrial use of microbes (production of penicillin, pollution control); bio fertilizers, bio pesticides, biosensors.				
			Total Contact Hours	: 45

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Apply depth knowledge in different areas of microbial research
●	Transfer their knowledge in developing techniques – Bacteria culture methods
●	Apply the concepts of nutritional requirements and its metabolic pathways
●	Working principles of different microscopes
●	Industrial applications and also in extraction and remediation purpose.

<b>Text Books:</b>	
1	Stanier R.Y., Ingrahm J.I., Wheelis M.L., and Painter P.R., “General Microbiology”, 5 <sup>th</sup> edition, McMillan Press 1986.
2	Ananthanarayanan R., and C.K. Jayaram Paniker., “Textbook of Microbiology”, 4 <sup>th</sup> edition, Orient Longman, 1990.
3	Schlegel, H.G., “General Microbiology”, 7 <sup>th</sup> edition, Cambridge University Press, 1993.

<b>Reference Books / Web links:</b>	
1	Pelczar MJ, Chan ECS and Krein NR, “Microbiology”, Tata McGraw Hill Edition, New Delhi, India.
2	Prescott L.M., Harley J.P., Klein DA, “Microbiology”, 3rd Edition, Wm. C. Brown Publishers, 1996.
3	Talaron K, Talaron A, Casita, Pelczar and Reid, “Foundations in Microbiology”, W.C. Brown Publishers, 1993.

PO/PSO CO	P O 1	P O 2	PO 3	P O 4	P O 5	P O 6	PO 7	PO 8	P O 9	PO 10	PO 11	PO1 2	PSO 1	PS O 2	PS O 3	PS O 4
CO 1	3	3	2	3	3	-	-	-	-	-	-	2	2	2	2	-
CO 2	3	3	2	3	3	-	-	-	-	-	-	2	2	2	2	-
CO 3	3	3	2	3	3	-	-	-	1	-	-	2	2	2	2	-

CO 4	3	3	2	3	3	-	-	-	-	-	2	2	2	2	2	-
CO 5	3	3	2	3	3	-	-	1	1	1	2	2	2	2	2	-
Average	3	3	2	3	3	0	0	1	1	1	2	2	2	2	2	-

Subject Code	Subject Name										Category	L	T	P	C
FT 17202	FOOD CHEMISTRY										PC	3	0	0	3

**Objectives:**

- The course aims to develop the knowledge of students in the basic area of Food Chemistry.
- This is necessary for effective understanding of food processing and technology subjects.
- This course will enable students to appreciate the similarities and complexities of the chemical components in foods.

<b>UNIT-I</b>	<b>CARBOHYDRATES</b>	<b>9</b>
Simple Sugars: mono and disaccharides, Hygroscopicity & solubility, optical rotation, mutarotation; sensory properties- Sweetness index, caramelization, Maillard reaction; Glucose syrup, high fructose syrup, Dextrose equivalent, Degree of polymerization; Sugar alcohols; Oligosaccharides: structure, nomenclature, occurrence, uses in foods. Polysaccharides: Starch- amylose and amylopectin- properties, thickening & gelatinization, modified starches, resistant starch, Dextrins and dextrans, Starch hydrolysates – Maltodextrins and dextrins; Pectin's: Gums & seaweeds- gel formation & viscosity. Fiber- Cellulose & hemicellulose; Food sources, functional role and uses in food.		
<b>UNIT-II</b>	<b>PROTEINS</b>	<b>9</b>
Review of protein structure & conformation; Properties & reactions of proteins in food systems: Dissociation, Optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Food enzymes; Texturized proteins; Functional role and uses in foods.		
<b>UNIT-III</b>	<b>LIPIDS</b>	<b>9</b>
Review of structure, composition and nomenclature of fats. Non-glyceride components in fats & oils; Properties of fats & oils: crystal formation, polymorphism, melting points, plasticity, isomerization, unsaturation; Modification of fats: hydrogenation- cis and trans isomers, inter-esterification, acetylation, winterization; Hydrolytic rancidity & oxidative rancidity; radiolysis, Shortening power of fats, tenderization, emulsification, frying - smoke point, auto oxidation, polymerization, fat replacements; Food sources, functional role and uses in foods.		
<b>UNIT-IV</b>	<b>WATER</b>	<b>9</b>
<b>A. WATER</b> Chemistry, Physical properties, free, bound & entrapped water, water activity. Drinking water, mineral water, water hardness, water quality for food processing.		
<b>B. MINERALS &amp; VITAMINS</b> Mineral & vitamin content of foods- stability & degradation during food processing.		

**C. COLOUR, FLAVOR & AROMA COMPONENTS**

Naturally occurring colours, acids, other flavour & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; synthetic colours and Naturally similar/artificial flavors, Threshold values, off flavors & food taints.

**D. OTHER COMPONENTS**

Naturally occurring toxic substances, protease inhibitors, bioactive components: phytates, polyphenols, saponins, phytoestrogens etc.

<b>UNIT-V</b>	<b>FOOD GROUPS &amp; COMPOSITION</b>	<b>9</b>
Food groups, proximate composition, food composition tables- uses, food composition data bases.		
<b>Total Contact Hours</b>		<b>45</b>

**Course Outcomes:**

On completion of course students will be able to

●	Understand and identify various food groups, nutrient components (macro and micro), proximate composition.
●	Understand and identify non-nutritive components in food, 36 naturally present.
●	Understand and use effectively, food composition tables and databases.
●	Grasp the functional role of food components and their interaction in food products in terms of colour, flavour, texture and nutrient composition.

**Text Books:**

1	Chopra, H.K. and P.S. Panesar. "Food Chemistry". Alpha Science International Limited, 2010
2	John M. deMan. "Principles of Food Chemistry". 3rd Edition, Springer, 1999.
3	Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 4th Edition, Kluwer-Academic, Springer, 2014.

**Reference Books / Web links:**

1	Gopalan C., B.V. Rama Sastri and S.C.Balasubramanian, "Nutritive value of Indian foods", NIN, ICMR-2004.
2	Damodaran, S., K.L. Parkin and O.R.Fennema., "Fennema's Food Chemistry", 4 <sup>th</sup> edition, CRC Press, 2008.
3	Belitz H.-D, Grosch W and Schieberle P., "Food Chemistry", 4th Revised Edition, Springer-Verlag, 2009.
4	Walstra, P., "Physical chemistry of Foods", Marcel Dekker Inc., 2003.
5	Owusu-Apenten, Richard, "Introduction to Food Chemistry" CRC Press, 2005.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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CO 1	3	-	2	2	3	1	1	1	2	2	3	3	2	2	2	2
CO 2	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2
CO 3	3	3	3	3	2	3	1	3	2	2	3	3	3	3	2	2
CO 4	3	3	3	2	3	2	2	1	1	2	3	3	3	3	2	2
CO 5	2	1	1	1	1	3	3	3	3	1	2	3	1	3	3	1
AVG	2.8	2.3	2.2	2.2	2.2	2.2	1.8	2	2.2	2	2.8	3	2.2	2.8	2.4	1.8

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT 17261	ENGINEERING PRACTICES LABORATORY	ES	0	0	4	2

**Objectives:**

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

**GROUP A (CIVIL & MECHANICAL)****I. List of Experiments (CIVIL ENGINEERING PRACTICE)****Buildings:**

- a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

**Plumbing Works:**

- a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
- b) Study of pipe connections requirements for pumps and turbines.
- c) Preparation of plumbing line sketches for water supply and sewage works.
- d) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
- e) Demonstration of plumbing requirements of high-rise buildings.

**Carpentry using Power Tools only:**

- a) Study of the joints in roofs, doors, windows and furniture.
- b) Hands-on-exercise: Wood work, joints by sawing, planning and cutting.

**II. List of Experiments (MECHANICAL ENGINEERING PRACTICE)****WELDING:**

- a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
- b) Gas welding practice

**Basic Machining:**

a)	Simple Turning and Taper turning
b)	Drilling Practice
<b>Sheet Metal Work:</b>	
a)	Forming & Bending:
b)	Model making – Trays and funnels.
c)	Different type of joints.
<b>Machine assembly practice:</b>	
a)	Study of centrifugal pump
b)	Study of air conditioner
<b>Demonstration on:</b>	
a)	Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
b)	Foundry operations like mould preparation for gear and step cone pulley
c)	Fitting – Exercises – Preparation of square fitting and V – fitting models

### GROUP B (ELECTRICAL & ELECTRONICS)

<b>III. List of Experiments (ELECTRICAL ENGINEERING PRACTICE) 15</b>	
1.	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2.	Fluorescent lamp wiring.
3.	Stair case wiring
4.	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5.	Measurement of energy using single phase energy meter.
6.	Measurement of resistance to earth of an electrical equipment.

<b>III. List of Experiments (ELECTRONICS ENGINEERING PRACTICE) 15</b>	
1.	Study of Electronic components and equipment's – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2.	Study of logic gates AND, OR, EX-OR and NOT
3.	Generation of Clock Signal.
4.	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5.	Measurement of ripple factor of HWR and FWR.

**Total Hours: 60 Periods**

<b>Course Outcomes:</b>	
<b>The students will be able to</b>	
●	Fabricate carpentry components
●	Fit pipe connections including plumbing works.
●	Use welding equipment's to join the structures.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT 17211	FOOD CHEMISTRY LABORATORY	PC	0	0	4	2

<ul style="list-style-type: none"> <li>• To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (Proteins, carbohydrates, lipids, metabolites, etc.,) and laboratory analysis of the same.</li> </ul>	
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List of Experiments			
1	Preparation and measurement of pH standard buffers (phosphate, carbonate, borate, TRIS etc.)		
2	Qualitative analysis of carbohydrates		
3	Quantitative analysis of carbohydrates (Benedict, DNS method)		
4	Enzymatic hydrolysis of glycogen by $\alpha$ and $\beta$ amylase		
5	Quantitative analysis of proteins (Lowry, Bradford, UV method)		
6	Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids, etc)		
7	Estimation of viscosity & refractive index of foods		
8	Specific gravity and Oxidative rancidity of fats and oils		
9	Enzymatic Browning in foods		
10	Iso-electric precipitation of casein, Effect of rennin on milk proteins		
11	Gelling properties of starch		
12	Acid hydrolysis and action of salivary amylase on starch		
13	Enzymatic hydrolysis of sucrose and measurement of optical rotation		
			<b>Total Contact Hours : 60</b>

<ul style="list-style-type: none"> <li>• Better understanding the physical and chemical properties of food. Familiarize in precipitation of casein and gelation of starch.</li> </ul>	
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References:	
1.	Plummer, D.T., “Introduction of Practical Biochemistry”, 3 <sup>rd</sup> Edition, Tata McGraw Hill, 1987
2.	Wilson, Keith and John Walker, “Principles and Techniques of Biochemistry and Molecular Biology”, 6 <sup>th</sup> edition, Cambridge University Press, 2006
3.	Segel, Irwin H., “Biochemical Calculations: How to solve mathematical problem in general biochemistry”, 2 <sup>nd</sup> edition, John Wiley, 2006
4.	Weaver, C.M., and J.R.Daniel “The Food Chemistry Laboratory-A manual for experimental foods, Dietetics & Food Scientists” 2 <sup>nd</sup> edition, CRC Press, 2005.

### LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	Name of the equipment	Quantity
1.	Viscometer	2
2.	Vortex mixer	5
3.	Pycnometer	5
4.	Texture Analyser	1
5.	Refractometer	2
6.	Soxhlet apparatus	3
7.	Muffle Furnace	1
8.	Polarimeter	1
9.	pH meter	3
10.	Heating mantle	5
11.	Weighing balance	2
12.	Thermometer	5
13.	Water bath	4
14.	Colorimeter	5
15.	Hot air oven	1
16.	Analytical Balance	1
17.	Moisture Balance	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	1	2	3	3	-	-	1	3	2	2	3	3	3	3	1
CO 2	3	2	3	3	3	-	-	2	3	2	2	3	3	2	2	2
CO 3	3	2	3	3	2	-	-	2	2	3	1	2	1	2	1	1
CO 4	2	2	3	3	2	-	-	2	2	1	2	2	3	2	1	2
CO 5	2	2	2	3	2	-	-	1	2	1	1	1	2	2	2	1
AVG	2.6	1.8	2.6	3	2.4	-	-	1.6	2.4	1.8	1.6	2.2	2.4	2.2	1.8	1.4

<b>Subject</b>	<b>Subject Name</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>Code</b>						
<b>MA 17351</b>	<b>TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS</b>	<b>BS</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**Objectives:**

•	To introduce the basic concepts of PDE for solving standard partial differential equations.
•	To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
•	To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
•	To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

<b>UNIT-I</b>	<b>PARTIAL DIFFERENTIAL EQUATIONS</b>	<b>12</b>
Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.		
<b>UNIT-II</b>	<b>FOURIER SERIES</b>	<b>12</b>
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.		
<b>UNIT-III</b>	<b>APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS</b>	<b>12</b>
Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.		
<b>UNIT-IV</b>	<b>FOURIER TRANSFORMS</b>	<b>12</b>
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity		
<b>UNIT-V</b>	<b>Z - TRANSFORMS AND DIFFERENCE EQUATIONS</b>	<b>12</b>
Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.		
<b>Total Contact Hours</b>		<b>: 60</b>

**Course Outcomes:**

On completion of course students will be able to

•	Understand how to solve the given standard partial differential equations.
•	Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

●	Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
●	Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
●	Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

**Text Books:**

1	Grewal B.S., "Higher Engineering Mathematics", 43 <sup>rd</sup> Edition, Khanna Publishers, New Delhi, 2014.
2	Narayanan S., Manicavachagom Pillay.T. K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

**Reference Books / Web links:**

1	Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9 <sup>th</sup> Edition, Laxmi Publications Pvt. Ltd, 2014.
3	Erwin Kreyszig, "Advanced Engineering Mathematics ", 10 <sup>th</sup> Edition, John Wiley, India, 2016.
4	James, G., "Advanced Modern Engineering Mathematics", 3 <sup>rd</sup> Edition, Pearson Education, 2007.
5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6	Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics", Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4		
CO 1	3	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-		
CO 2	3	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-		
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
AVG	3	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-		
	Subject Code		Subject Name (Theory course)										Category		L	T	P	C
	FT 17301		INTRODUCTION TO FOOD PROCESSING										PC		3	0	0	3

<b>Objectives:</b>	
●	The course aims to introduce the students, the core area/concept of Food Processing.
●	This is necessary for effective understanding of a detailed study of food processing and technology subjects.
●	This course will enable students to appreciate the importance of food processing with respect to the stakeholders in food supply chain.

<b>UNIT-I</b>	<b>PROCESSING OF FOOD AND ITS IMPORTANCE</b>	<b>9</b>
Sources of food - plant, animal and microbial origin; different foods and groups of foods, raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing of foods.		
<b>UNIT-II</b>	<b>METHODS OF FOOD HANDLING AND STORAGE</b>	<b>9</b>
Nature of harvested crop, Basic farm storage and processing equipment's, storage of raw materials and products using low temperature; equipment's in post-harvest handling of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.		
<b>UNIT-III</b>	<b>LARGE-SCALE FOOD PROCESSING</b>	<b>12</b>
Milling of grains and pulses; edible oil extraction; Pasteurisation of milk; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables; animal products; preservation by use of Class I and II Preservatives; Pickling and curing with microorganisms, use of salt, microbial fermentation; Unit operations – evaporation, heat processing, frying, baking, extrusion cooking, snack foods.		
<b>UNIT-IV</b>	<b>FOOD WASTES IN VARIOUS PROCESSES</b>	<b>6</b>
Types of waste in food processing-peel, skin, bones, unprocessed water etc. Waste disposal-solid and liquid waste; solid waste management, utilization of waste water, rodent and insect control; use of pesticides; ETP; selecting and installing necessary treatment systems in food industry.		
<b>UNIT-V</b>	<b>FOOD HYGIENE</b>	<b>9</b>
Food related hazards –physical, chemical & biological hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage, handling and preparation; Relationship of microbes, SPS measures, PRP programme, Public health hazards due to contaminated water and food; Personnel hygiene; GHP, Training& Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course, students will be able to	
●	Be aware of the different methods applied to processing foods.
●	Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

<b>Text Book (s):</b>	
1	Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.
2	VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”., Surbhi Publications, 2001.
3	Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.
4	Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	3	2	3	3	3	3	3	3	2	3	2	2	1	3
CO 2	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO 3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO 4	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO 5	3	3	2	2	3	2	1	3	3	2	3	2	2	2	1	2
AVG	3	3	2.8	2	3	2.2	2.6	3	3	2.8	2.8	2.8	2.6	2.6	1	2.8

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17302	FOOD PROCESS CALCULATIONS	PC	3	1	0	4

<b>Objectives:</b>	
●	Units and Dimensions; Basic and derived units, use of model units in food calculations, Methods of expression, compositions of mixture and solutions. Ideal and real gas laws – Gas constant - calculations of pressure, volume and temperature using ideal gas law

UNIT-I	12
Basic Food processing operations; fundamental concept of work heat and energy; energy, work, heat involved in food processing; need for calculation in food processing, fundamental Calculations in food industry. Basic problems in food processing industrial operations.	
UNIT-II	12



Humidity - calculation of absolute humidity, relative humidity- Use of humidity in condensation and drying - Humidity chart, dew point. Energy requirements for food processing operations, problems related to energy requirements.			
<b>UNIT-III</b>			<b>12</b>
Basic Principles of Stoichiometry - Importance of material balance and energy balance in a process Industry-Dimensions, Units, conversion factors and their use –Data sources, Humidity and applications. Material Balance: Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallization, drying, extraction, Leaching.			
<b>UNIT-IV</b>			<b>12</b>
Energy Balance: Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.			
<b>UNIT-V</b>			<b>12</b>
Enthalpy Changes: Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction.			
		<b>Total Contact Hours</b>	<b>: 60</b>
<b>(Use of Psychometric chart is permitted in the examination)</b>			

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Understand the basic units in food processing.
●	Perform basic humidity calculations.
●	Perform material balance for process operations.
●	Make energy balance in food technology.
●	Understand the heat content and enthalpy in food processing.

<b>Text Book (s):</b>	
<b>1</b>	Bhatt, B.L and Vora, S.M., "Stoichiometry", Third Edition, McGraw-Hill, New York, 2004.
<b>2</b>	Gavhane, K.A "Introduction to Process Calculations" (Stoichiometry) NiraliPrakashan Publications, Pune, 2009.

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Venkataramani, V. and Anantharaman, N., "Process Calculations", Prentice Hall of India, New Delhi, 2011.
<b>2</b>	Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Eighth Edition, Prentice Hall India, New Delhi, 2015.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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CO1	3	3	1	2	0	0	0	3	3	1	3	3	3	3	1	1
CO2	3	3	1	1	2	0	0	2	1	2	3	3	3	3	0	1
CO3	3	2	3	3	0	0	0	3	1	1	2	1	3	2	0	1
CO4	2	3	3	3	0	0	0	3	1	1	3	2	3	3	1	0
CO5	2	3	3	3	0	0	0	3	1	1	3	3	2	2	1	0
Average	2.6	2.8	2.2	2.4	2	0	0	2.8	1.4	1.2	2.8	2.4	2.8	2.6	1	1.5

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17303	FOOD MICROBIOLOGY	PC	3	0	0	3

**Objectives:**

- The course aims to develop the knowledge of students in the basic area of Food Microbiology.
- This is necessary for effective understanding of food processing and technology subjects as well as food safety.
- This course will enable students to appreciate the role of microbes in food spoilage, preservation of foods and food borne infections.

<b>UNIT-I</b>	<b>ROLE OF MICROBES IN SPOILAGE OF FOODS</b>	<b>9</b>
Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Gram positive and gram negative bacteria, Morphological characteristics of microbes, Microbiological spoilage problems associated with typical food products.		
<b>UNIT-II</b>	<b>CONTROL OF MICROBES IN FOODS</b>	<b>9</b>
Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbates / propionates naturally occurring antimicrobials, mechanism of inhibition; growth and inactivation kinetics; Thermal death curve – D value value,Z value;physical methods- low and high temperatures, drying, radiation and high pressure; tolerance of microbes to chemical and physical methods in various foods.		
<b>UNIT-III</b>	<b>MICROBES IN FOOD FERMENTATIONS</b>	<b>9</b>
Microbes in food industry; microbes of importance in food fermentations, – homo & hetero-fermentative bacteria, yeasts & fungi; biochemistry of fermentations – pathways involved, lactic acid bacteria fermentation and starter cultures, alcoholic fermentations -yeast fermentations - characteristics and strain selection, fungal fermentations. microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.		
<b>UNIT-IV</b>	<b>MICROBIAL AGENTS OF FOOD BORNE ILLNESS</b>	<b>9</b>

Food borne infections and food poisoning, microbial toxins, Gram Negative and Gram positive food borne pathogens; toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.		
<b>UNIT-V</b>	<b>MICROBIAL EXAMINATION OF FOODS</b>	<b>9</b>
Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria; Rapid and automated microbial methods - development and impact on the detection of food borne pathogens; Applications of immunological, techniques to food industry; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. botulinum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course, students will be able to	
●	Be able to understand and identify the various microbes associated with foods and food groups.
●	Be able to understand and identify the role of these microbes in food spoilage, food preservation.
●	Understand the role of pathogens in food borne infections. • Understand the methods used to detect pathogens in foods.

<b>Text Book (s):</b>	
<b>1</b>	Banwart, G.J. "Basic Food Microbiology" 2 <sup>nd</sup> Edition. CBS Publishers, 1998.
<b>2</b>	Vijaya Ramesh. "Food Microbiology". MJP Publishers, Chennai, 2007.
<b>3</b>	Jay, J.M. "Modern Food Microbiology". 4 <sup>th</sup> Edition. CBS Publishers, 2003.
<b>4</b>	Adams, M.R. and M.O. Moss. "Food Microbiology". New Age International, 2002
<b>5</b>	Khetarpaul, Neelam. "Food Microbiology" Daya Publishing House, 2006.

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Montville, Thomas J. and Karl R. Matthews "Food Microbiology: An Introduction". ASM Press, 2005
<b>2</b>	Ray, Bibek and ArunBhunia. "Fundamental Food Microbiology" 4 <sup>th</sup> Edition, CRC Press, 2008
<b>3</b>	Pawsey, R. K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.
<b>4</b>	Forsythe, S.J. "The Microbiology of Safe Food". Blackwell Science, 2000.
<b>5</b>	Doyle, Michael P. "Food Microbiology: Fundamentals and Frontiers". 2 <sup>nd</sup> Edition, ASM Press, 2001.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	3	2	2	-	-	-	2	1	1	2	2	2	3
CO2	1	2	2	2	3	3	-	-	-	2	1	2	2	3	2	3
CO3	2	2	2	2	3	3	-	-	-	2	1	3	3	1	3	3
CO4	2	3	3	2	3	2	-	-	-	2	2	2	1	3	1	3
CO5	3	3	3	2	3	2	-	-	-	3	2	3	2	2	2	3
Average	2	2.2	2.2	2.2	2.8	2.4	0	0	0	2.2	1.4	2.2	2	2.2	2	3

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17304	FLUID MECHANICS	PC	3	1	0	4

**Objectives:**

- To introduce the students to the mechanics of fluids through a thorough understanding of the properties of the fluids, behaviour of fluids under static conditions. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy.
- To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on vanes.

<b>UNIT-I</b>	<b>PROPERTIES OF FLUIDS</b>	<b>12</b>
Properties of fluids – definition –concept of continuum, pressure; units of measurement - Mass density – specific weight, specific volume – specific gravity equation of state – perfect gas - Viscosity – vapour pressure – compressibility and elasticity surface tension – capillarity. Fluid pressure and measurement – simple, differential and micro manometers - Mechanical gages – calibration. Hydrostatic forces on surfaces – total pressure and centre of pressure - Horizontal-vertical and inclined plane surface - Pressure diagram – total pressure on curved surface. Archimedes principles – buoyancy – meta centre – metacentric height		
<b>UNIT-II</b>	<b>FLUID FLOW ANALYSIS</b>	<b>12</b>
Fluid Statistics-Types of fluid flow – velocity and acceleration of a fluid particle - Rotational – irrotational – circulation and vorticity - Flow pattern – stream line – equipotential line – stream tube – path line– streak line – flow net – velocity potential – stream function. Principles of conservation of mass– energy – momentum – continuity equation in Cartesian co-ordinates -Euler's equation of motion.		
<b>UNIT-III</b>	<b>FLOW MEASUREMENTS</b>	<b>12</b>
Bernoulli's equation – applications - Venturimeter – orifice meter – nozzle meter rota meter – elbow meter pitot tube – Orifice – sharp edged orifice discharging free – submerged orifice – mouth piece - Flow through orifice under variable head – time of emptying a tank with and without inflow. Flow through pipes – laminar and turbulent flow in pipes - Reynold's experiment - Darcy –		

Weisbach equation for friction head loss – Chezy's formula – Manning's formula – Hazen-William's formula - Major and minor losses in pipes – hydraulic gradient line – energy gradient line. Siphon – water hammer in pipes – gradual and sudden closure of valves.		
<b>UNIT-IV</b>	<b>OPEN CHANNEL FLOW</b>	<b>9</b>
Types of flow in channel – uniform flow – most economical section of channel – rectangular – trapezoidal. Specific energy and critical depth - momentum in open channel flow – specific force - critical flow – computation. Flow measurement in channels – notches – rectangular, Cippollette and triangular – float method - Flow measurement in rivers/ streams/ canals – weirs – free and submerged flow – current meter – Parshall flume.		
<b>UNIT-V</b>	<b>DIMENSIONAL ANALYSIS &amp; PUMPS</b>	<b>12</b>
Dimensional analysis – concept of geometric, kinematic and dynamic similarity. Important nondimensional numbers – Reynolds, Froude, Euler, Mach and Weber. Pump terminology – suction lift, suction head, delivery head, discharge, water horse power – selection of pump capacity. Centrifugal pumps – components – working – types of pumps and impellers - Priming		
<b>Total Contact Hours</b>		<b>: 60</b>

<b>Course Outcomes:</b>	
On completion of course, students will be able to:	
●	Get a basic knowledge of fluids in static, kinematic and dynamic equilibrium.
●	Gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.

<b>Text Book (s):</b>	
<b>1</b>	Modi, P.N. and Seth S.M. “Hydraulics and fluid mechanics”. Standard Publishers Distributors, New Delhi, 2010
<b>2</b>	Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. (9 <sup>th</sup> ed) Tata McGraw Hill, New Delhi, 1998

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Bansal, R.K., “A text book of fluid mechanics and hydraulic machinery”, Laxmi publications (P) Ltd., New Delhi, 2002
<b>2</b>	Grade, R.J., “Fluid mechanics through problems”. Wiley eastern Ltd., Madras, 2002
<b>3</b>	Jain A. K. “Fluid Mechanics”. Khanna Publishers 1995.
<b>4</b>	Jagdish Lal, “Hydraulic machines”. Metropolitan book house, New Delhi, 2000
<b>5</b>	Michael, A.M., “Irrigation Theory and practice”, Vikas publishing house, New Delhi, 2008

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	1	1	1	0	0	0	0	1	3	2	0	0

CO2	3	3	2	2	1	1	1	0	0	0	1	1	3	3	0	0
CO3	2	3	3	2	2	1	1	0	0	0	1	1	3	2	0	0
CO4	3	2	3	3	1	0	0	0	0	0	1	1	3	2	0	0
CO5	3	2	3	2	1	1	1	0	0	0	0	1	2	3	1	1
Average	2.8	2.4	2.8	2.2	1.2	1	1	0	0	0	1	1	2.8	2.4	1	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17305	HUMAN NUTRITION AND DIETICS	PC	3	0	0	3

**Objectives:**

- The course aims to develop the knowledge of students in the basic area of Food Chemistry, nutrition and dietetics.
- This is necessary for effective understanding of food processing and technology subjects.
- This course will enable students to appreciate the similarities and complexities of the chemical components in foods.

<b>UNIT-I</b>	<b>AN OVERVIEW OF NUTRITION</b>	<b>9</b>
Definition, six classes of nutrients, calculating energy values from food, using the RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, dietary recommendations, Balanced diet planning: Diet planning principles, dietary guidelines; food groups, exchange lists, personal diet analysis; Digestion, Absorption and Transport: Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption of nutrients.		
<b>UNIT-II</b>	<b>ENERGY &amp; CARBOHYDRATES</b>	<b>9</b>
Energy balance, Assessment of Energy requirements-Food quality characteristics, carbohydrates-definition, classification and functions: mono and disaccharides, Caramelization; Oligosaccharides, uses in foods. Polysaccharides: Starch- Structure, Properties, Functional role in food system, Modified starches, Resistant starch, Starch hydrolysates, Applications in food industry. Pectin's, Gums & Hydrocolloid, Fiber - Cellulose & hemicellulose; Digestion and absorption of carbohydrates, lactose intolerance; Glycemic and Non-glycemic carbohydrates, blood glucose regulation, recommendations of sugar intake for health, health effects of fibre and starch intake, Artificial sweeteners; Importance of blood sugar regulation, Dietary recommendations for NIDDM and IDDM.		
<b>UNIT-III</b>	<b>PROTEINS &amp; LIPIDS</b>	<b>9</b>
Protein - Definition, classification and functions; Assessment of protein quality (BV, PER, NPU); Properties & reactions of proteins in food systems-hydration, foam formation, emulsification, thickening: factors affecting protein bioavailability including ant nutritional factors; Maillard reaction; Food enzymes; Texturized proteins;		

Lipids – definition, classification and functions; digestion and absorption, intestinal resynthesis of triglycerides. Types of fatty acids, role and nutritional significance (SFA, MUFA, PUFA, Omega 3)		
<b>UNIT-IV</b>	<b>WATER, MINERALS, VITAMINS AND MICRONUTRIENTS</b>	<b>9</b>
Water - Chemistry, physical properties, free, bound & entrapped water, water activity. Drinking water, mineral water, water hardness, water quality for food processing. Minerals & vitamins- physiological role, bioavailability and Requirements-Food and Pharmaceutical grades; Recommended daily intake, toxicities, deficiencies, factors affecting bioavailability, Stability under food processing conditions.		
<b>UNIT-V</b>	<b>METABOLISM, ENERGY BALANCE AND BODY COMPOSITION</b>	<b>9</b>
Review of catabolic and anabolic pathways of glucose, fats and amino acids; Definition, units, calorific value of foods – bomb calorimeter; energy requirements – basal metabolism, specific dynamic action of foods, direct and indirect calorimetry, physiological energy value of foods; body weight and body composition; obesity, BMR and BMI calculations; Weight Control; hunger, satiety and satiation; dangers of weight loss; how to identify unsafe weight loss schemes; treatment of obesity; attitudes and behaviours toward weight control.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course, students will be able to:	
●	Be able to understand and identify the various food groups; the nutrient components (macro and micro), proximate composition.
●	Be able to understand and identify the non-nutritive components in food, naturally present
●	Understand and use effectively, food composition tables and databases.
●	Grasp the functional role of food components and their interaction in food products in terms of colour, flavour, texture and nutrient composition.

<b>Text Book (s):</b>	
<b>1</b>	Chopra, H.K. and P.S. Panesar. “Food Chemistry”, Narosa, 2010.
<b>2</b>	Meyer, Lillian Hoagland. “Food Chemistry”, CBS Publishers, 1987.
<b>3</b>	Deman, John M. “Principles of Food Chemistry”, 3 <sup>rd</sup> Edition. Springer, 1999.
<b>4</b>	Vaclavik, V. A. and Christian E. W. “Essentials of Food Science”. II Edition, Kluwer-Academic, Springer, 2003.
<b>5</b>	Mann, Jim and Stewart Truswell “Essentials of Human Nutrition”, 3 <sup>rd</sup> Edition. Oxford University Press, 2007.
<b>6</b>	Gibney, Michael J., et al., “Introduction to Human Nutrition”. 2 <sup>nd</sup> Edition. Blackwell, 2009.
<b>7</b>	Gropper, Sareen S. and Jack L. Smith “Advanced Nutrition and Human Metabolism”. 5 <sup>th</sup> Edition. Wadsworth Publishing, 2008.

Reference Books(s) / Web links:	
1	Gopalan C., B.V. Rama Sastri, and S.C. Balasubramanian S. C. “Nutritive Value of Indian Foods”. NIN, ICMR, 2004.
2	Damodaran, S., K.L. Parkin and O.R. Fennema. “Fennema’s Food Chemistry”. 4 <sup>th</sup> Edition, CRC Press, 2008
3	Belitz, H.-D, Grosch W and Schieberle P. “Food Chemistry”, 3 <sup>rd</sup> Rev. Edition, Springer-Verlag, 2004.
4	Walstra, P. “Physical Chemistry of Foods”. Marcel Dekker Inc. 2003.
5	Owusu-Apenten, Richard. “Introduction to Food Chemistry”. CRC Press, 2005.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	0	0	0	2	2	2	0	2	0	1	1	1	0	1
CO2	1	1	0	0	0	3	1	2	0	2	0	1	2	2	0	1
CO3	1	1	0	0	0	2	3	2	0	2	0	1	1	2	0	1
CO4	1	1	0	0	0	2	3	2	0	2	0	1	2	2	0	1
CO5	1	2	2	1	0	2	2	2	0	2	0	2	1	2	2	1
Average	1.2	1.4	2	1	0	2.2	2.2	2	0	2	0	1.2	1.4	1.8	2	1

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT17311	FOOD MICROBIOLOGY LABORATORY	PC	0	0	4	2

Objectives:	
●	Enable students to understand the methods of isolating and characterizing various microbes associated with foods and food groups.
●	Enable students to understand and use various microbiological techniques for the study of foods.
●	Understand the methods used to detect pathogens in foods.

List of Experiments	
1	Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques; Culture Media-Types and Use; Preparation of Nutrient broth and agar, GLP prescribed by FSSAI.
2	Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs.
3	Microscopy – Working and care of Microscope; Microscopic Methods in the Study of Microorganisms; Staining Techniques - Simple, Differential- Gram’s Staining
4	Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in food products TVC



5	Microbiological quality of water (MPN)			
6	Microbiological quality of milk: Enumeration of Lactic acid bacteria from fermented foods			
7	Yeast & Mold Count from fruits			
8	Enumeration of spores from pepper			
9	Inhibitory effect of spices on microbial load in fish & flesh foods			
10	Enumeration & Isolation of E. coli from processed meat/chicken			
11	Thermal destruction of microbes: TDT & TDP			
12	Enumeration & Isolation of Staphylococci from ready to eat street foods			
13	Effect of cleaning and disinfection on microbial load			
		Total Contact Hours	:	60

**Course Outcomes:****The students will be able to**

- Complete understanding of isolation, characterization of various microbes associated with foods and food groups.
- Familiarize with microbiological techniques for the study of foods.
- Better understanding of methods to detect pathogens in foods.

**References:**

1. Harrigan, W.F. "Laboratory Methods in Food Microbiology" Academic Press, 2011

**LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS****Equipment Required**

S.No.	Name of the equipment	Quantity
1.	Autoclave	1
2.	Static Incubator	1
3.	Light Microscope	5
4.	Incubator Shaker	1
5.	Colorimeter	2
6.	Laminar Air Flow Chamber	3
7.	Refrigerator	2
8.	Colony counter	5
9.	Water bath	4
10.	pH Meter	1
11.	Weighing balance	2
12.	Analytical Balance	1
13.	Glassware/ Chemicals / Media as required	

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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<b>Objectives:</b>	
●	To study and understand the physical and chemical properties of foods
●	This course will enable the students to – be familiar with nutrient composition of foods
●	To gain knowledge in quantitative methods in assessing nutritional status of individuals and groups and to expertise in the field of diet planning.

<b>Course Outcomes:</b>
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The students will be able to	
•	Better understanding the physical and chemical properties of food.
•	Familiarize in precipitation of casein and gelation of starch.
•	Understanding the food groups, constituents of food, energy from food
•	Exposing to nutritional assessment, food constituents and their daily dietary allowances

### LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required																
S.No	Name of the equipment										Quantity					
1.	Viscometer										2					
2.	Vortex mixer										5					
3.	Pycnometer										5					
4.	Texture Analyser										1					
5.	Refractometer										2					
6.	Muffle Furnace										1					
7.	Soxhlet's Apparatus										3					
8.	Polarimeter										1					
9.	pH meter										3					
10.	Heating mantle										5					
11.	Weighing balance										2					
12.	Thermometer										5					
13.	Water bath										4					
14.	Colorimeter										5					
15.	Hot air oven										1					
16.	Analytical Balance										1					
17.	Moisture Balance										1					
18.	Stadiometer										2					
19.	Skin fold calliper										5					
20.	Weight machine										2					
PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	0	0	0	1	1	0	2	1	1	2	1	1	1	1
CO2	2	2	0	2	3	1	0	0	2	1	0	1	2	3	0	2
CO3	2	1	0	0	3	1	0	0	2	1	1	2	2	2	1	2
CO4	1	1	0	0	0	0	2	1	2	1	0	3	1	0	1	1
CO5	1	2	2	2	3	1	1	2	2	1	0	1	2	2	1	2
Average	1.6	1.4	2	2	3	1	1.3	1.5	2	1	1	1.8	1.6	2	1	1.6

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
HS 17361	INTERPERSONAL SKILLS/LISTENING AND SPEAKING	EEC	0	0	2	1

<b>Objectives:</b>	
●	Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
●	Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
●	Improve general and academic listening skills
●	Make effective presentations.

<b>UNIT-I</b>		<b>6</b>
Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.		
<b>UNIT-II</b>		<b>6</b>
Listen to a process information- give information, as part of a simple explanation - conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.		
<b>UNIT-III</b>		<b>6</b>
Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept -decline - take leave - listen for and follow the gist- listen for detail		
<b>UNIT-IV</b>		<b>6</b>
Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.		
<b>UNIT-V</b>		<b>6</b>
Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.		
		<b>Total Contact Hours : 30</b>

<b>Course Outcomes:</b>	
<b>At the end of the course Learners will be able to:</b>	
●	Listen and respond appropriately
●	Participate in group discussions
●	Make effective presentations
●	Participate confidently and appropriately in conversations both formal and informal

<b>Text Book (s):</b>	
<b>1</b>	Brooks, Margret., “Skills for Success. Listening and Speaking. Level 4”, Oxford University Press, Oxford: 2011.
<b>2</b>	Richards, C. Jack. & David Bholke. “Speak Now Level 3” Oxford University Press, Oxford: 2010

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Bhatnagar, Nitin and Mamta Bhatnagar., “Communicative English for Engineers and Professionals”. Pearson: New Delhi, 2010.
<b>2</b>	Hughes, Glyn and Josephine Moate. “Practical English Classroom”, Oxford University Press: Oxford, 2014.
<b>3</b>	Vargo, Mari. “Speak Now Level 4”., Oxford University Press: Oxford, 2013.
<b>4</b>	Richards C. Jack., “Person to Person (Starter)”., Oxford University Press: Oxford, 2006.
<b>5</b>	Ladousse, Gillian Porter, “Role Play”, Oxford University Press: Oxford, 2014

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	2	3	1	-	-	-	-	-
CO2	-	-	-	1	-	1	-	-	-	3	1	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-
CO5	-	-	-	-	-	1	-	-	2	3	1	-	-	-	-	-
Average	-	-	-	1	-	1	-	-	1.6	3	1	-	-	-	-	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
MA 17353	PROBABILITY AND STATISTICS	BS	3	1	0	4

<b>Objectives:</b>	
●	This course aims at providing the required skill to apply the statistical tools in engineering problems.
●	To introduce the basic concepts of probability and random variables.
●	To introduce the basic concepts of two dimensional random variables.
●	To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
●	To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

<b>UNIT-I</b>	<b>PROBABILITY AND RANDOM VARIABLES</b>	<b>12</b>
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Probability – The axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.		
<b>UNIT-II</b>	<b>TWO - DIMENSIONAL RANDOM VARIABLES</b>	<b>12</b>
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).		
<b>UNIT-III</b>	<b>TESTING OF HYPOTHESIS</b>	<b>12</b>
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.		
<b>UNIT-IV</b>	<b>DESIGN OF EXPERIMENTS</b>	<b>12</b>
One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.		
<b>UNIT-V</b>	<b>STATISTICAL QUALITY CONTROL</b>	<b>12</b>
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.		
<b>Total Contact Hours</b>		<b>: 60</b>

<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
●	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
●	Apply the concept of testing of hypothesis for small and large samples in real life problems.
●	Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
●	Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

<b>Text Book (s):</b>	
<b>1</b>	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8 <sup>th</sup> Edition, 2015.
<b>2</b>	Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4 <sup>th</sup> Edition, 2007.

Reference Books(s) / Web links:	
1	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8 <sup>th</sup> Edition, 2014.
2	Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4 <sup>th</sup> Edition, New Delhi, 2010.
3	Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3 <sup>rd</sup> Edition, Elsevier, 2004.
4	Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5	Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8 <sup>th</sup> Edition, 2007.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	2	2	-	-	-	-	-	-	-	1	-	1	-	-
CO 4	3	2	2	3	-	-	-	-	-	-	-	1	-	1	-	-
CO 5	3	2	2	2	-	-	-	-	-	-	-	-	-	1	-	-
Average	3	2	2	2	-	-	-	-	-	-	-	1	-	1	-	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT17401	FOOD ANALYSIS	PC	3	0	0	3

Objectives:	
●	To expose the students to the principles, methods and techniques of chemical and instrumental methods of food analysis.

UNIT-I	INTRODUCTION	9
Introduction, food regulations and standards; sampling methods for food articles, and sample preparation for analysis; sub sampling statistical evaluation of analytical data. General methods of		

food analysis-wet chemistry methods-proximate analysis, nutritional data-Moisture determination by different methods; ash analysis-different methods; titrable acidity in foods; determination of crude fiber and dietary fibre.		
<b>UNIT-II</b>	<b>LIPIDS, PROTEINS AND CARBOHYDRATE ANALYSIS</b>	<b>9</b>
Analysis of oils and fats for physical and chemical parameters and quality standards, protein analysis by different techniques; analysis of carbohydrates by different techniques as per FSSAI guidelines.		
<b>UNIT-III</b>	<b>SPECTROSCOPIC TECHNIQUES</b>	<b>9</b>
Basic principles; application of UV-Visible spectrophotometer in the analysis of food additives; IR Spectroscopy in online determination of components of food- FT-IR; Tintometer in colour intensity determination; application of Atomic Absorption Spectrophotometer and ICP-AES in analysis of mineral elements and fluorimeter in vitamin analysis.		
<b>UNIT-IV</b>	<b>CHROMATOGRAPHIC TECHNIQUES</b>	<b>9</b>
Basic principles; application of paper chromatography and TLC in food analysis; detection of adulterants in foods; Column chromatography for purification analysis- Ion exchange and affinity chromatography; HPLC and GC in food analysis; Significance of MS detectors in HPLC and GC; FAME analysis in oils and fats.		
<b>UNIT-V</b>	<b>ELECTROPHORESIS, REFRACTOMETRY AND POLARIMETRY</b>	<b>9</b>
Basic principles; application of the electrophoresis in food analysis; Brix value of fruit juices; total soluble solids in fruit products; Refractive indices of oils and fats; specific rotations of sugars; Estimation of simple sugars and disaccharides by polarimeter.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	To understand the principles behind analytical techniques in food analysis.
●	To know the methods of selecting appropriate techniques in the analysis of food products.
●	Appreciate the role of food analysis in food standards and regulations for the manufacture and the sale of food products and food quality control in food industries.
●	To familiarize with the current state of knowledge in food analysis.

<b>Text Book (s):</b>	
<b>1</b>	Pomeranz, Yeshajahu. "Food Analysis: Theory and Practice". 3rd Edition. Aspen Publishers / Springer, 2000
<b>2</b>	Kirk, R.S. and R. Sawyer "Pearson"s Composition and Analysis of Food". 9th Edition. Longman, New York, 1991
<b>3</b>	Nielsen, S. Suzanne. "Food Analysis". 3rd Edition. Springer, 2003.



Reference Books(s) / Web links:	
1	Otles, Semih. "Methods of Analysis of Food Components and Additives". CRC Press, 2005.
2	Nollet, Leo M.L. "Hand Book of Food Analysis" II Rev. Edition. Vol. I, II & III, Marcel & Dekker, 2004.
3	Nollet, Leo M.L. "Food Analysis by HPLC". II Rev. Edition, Marcel & Dekker, 2000.
4	Otles, Semih. "Handbook of Food Analysis Instruments". CRC Press, 2009

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4
CO1	3	3	3	2	3	3	3	3	3	3	2	3	2	2	1	3
CO2	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO4	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO5	3	3	2	2	3	1	1	3	3	2	3	2	2	2	1	2
Average	3	3	2.8	2	3	2	2.6	3	3	2.8	2.8	2.8	2.6	2.6	1	2.8
<b>Subject Code</b>	<b>Subject Name (Theory course)</b>										<b>Category</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>FT 17402</b>	<b>FUNDAMENTALS OF HEAT AND MASS TRANSFER</b>										<b>PC</b>		3	0	0	3

<b>Objectives:</b>	
●	To understand the principles and applications of heat and mass transfer operations.

<b>UNIT-I</b>	<b>HEAT TRANSFER – CONDUCTION</b>	<b>9</b>
Basic transfer processes – heat, mass and momentum – heat transfer process - conductors and insulators - conduction – Fourier’s fundamental equation – thermal conductivity and thermal resistance - linear heat flow – heat transfer through homogenous wall, composite walls, radial heat flow through cylinders and sphere – extended surfaces (fins) — solving problems in heat transfer by conduction.		
<b>UNIT-II</b>	<b>HEAT TRANSFER - CONVECTION</b>	<b>9</b>
Newton Rikhman’s law – film coefficient of heat transfer - convection – free and forced convection - dimensional analysis and its application – factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in heat transfer by convection.		
<b>UNIT-III</b>	<b>HEAT TRANSFER – HEAT EXCHANGER</b>	<b>9</b>
Heat exchangers – parallel, counter and cross flow – evaporator and condensers - Logarithmic Mean Temperature Difference – overall coefficient of heat transfer – tube in tube heat exchanger, shell and tube heat exchanger, plate heat exchanger – applications of heat exchangers - solving problems in heat exchangers.		
<b>UNIT-IV</b>	<b>HEAT TRANSFER: RADIATION</b>	<b>9</b>

Radiation heat transfer – concept of black and grey body - monochromatic total emissive power – Kirchoff's law – Planck's law - Stefan-Boltzmann's law – heat exchange through non-absorbing media - solving problems in heat transfer by radiation.			
<b>UNIT-V</b>	<b>MASS TRANSFER</b>		<b>9</b>
Mass transfer – introduction – Fick's law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of gas A through non-diffusing or stagnant B - diffusion through a varying cross sectional area and diffusion coefficients for gases - molecular diffusion in liquids, biological solutions and gels.			
		<b>Total Contact Hours</b>	<b>: 45</b>

<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	To understand and apply the principles in heat transfer phenomena
●	To understand and apply the principles in mass transfer phenomena
●	To design heat and mass transfer equipment's.

<b>Text Book (s):</b>	
<b>1</b>	Bellaney, P.L. "Thermal Engineering". Khanna Publishers, New Delhi, 2001
<b>2</b>	Geankoplis C.J. "Transport Process and Unit Operations". Prentice-Hall of India Private Limited, New Delhi, 1999

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Jacob and Hawkins. "Elements of Heat Transfer". John Willey and Sons Inc. New York, 1983.
<b>2</b>	EcKert, E.R.G. "Heat and Mass Transfer". McGraw Hill Book Co., New York, 1981
<b>3</b>	Holman, E.P. "Heat Transfer". McGraw-Hill Publishing Co. New Delhi, 2001
<b>4</b>	Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004
<b>5</b>	McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2003.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	0	0	0	0	1	1	3	2	0	1
CO2	3	3	3	3	1	1	1	0	0	0	1	1	3	3	0	1
CO3	2	3	2	3	1	1	1	0	0	0	1	1	3	3	0	0
CO4	3	3	2	3		1	1	0	0	0	1	1	3	3	0	0
CO5	3	3	3	3	1	1	1	0	0	0	1	1	3	3	0	1

Average	2.8	3	2.4	3	1	1	1	0	0	0	1	1	3	2.8	0	1
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Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CY17251	ENVIRONMENTAL SCIENCE AND ENGINEERING	BS	3	0	0	3

**Objectives:**

●	To study the nature and facts about environment.
●	To finding and implementing scientific, technological, economic and political solutions to environmental problems.
●	To study the interrelationship between living organism and environment.
●	To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
●	To study the dynamic processes and understand the features of the earth's interior and surface.
●	To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT-I	ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY	14
Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.		
UNIT-II	ENVIRONMENTAL POLLUTION	8
Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.		
UNIT-III	NATURAL RESOURCES	10
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and		

ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.		
<b>UNIT-IV</b>	<b>SOCIAL ISSUES AND THE ENVIRONMENT</b>	<b>7</b>
From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.		
<b>UNIT-V</b>	<b>HUMAN POPULATION AND THE ENVIRONMENT</b>	<b>6</b>
Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course
●	Public awareness of environmental is at infant stage.
●	Ignorance and incomplete knowledge has led to misconceptions
●	Development and improvement in std. of living has led to serious environmental disasters

<b>Text Book (s):</b>	
<b>1</b>	Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

2	Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2 <sup>nd</sup> edition, Pearson Education, 2004.
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Reference Books(s) / Web links:	
1	Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD, New Delhi, 2007.
2	Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hyderabad, 2015.
3	Rajagopalan, R, „Environmental Studies-From Crisis to Cure“, Oxford University Press, 2005.
4	G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	-	-	1	-	-	1	1	1	-	-	-	-	-	-	-	-
CO 2	-	-	1	-	-	1	1	1	-	-	-	-	-	-	-	-
CO 3	-	-	1	-	-	1	2	1	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	1	1	1	-	-	-	-	-	1	-	1
CO 5	-	-	1	-	-	1	1	1	-	-	-	-	-	-	-	-
Average	-	-	1	-	-	1	1.2	1	-	-	-	-	-	1	-	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17403	FOOD ADDITIVES	PC	3	0	0	3

Objectives:	
●	To understand the principles of chemical preservation of foods.
●	To understand the role of different food additives
●	To know the regulations pertaining to the food additives

UNIT-I	FOOD ADDITIVES	9
Definitions, role in food processing and preservation, Preservatives-Class I, II chemical preservatives; acidulants and low pH – organic acids and esters; so2 nitrites antibiotics; surface preservation; Permitted preservatives in foods – Antioxidants natural and chemical antioxidants; mechanism of antioxidants; primary and secondary antioxidants; sequestarants. selection and application of antioxidants in foods; evaluation of antioxidant effectiveness in foods. -permitted antioxidants in foods. FSSAI guidelines for food additives.		
UNIT-II	FOOD COLOURS	9
Natural and synthetic colours, dyes, solutions, synthesis and usage; fake colours; inorganic pigments; applications of food colours; restrictions; Food flavouring agents-concept of flavours in		

food; natural food flavours; nature identical flavours and artificial flavouring agents; synthesis; FSSAI guidelines on usage of food colours, flavours and flavouring agents.		
<b>UNIT-III</b>	<b>EMULSIFIERS THICKENERS AND STABILIZERS</b>	<b>9</b>
Emulsions in food - definition; properties; HLB value; function of emulsifiers and stabilizers in foods; permitted emulsifiers and stabilizers used in foods; Thickeners and polyols – physical and chemical properties, chemistry; application in food industry, permitted thickeners and polyols in foods. FSSAI guidelines on usage of food emulsifiers, thickeners and stabilizers.		
<b>UNIT-IV</b>	<b>SWEETENERS</b>	<b>9</b>
Natural and chemical sweeteners nutritive and non-nutritive sweeteners; chemical structure & sweetness; saccharine, acesulfame K, aspartame, sucralose; restriction on the use of sweeteners in foods; Food acids – their function and application in foods; permitted food acids; nutritive additives; enrichment of foods. FSSAI guidelines on sweeteners and food acids.		
<b>UNIT-V</b>	<b>FOOD SAFETY</b>	<b>9</b>
Food – Safety in the use of food additives in foods; regulations and monitoring agencies including FSSAI and CODEX; toxicological evaluation of additives; interaction of additives with food ingredients.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	Students will learn the concept of food preservation and processing via the usage of food additives by different natural and artificial chemical additives.

<b>Text Book (s):</b>	
<b>1</b>	Mahindru, S.N. “Food Additives: Characteristics, Detection and Estimation”. Tata McGraw-Hill.
<b>2</b>	Brennen, Alfred Larry. “Food Additives”. 2 <sup>nd</sup> Edition, CRC Press.

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Clydesdale, Fergus M. “Food Additives- Toxicology Regulation and Properties”. CRC Press.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS O1	PS O2	PS O3	PS O4
CO1	3	3	3	3	3	1	3	1	-	-	-	2	2	2	-	2
CO2	3	3	3	3	2	1	1	1	-	-	-	1	2	2	-	2
CO3	3	3	3	3	2	1	1	1	-	-	-	1	2	2	-	2
CO4	3	3	3	3	2	1	1	1	-	-	-	1	2	2	-	2
CO5	3	3	3	1	1	1	-	1	-	-	-	2	1	-	-	2
Average	3	3	3	2.6	2	1	1.2	1	0	0	0	1.4	1.8	2	0	2

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17404	UNIT OPERATIONS FOR FOOD INDUSTRIES	PC	3	0	0	3

<b>Objectives:</b>	
●	To understand the various unit operations involved in Food Processing
●	To understand the principles involved in separation methods

<b>UNIT-I</b>	<b>EVAPORATION AND CONCENTRATION</b>	<b>9</b>
Unit operations in food processing –conservation of mass and energy – overall view of an engineering process-dimensions and units – dimensional and unit consistency – dimensionless ratios- evaporation – definition – liquid characteristics – single and multiple effect evaporation- performance of evaporators and boiling point elevation – capacity – economy and heat balance-types of evaporators – once through and circulation evaporators – short tube evaporators and long tube evaporators – agitated film evaporator		
<b>UNIT-II</b>	<b>MECHANICAL SEPARATION</b>	<b>9</b>
Filtration – definition –filter media – types and requirements-constant rate filtration – constant pressure filtration – filter cake resistance-filtration equipment – rotary vacuum filter – filter press- sedimentation – gravitational sedimentation of particles in a fluid – Stoke’s law, sedimentation of particles in gas-cyclones – settling under sedimentation and gravitational sedimentation-centrifugal separations – rate of separations – liquid – liquid separation – centrifuge equipment.		
<b>UNIT-III</b>	<b>SIZE REDUCTION</b>	<b>9</b>
Size reduction – grinding and cutting – principles of comminuting – characteristics of comminuted products – particle size distribution in comminuted products-energy and power requirements in comminuting – crushing efficiency – Rittinger’s, Bond’s and Kick’s laws for crushing-size reduction equipment’s – crushers – jaw crusher, gyratory crusher-crushing rolls – grinders – hammer mills – rolling compression mills - attrition, rod, ball and tube mills – construction and operation.		
<b>UNIT-IV</b>	<b>CONTACT EQUILIBRIUM SEPARATION</b>	<b>9</b>
Contact equilibrium separation processes – concentrations – gas-liquid and solid-liquid equilibrium – equilibrium concentration relationships – operating conditions-calculation of separation in contact – equilibrium processes-gas absorption – rate of gas absorption – stage – equilibrium gas –absorption equipment-properties of tower packing – types – construction – flow through packed towers- extraction – rate of extraction – stage equilibrium extraction-equipment for leaching coarse solids – intermediate solids – basket extractor-extraction of fine material – Dorr agitator – continuous leaching – decantation systems – extraction towers-washing – equipment’s		
<b>UNIT-V</b>	<b>CRYSTALLIZATION AND DISTILLATION</b>	<b>9</b>
Crystallization – equilibrium -solubility and equilibrium diagram – rate of crystal growth – equilibrium crystallization-crystallization equipment – classification – construction and operation-		

**Course Outcomes:**

- To understand Principles of separation methods used in the process industry.

- To appreciate different equipment's developed for separation.

**Text Book (s):**

- |          |   |
|----------|---|
| <b>1</b> | Geankoplis, C.J. “Transport Processes and Separation Process Principles”, 4 <sup>th</sup> Edition, Prentice Hall, 2003. |
| <b>2</b> | McCabe W.L., Smith J.C. “Unit Operations in Chemical Engineering”, 7 <sup>th</sup> Edition, McGraw – Hill Int., 2001    |
| <b>3</b> | Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.                                      |
| <b>4</b> | Geankoplis C.J.1999. Transport Process and Unit Operations. Prentice-Hall of India Private Limited, New Delhi.          |

**Reference Books(s) / Web links:**

- |          |  |
|----------|--|
| <b>1</b> | Richardson, J.E. <i>et al.</i> , “Coulson & Richardson’s Chemical Engineering” Vol.2 (Particle Technology & Separation Processes”) 5 <sup>th</sup> Edition, Butterworth – Heinemann, Elsevier, 2003. |
| <b>2</b> | Coulson, J.M and J.F. Richardson, “Chemical Engineering”. Volume I to V. The Pergamon Press. New York, 1999  |
| <b>3</b> | McCabe, W.L., J.C. Smith and Harriot, “Unit Operations of Chemical Engineering”. McGraw-Hill. Inc. Kosaido Printing Ltd. Tokyo, Japan, 2001  |
| <b>4</b> | Sahay, K. M. and K.K. Singh, “Unit operation of Agricultural Processing”, Vikas Publishing House Pvt. Ltd., New Delhi, 2004  |

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	1	1	-	-	-	3	2	2	-	-
CO2	3	3	3	2	2	2	1	1	-	-	-	3	2	2	-	-
CO3	3	3	3	2	2	2	1	1	-	-	-	3	2	2	-	-
CO4	3	3	3	2	2	2	1	1	-	-	-	3	2	2	-	-
CO5	3	3	3	2	2	2	1	1	-	-	-	3	2	2	-	-



- Analysis of foods and food products for chemical components, compliance to standards; detection of adulterants in foods.

1	Determination of moisture in spices powder by distillation method and Hot air oven method.			
2	Determination of total fat, protein in milk and milk products.			
3	Rancidity test for fried foods to assess primary and secondary oxidative products.			
4	Determination of Vitamin C in fruit juices.			
5	Estimation of synthetic Food colour in sweets, confectioneries and beverages.			
6	Determination of Iron content in foods.			
7	Determination of Iodine content in iodized salt.			
8	Detection and estimation of Annatto, lead, MSG, sulphur-di-oxide, Emulsifiers and stabilizers in food products.			
9	Estimation of antioxidants in foods			
10	Determination of soluble and insoluble fibre in foods.			
11	Detection of adulterants in edible oil and ghee.			
12	Column chromatographic separation of colours.			
13	The identification of sugars in fruit juice using TLC.			
		Total Contact Hours	:	60

●	Better understanding in analysis of foods and food products for chemical components, Knowing standards for food products.
●	Obtain knowledge of adulterants in foods.

1.	Skoog, D.A. et al. "Principles of Instrumental Analysis", V Edition, Thomson / Brooks – Cole, 1998.
2.	Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987
3.	Willard, H.H. et al. "Instrumental Methods of Analysis", VII Edition, CBS, 1986.

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| 4. | Ewing, G.W. "Instrumental Methods of Chemical Analysis", V Edition, McGraw-Hill, 1985. |
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### LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required																
S.No.	Name of the equipment															Quantity
1.	Soxhlet apparatus															5
2.	Kjeldahl apparatus															2
3.	UV spectrophotometer															1
4.	Colour comparator															1
5.	pH meter															3
6.	Water bath															2
7.	Fume hood															1
8.	Dean and stark apparatus															1
9.	Weighing balance															1
10.	Hot air oven															1
11.	TLC paper strips As required															
12.	Glasswares/Chemicals as required															

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO5	3	3	3	1	1	3	3	3	2	-	3	3	3	3	-	3
Average	3	2.4	2.6	1.8	2.6	2	2.2	2.4	1.2	-	2.4	2.2	2.6	2.4	-	3

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT 17412	UNIT OPERATIONS LABORATORY	PC	0	0	4	2

#### Objectives:

- To develop knowledge in handling basic operation equipment's

#### List of Experiments

1	Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
2	Determination of economy and thermal efficiency of rotary flash evaporator
3	Solving problems on single and multiple effect evaporator
4	Determination of separation efficiency of centrifugal separator.
5	Determination of collection efficiency in cyclone separator.

**The students will be able to**

- |   |   |
|---|---|
| ● | Have knowledge on the basic principles of chemical engineering and its applications.              |
| ● | Be able to apply the skill of material balance and energy balance in unit operations unit process |

1.	Warren Lee McCabe. “Unit Operations of Chemical Engineering”, McGraw-Hill, 1967
2.	Maria Margarida Cortez Vieira. “Experiments in Unit Operations and Processing of Foods”, Springer, 2008

Equipment Required		
S.No.	Name of the equipment	Quantity
1.	Orifice meter	1
2.	Venturi meter	1
3.	Rotameter	1
4.	Packed column	1
5.	Centrifugal separator	1
6.	Steam distillation unit	2
7.	Fluidized bed column	1
8.	Rotary flash evaporator	1
9.	Cyclone separator	1
10.	Ball mill	1
11.	Hammer mill	1
12.	Burr mill	1
13.	Pin mill	1

14.	Glassware / Chemicals As required															
PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO2	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO3	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO4	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO5	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
Average	3	3	2	3	1	1	0	0	3	3	0	3	3	3	0	1

Code	Subject Name (Theory course)	Category	L	T	P	C
HS 17461	ADVANCED READING AND WRITING	EEC	0	0	2	1

<b>Objectives:</b>	
●	Strengthen the reading skills of students of engineering.
●	Enhance their writing skills with specific reference to technical writing
●	Develop students' critical thinking skills.
●	Provide more opportunities to develop their project and proposal writing skills.

<b>UNIT-I</b>	<b>6</b>
<b>Reading</b> - Strategies for effective reading -Use glosses and footnotes to aid reading comprehension- Read and recognize different text types -Predicting content using photos and title <b>Writing</b> -Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence –Write a descriptive paragraph	
<b>UNIT-II</b>	<b>6</b>
<b>Reading</b> -Read for details -Use of graphic organizers to review and aid comprehension <b>Writing</b> - State reasons and examples to support ideas in writing- Write a paragraph with reasons and examples- Write an opinion paragraph	
<b>UNIT-III</b>	<b>6</b>
<b>Reading</b> - Understanding pronoun reference and use of connectors in a passage- speed reading techniques - <b>Writing</b> - Elements of a good essay -Types of essays- descriptive-narrative- issue-based-argumentative-analytical.	
<b>UNIT-IV</b>	<b>6</b>
<b>Reading</b> - Genre and Organization of Ideas- <b>Writing</b> - Email writing- resumes – Job application- project writing-writing convincing proposals.	
<b>UNIT-V</b>	<b>6</b>
<b>Reading</b> - Critical reading and thinking- understanding how the text positions the reader- identify <b>Writing</b> - Statement of Purpose- letter of recommendation- Vision statement	

	<b>Total Contact Hours</b>	<b>:</b>	<b>30</b>
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<b>Course Outcomes:</b>	
Upon successful completion of the course, students will be able to:	
●	Write different types of essays.
●	Write winning job applications.
●	Read and evaluate texts critically.
●	Display critical thinking in various professional contexts.

<b>Text Book (s):</b>	
<b>1</b>	Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011
<b>2</b>	Debra Daise, CharlNorloff, and Paul Carne Reading and Writing (Level 4) Oxford University Press: Oxford, 2011

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	Davis, Jason and Rhonda Liss.Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006
<b>2</b>	E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
<b>3</b>	Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge University Press: Cambridge, 2004
<b>4</b>	Goatly, Andrew. Critical Reading and Writing. Routledge: United States of America, 2000
<b>5</b>	Petelin, Roslyn and Marsh Durham. The Professional Writing Guide: Knowing Well and Knowing Why. Business & Professional Publishing: Australia, 2004

<b>Subject Code</b>	<b>Subject Name</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>FT 17501</b>	<b>THERMODYNAMICS</b>	<b>PC</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

<b>Objectives:</b>	
●	To identify and use units and notations in thermodynamics
●	To state and illustrate first and second laws of thermodynamics
●	To understand the concepts of entropy, enthalpy, reversibility and irreversibility
●	To get conversant with properties of steam, thermodynamic vapour cycles, and performance estimation
●	To get conversant with psychrometric chart and psychrometric processes.

<b>UNIT-I</b>	<b>THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS</b>	<b>12</b>
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First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non-ideal behaviour; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.		
<b>UNIT-II</b>	<b>SOLUTION THERMODYNAMICS</b>	<b>12</b>
Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.		
<b>UNIT-III</b>	<b>PHASE EQUILIBRIA</b>	<b>12</b>
Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.		
<b>UNIT-IV</b>	<b>CHEMICAL REACTION EQUILIBRIA</b>	<b>12</b>
Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.		
<b>UNIT-V</b>	<b>THERMODYNAMIC DESCRIPTION FOR MICROBIAL GROWTH AND PRODUCT FORMATION</b>	<b>12</b>
Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation		
<b>Total Contact Hours</b>		<b>: 60</b>

**Course Outcomes:**

On completion of course students will be able to

- Apply various thermodynamic laws to the real system
- Calculate the entropy changes in the system
- Analyse basic thermodynamic cycles
- Demonstrate the interrelationship between thermodynamic cycles
- Solve problems using the properties and relationships of thermodynamic fluids

**Text Books:**

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|----------|--|
| <b>1</b> | Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", VI Edition. Tata McGraw-Hill, 2003. |
| <b>2</b> | Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.  |
| <b>3</b> | Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.             |

**Reference Books / Web links:**

- |          |   |
|----------|---|
| <b>1</b> | Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989. |
|----------|---|

RO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	1	0	0	0	1	1	2	3	0	1
CO2	2	3	3	2	1	1	1	0	0	0	0	1	3	3	0	0
CO3	3	3	3	3	1	1	1	0	0	0	1	1	3	3	0	0
CO4	2	3	3	3	1	1	1	0	0	0	1	1	3	3	0	1
CO5	3	3	3	3	1	1	1	0	0	0	1	1	3	3	1	1
Average	2.6	3	2.8	2.8	1	1	1	0	0	0	1	1	2.8	3	1	1

Subject Code	Subject Name	Category	L	T	P	C
FT 17502	FOOD PROCESSING AND PRESERVATION TECHNOLOGY	PC	3	0	0	3

Objectives:	
●	To understand the basic principles of food processing and preservation methods
●	To get familiarize with basic thermal processing methods
●	To understand the importance of low temperature storage on shelf-life of foods
●	To highlight the role of non-thermal processing methods in hurdle technology
●	To understand the key aspects of novel processing methods and food packaging

	<b>HIGH TEMPERATURE PROCESSING</b>	<b>9</b>
Introduction, classification of Thermal Processes; Blanching, Pasteurization, Sterilization, commercial sterilization, Principles of thermal processing, Thermal resistance of microorganisms, Thermal Death Time, Lethality concept, characterization of heat penetration data, Thermal process Calculations Commercial heat preservation methods: Canning; Types and classification of foods used for canning; spoilage of canned and bottled foods, storage of canned foods; Influence of canning on the quality of food, Retort pouch processing		
<b>UNIT-II</b>	<b>PRESERVATION BY LOW TEMPERATURE STORAGE</b>	<b>9</b>
Refrigeration: Definition, necessity of refrigeration, Refrigerants used in food industry, Effect on enzymes, Microbes; Response of microbes for low temperature, Microbe inactivation mechanism and Food system, Freezing: Freezing curve for Homogenous and Non-homogenous food system, Freezing point depression, Freezing rate, Effect of freezing: Physical and chemical changes in Foods, Enzyme activity, Microbe inactivation and Food quality: sensory quality, nutritional aspects.		
<b>UNIT-III</b>	<b>PRESERVATION BY CONTROL OF WATERACTIVITY</b>	<b>9</b>
Dehydration: Theory of Drying, Factors influencing drying rate, traditional and modern methods of drying, types of driers, Effect of drying on Foods, pigments and enzymes. Osmotic dehydration: Concept of Osmotic dehydration, Factors influencing osmosis, and Preservative effects on foods. Food Concentration: Evaporation and membrane technology- Intermediate moisture food concepts.		
<b>UNIT-IV</b>	<b>NON THERMAL METHODS OF FOOD PROCESSING</b>	<b>9</b>
Non-thermal methods: Chemical Preservatives, Salting and Curing, Smoking, Pickling, Fermentation, Food Irradiation technology, Ultrasound technology, High pressure processing, Hurdle technology.		

<b>UNIT-V</b>	<b>NOVEL PROCESSING METHODS &amp; FOOD PACKAGING</b>	<b>9</b>
<p>Novel processing: Ohmic heating, Microwave, Radio frequency heating and Infra-red heating, Ozone processing, Dense phase carbon dioxide processing of fluid foods Pulsed electric field, and Pulsed X-Ray.</p> <p>Packaging: Definition, Significance, functions, basic packaging materials, and role of different packaging methods in food preservation.</p>		
		<b>Total Contact Hours : 45</b>

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**Course Outcomes:**

On completion of course students will be able to

●	Apply preservation methods that make use of heat/cold, drying, acid, added chemicals, controlled air, pressure, and high-energy radiation.
●	Use indirect approaches to food preservation – packaging, food hygiene, sanitation, Gas packaging.
●	Explain the principles and current practices of processing techniques and the effects of processing parameters on product quality.
●	Demonstrate the advanced technology available in the field of processing
●	Distinguish between preservation methods appropriate for “natural” foods

**Text Books:**

1	Khetarpaul, Neelam. “Food Processing and Preservation.” Daya Publications, 2005
2	Singh, M.K. “Food Preservation” Discovery Publishing, 2007.
3	Fellows, P.J. “Food Processing Technology: Principles and Practice”. 2 <sup>nd</sup> Edition, CRC/Wood Head Publishing, 2000.
4	Gopala Rao, Chandra. “Essentials of Food Process Engineering”. B.S. Publications, 2006.

**Reference Books / Web links:**

1	Rahman, M. Shafiur. “Handbook of Food Preservation”. Marcel & Dekker, 2006.
2	Zeuthen, Peter and Bogh-Sorensen, Leif. “Food Preservation Techniques”. CRC / Wood Head Publishing, 2003.
3	Ranganna, S. “Handbook of Canning and Aseptic Packaging”. Tata McGraw-Hill, 2000.
4	P. J. Cullen, “Novel Thermal and Non-Thermal Technologies for Fluid Foods”. Academic Press, 2012

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2	2	2	2	2	2	2	3	2	3	2
CO2	3	2	3	3	3	2	2	2	2	2	2	2	3	3	3	2
CO3	3	3	2	3	3	2	2	2	2	2	2	2	3	3	3	2
CO4	3	3	3	3	3	3	2	2	2	2	2	2	3	3	3	2
CO5	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3	2
Average	3	2.8	2.8	3	3	2.2	2	2	2	2	2	2	3	2.8	3	2

Subject	Subject Name	Category	L	T	P	C
Curriculum and Syllabus	B.TECH. Food Technology R2017					



<b>Code</b>						
<b>FT 17503</b>	<b>BAKING AND CONFECTIONARY TECHNOLOGY</b>	<b>PC</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

<b>Objectives:</b>	
●	To understand the basic principles of baking technology
●	To get familiarize with equipment's for baking
●	To understand the importance of ingredients in bread baking process.
●	To get familiarize with manufacturing of different bakery products.
●	To understand the key aspects of ingredients and technology in production of confectionary products

<b>UNIT-I</b>	<b>INTRODUCTION TO BAKING</b>	<b>9</b>
Classification of bakery products. Bakery ingredients and their Functions-Essential ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavour, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants.		
<b>UNIT-II</b>	<b>EQUIPMENTS</b>	<b>9</b>
Introduction to utensils and equipment's used in bakery industry with their purpose. Bulk handling of ingredients- Dough mixing and mixers, Dividing, rounding, sheeting, and Laminating-Fermentation enclosures and brew equipment - Ovens and Slicers; Extrusion. Rheology of dough-Farinograph, Amylograph, Alveograph and Extensiograph.		
<b>UNIT-III</b>	<b>BREAD MAKING PROCESS</b>	<b>9</b>
The Chemistry of dough development. Bread making methods- Straight dough/bulk fermentation – Sponge dough- Activated dough development- Chorley wood bread process- Dough retarding and freezing, No time process, Advantages and disadvantages of various methods of bread-making. Characteristics of good bread: Internal characters; external characters. Bread defects/faults and remedies. Spoilage of Bread-Causes, detection and prevention.		
<b>UNIT-IV</b>	<b>BAKERY PRODUCTS</b>	<b>9</b>
Production of cakes and cookies/biscuits. Types of biscuit dough 's –Developed dough, short dough 's, semi-sweet, enzyme modified dough 's and batters. Cake making: Ingredients and their function; Structure builders, Tenderizers, moisteners and flavour enhancers. Production process for wafers- type of flour, raising agents and maturing agents; Other miscellaneous products- puff pastry, chemically leavened, Problems of baking.		
<b>UNIT-V</b>	<b>CONFECTIONERY PRODUCTS</b>	<b>9</b>
Definition, importance of sugar confectionery. General technical aspects of industrial sugar confectionery manufacture - compositional effects. Manufacture methods of high boiled sweets: ingredients - prevention of recrystallization and stickiness. Types of confectionery products: Caramel, Toffee and Fudge and other confectionaries; ingredients - Formulation – Processing method- Quality control- Aerated confectionery- Methods of aeration- Manufacturing process -product quality parameters, faults and corrective measures. Spoilage of confectionery products.		

	<b>Total Contact Hours</b>	<b>:</b>	<b>45</b>
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**Course Outcomes:**

On completion of course students will be able to

- Apply basic principles of baking technology for product manufacturing.
- Demonstrate the different bread baking process.
- Explain the principles and operate the equipment's in baking industry.
- Assess the quality of ingredients and its impact on bread and cake
- Prepare confectionary products and evaluate its quality characteristics.

**Text Books:**

- 1 Matz, Samuel A., "Bakery Technology and Engineering", III Edition, Chapman & Hall London.
- 2 Cauvain, Stanley P, and Young, Linda S., "Technology of Bread Making", II Edition Aspen publication. Maryland, 1999

**Reference Books / Web links:**

- 1 Edwards W.P. "Science of bakery products", RSC, UK,2007
- 2 Samuel A. Matz., "Equipment for Bakers", Pan Tech International Publication. 1988.
- 3 Sugar Confectionery manufacture-(Ed) E.B. Jackson, II edition, Blackie Academic and professional, Glasgow,1995.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	1	1	1	-	-	1	1	3	2	-	1
CO2	3	2	3	2	3	1	3	2	-	-	3	2	2	2	-	1
CO3	3	3	3	2	3	1	2	1	-	-	3	2	2	2	-	1
CO4	3	3	3	2	3	2	3	2	-	-	2	2	3	3	-	1
CO5	3	3	3	1	3	3	3	1	-	-	3	2	3	3	-	2
Average	3	2.6	2.8	1.8	3	1.6	2.4	1.4	0	0	2.4	1.8	2.6	2.4	0	1.2

Subject Code	Subject Name	Category	L	T	P	C
FT 17504	PROFESSIONAL ETHICS FOR FOOD TECHNOLOGISTS	PC	3	0	0	3

**Objectives:**

- To provide basic knowledge about engineering Ethics, Variety of moral issues and Moral dilemmas, Professional Ideals and Virtues
- To provide basic familiarity about Engineers as responsible Experimenters, Research Ethics, Codes of Ethics, Industrial Standards, Exposure to Safety and Risk, Risk Benefit Analysis
- To have an idea about the Collegiality and Loyalty, Collective Bargaining, Confidentiality, Occupational Crime, Professional, Employee, Intellectual Property Rights.

●	To have an adequate knowledge about MNC's, Business, Environmental, Computer Ethics, Honesty, Moral Leadership, sample Code of Conduct.
●	To make the students realize the significance of ethics in professional environment.

<b>UNIT-I</b>	<b>HUMAN VALUES</b>	<b>10</b>
Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.		
<b>UNIT-II</b>	<b>ENGINEERING ETHICS</b>	<b>9</b>
Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		
<b>UNIT-III</b>	<b>ENGINEERING AS SOCIAL EXPERIMENTATION</b>	<b>9</b>
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.		
<b>UNIT-IV</b>	<b>SAFETY, RESPONSIBILITIES AND RIGHTS</b>	<b>9</b>
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest –Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.		
<b>UNIT-V</b>	<b>GLOBAL ISSUES</b>	<b>8</b>
Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.		
		<b>Total Contact Hours : 45</b>

#### Course Outcomes:

On completion of course students will be able to

●	Provide basic knowledge about engineering Ethics, Variety of moral issues and Moral dilemmas, Professional Ideals and Virtues
●	Provide basic familiarity about Engineers as responsible Experimenters, Research Ethics, Codes of Ethics, Industrial Standards, Exposure to Safety and Risk, Risk Benefit Analysis
●	Demonstrate an idea about the Collegiality and Loyalty, Collective Bargaining, Confidentiality, Occupational Crime, Professional, Employee, Intellectual Property Rights.
●	Understand about MNC's, Business, Environmental, Computer Ethics, Honesty, Moral Leadership, sample Code of Conduct.
●	Realize the significance of ethics in professional environment.

<b>Text Books:</b>	
1	Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2	Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

<b>Reference Books</b>	
1	Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3	John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4	Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5	Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.
<b>Web links:</b>	
1.	<a href="http://www.onlineethics.org">www.onlineethics.org</a>
2.	<a href="http://www.nspe.org">www.nspe.org</a>
3.	<a href="http://www.globalethics.org">www.globalethics.org</a>
4.	<a href="http://www.ethics.org">www.ethics.org</a>

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO2	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO3	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO4	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO5	1	1	1	1	1	3	2	3	3	3	3	3	2	2	3	3
Average	1	1	1	1	1	3	1.2	3	3	3	3	3	2	2	3	3

Subject Code	Subject Name	Category	L	T	P	C
FT 17511	FOOD PROCESSING AND PRESERVATION TECHNOLOGY LABORATORY	PC	0	0	4	2

<b>Objectives:</b>	
●	To describe food processing in terms of unit operations, both conceptually and in the pilot plant
●	To get familiar with mass and energy balances for food processing
●	To gain experience with common food processing equipment at the pilot plant scale



**LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS**

<b>Equipment Required</b>		
<b>S.No.</b>	<b>Name of the equipment</b>	<b>Quantity</b>
1.	Plate heat exchanger	1
2.	Refrigerator	2
3.	Deep freezer	1
4.	Tray dryer	1
5.	Microwave dryer	1
6.	Hot air oven	2
7.	Refractometer	5
8.	Extruder	1
9.	RO equipment	1
10.	Double seamer machine	1
11.	Canning and bottling unit	1
12.	Pasteurizer	1
13.	Spray dryer	1
14.	Retort unit	1
15.	Ohmic heater	1
16.	Thermometer	3
17.	Water vapour permeability tester	1
18.	Oxygen permeability tester	1
19.	Tensiometer	1
20.	Viscometer	1
21.	Desiccator	5
22.	Weighing balance	2
23.	Vegetable chopper	1

<b>PO/PSO CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	3	3	3	2	2	2	2	2	2	2	1	3	3	2	3	3
<b>CO2</b>	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3	3
<b>CO3</b>	3	2	3	3	2	2	2	2	2	2	1	3	3	3	3	3
<b>CO4</b>	3	2	3	3	2	3	2	2	2	2	2	3	3	3	3	3
<b>CO5</b>	3	2	3	2	2	3	2	2	2	2	2	2	3	3	3	3
<b>Average</b>	3	2.4	3	2.6	2.2	2.4	2	2	2	2	1.6	2.6	3	2.8	3	3
<b>Subject Code</b>	<b>Subject Name (Laboratory Course)</b>										<b>Category</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>FT17512</b>	<b>BAKING AND CONFECTIONARY TECHNOLOGY LABORATORY</b>										<b>PC</b>		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

<b>Objectives:</b>	
●	To learn the manufacturing process associated with bakery products.
●	To get familiar with various bread baking techniques.
●	To study the effect of ingredients on bakery products.
●	To learn the manufacturing process associated with Sugar and chocolate confectionary products.
●	To study the rheological properties of dough.

<b>List of Experiments</b>			
1	Determination of physical and chemical properties of flour- sieve analysis, sedimentation value, falling number, gluten index.		
2.	Determination of alcoholic acidity of the sample of the wheat flour / Maida		
3.	Experiment on leavening action of baking powder, sodium- bicarbonate and ammonium-bicarbonate in cakes.		
4.	Determination of dough rising capacity of yeast		
5.	Studies of dough characteristics- Farinograph, Amylograph and Extensiograph		
6.	Preparation of biscuits-different types.		
7.	Optimization and production of Bread: Straight dough method, sponge dough method and No time dough method.		
8.	Identification of different stages of sugar boiled confectionery		
8.	Preparation of sugar boiled confectionery – Hard and soft candy		
9.	Preparation of chocolate confectionery		
10.	Preparation of Fudge and Fondant		
11.	Visit to Baking/Confectionery industry		
			<b>Total Contact Hours : 60</b>

<b>Course Outcomes:</b>	
<b>The students will be able to</b>	
●	Demonstrate the manufacturing process associated with bakery products.
●	Prepare bread by various baking techniques.
●	Examine the effect of ingredients on bakery products.
●	Demonstrate the manufacturing process associated with Sugar and chocolate confectionary products.
●	Evaluate the rheological properties of dough.

### **LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS**

<b>Equipment Required</b>		
<b>S.No.</b>	<b>Name of the equipment</b>	<b>Quantity</b>
1.	Counter top dough Mixer	1
2.	Electric Deck Oven	1
3.	Convectional Oven	3

4.	Dough Proofer	1
5.	Dough sheeter	1
6.	Sheet pan racks	4
7.	Farinograph	1
8.	Extensograph	1
9.	Amylograph	1
10.	Texture Analyser	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3	1	3	3	2	2	2	3	2	2	1	3
CO2	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO4	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO5	3	2	1	1	3	1	1	3	3	2	3	2	2	2	1	2
Average	3	2.6	2.2	1.8	3	1.6	2.6	3	2.8	2.6	2.8	2.8	2.6	2.6	1	2.8

Subject Code	Subject Name	Category	L	T	P	C
FT 17601	FOOD PROCESS ENGINEERING AND ECONOMICS	PC	3	0	0	3

**Objectives:**

- To understand the physical properties of foods
- To get familiarize with thermal process calculations
- To understand the importance of drying and freezing in food processing
- To highlight the role of membrane processing
- To understand the key aspects of extrusion cooking

<b>UNIT-I</b>	<b>PROPERTIES OF FOOD</b>	<b>9</b>
Engineering properties of food materials - Rheological and textural Properties, Thermal Properties, Thermodynamic Properties, surface and gas exchange properties, electric and dielectric properties Water activity and states: a thermodynamic quantity, water sorption isotherms, hysteresis, theories of sorption hysteresis, water activity measurement methods, water binding, control of water activity and moisture, principles of IMF and their application		
<b>UNIT-II</b>	<b>THERMAL PROCESS CALCULATIONS</b>	<b>9</b>
Concept of thermo bacteriology- Microorganisms of importance in thermal processing, Determination of thermal resistance of bacteria, Thermal Process Evaluation- Basic considerations, General method, Mathematical method, Conversion of Heat penetration data, Process Determination Problems.		
<b>UNIT-III</b>	<b>DRYING AND FREEZING</b>	<b>9</b>
Basic Drying Theory - Three States of Water phase diagram for water, Heat Requirements for Vaporization, Thermodynamics of moist air (psychrometry) - Measurement of Humidity, Air Drying, Conduction Drying,		



drying under varying external condition, methods of drying, Drying Equipment, Dryer Efficiencies, calculation of drying time, Concept of Osmotic dehydration, Factors influencing osmosis.				
Freezing: Freezing curve for Homogenous and Non-homogenous food system, freezing point depression, freezing rate, freezing time calculation, Effect of freezing: Physical and chemical changes in Foods, Enzyme activity, Microbe inactivation and Food quality: sensory quality, nutritional aspects, freeze drying and freeze concentration				
UNIT-IV	MEMBRANE PROCESS			9
Membrane Process- Tangential Filtration, Mass transfer through MF and UF membranes, Mass Transfer in Reverse osmosis, Membrane system, Membrane process in food industries.				
UNIT-V	EXTRUSION			9
Introduction, Single screw & Twin screw extruder- Structure, Operation, Flow models, Extruder throughput, Advantages and shortcomings; Effect of extrusion cooking on foods, Applications in Food industries.				
				Total Contact Hours : 45

**Course Outcomes:**

On completion of course students will be able to

- Apply the knowledge of physical properties of foods during the processing
- Calculate time temperature required to achieve desired shelf life of foods.
- Explain the principles and current practices of drying and freezing techniques and the effects of processing parameters on product quality.
- Demonstrate the membrane technology available in the field of processing
- Develop novel products using extrusion cooking.

**Text Books:**

- 1 Toledo, Romeo T. "Fundamentals of Food Process Engineering" II Edition. CBS Publishers, 2000.
- 2 Fellows P. J "Food Processing Technology" Woodhead Publishing, 1998
- 3 Smith P. G "Introduction to Food Process Engineering". Springer, 2005
- 4 Earle, R.L, "Unit Operations in Food Processing". Pergamon Press. Oxford. U.K, 2003

**Reference Books / Web links:**

- 1 Sahay, K. M. and K.K. Singh. "Unit operation of Agricultural Processing", Vikas Publishing House Pvt. Ltd., New Delhi, 2004
- 2 Berk, Zeki. "Food Process Engineering and Technology". Elsevier, 2009.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4
CO1	3	2	3	3	3	3	2	0	1	1	2	3	2	2	2	3
CO2	3	1	3	3	3	3	1	0	1	2	3	3	3	3	1	3
CO3	3	2	3	3	3	2	1	0	1	1	2	2	3	3	1	3
CO4	2	3	3	1	3	3	1	0	1	1	2	3	2	2	2	2

CO5	3	3	2	3	2	3	2	0	1	1	2	2	2	3	1	3
Average	2.8	2.2	2.8	2.6	2.8	2.8	1.4	0	1	1.2	2.2	2.6	2.4	2.6	1.4	2.8
Subject Code	Subject Name										Category	L	T	P	C	
FT 17602	DAIRY PROCESS TECHNOLOGY										PC	3	0	0	3	

**Objectives:**

- To understand the basic properties of milk
- To get familiarize with processing and quality parameters of milk
- To get familiarize with milk products.
- To get familiarize with milk powder processing and substitutes
- To understand the key aspects of sanitation in storage of milk and effluent treatment.

<b>UNIT-I</b>	<b>PROPERTIES OF MILK</b>	<b>9</b>
Introduction: white revolution present milk industry scenario and its future. Milk-Types- Composition- Physical-Chemical and Thermal Properties-Heat Capacity, Density Freezing- Boiling Point-Expansion-Agitation-Viscosity-Classification of milk Market and Special Milk Handling-effects of Merits on Milk-toxicity of metals.		
<b>UNIT-II</b>	<b>PROCESSING AND QUALITY PARAMETERS OF MILK</b>	<b>9</b>
Processing of Milk- calculation and standardisation of raw milk, Pasteurization-HTST, UHT, sterilization, Homogenization, Filtering and Clarification of Milk-cream Separation-Methods and Equipment's-Emulsification – Fortification, packaging of milk and milk products, judging and grading of milk, national and international standards of milk and milk products. membrane separation of milk – ultra filtration - reverse osmosis—membrane material and structures.		
<b>UNIT-III</b>	<b>MILK PRODUCTS</b>	<b>9</b>
Traditional dairy products, Technology of traditional Indian dairy products. Technology of fermented milk and milk products and probiotic milk based products., Manufacturing of Yogurt, Cheese, Butter, Ghee, Ice-cream, overrun calculation in ice-cream, malted products, evaporated milk products - properties, Classification-processing Methods, Equipment used, standards and quality parameters.		
<b>UNIT-IV</b>	<b>MILK POWDER PROCESSING AND MILK SUBSTITUTES</b>	<b>9</b>
Processing of Milk Powder- Composition - Properties- methods of drying, comparison of different drying methods and calculating of drying efficiency, quality evaluation, Instantization, flow ability dustiness, reconstituability, dispersability, wet ability, sink ability and appearance of milk powders substitutes for milk and milk products – casein, lactose and other by-products and its use in formulated foods, weaning foods, therapeutic foods, fortification and enrichment.		
<b>UNIT-V</b>	<b>STORAGE SANITATION AND EFFLUENT TREATMENT</b>	<b>9</b>
Storage of Milk in Tanks-Storage of ice cream and other milk products - in cold storage Cleaning and Sanitation-Importance-Detergents-Properties-Cleaning Procedures-Cleaning in Place-Dairy effluent treatment and disposal.		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Apply basic properties of milk for product manufacturing.
- Demonstrate the processing and quality analysis of milk.
- Prepare the various milk based products.
- Assess the properties of milk powder and milk substitutes.
- Demonstrate the importance of sanitation in dairy industries.

**Text Books:**

- 1 Ananthakrishnan, C.P., and Sinha, N.N., “Technology and Engineering of Dairy Plant Operations, Laxmi Publications, New Delhi, 1984.
- 2 Warner, J.N., “Principles of Dairy Processing”, Wiley Eastern Pub. Co., New York, 1975.
- 3 Walstra, P., “Dairy Technology: Principles of Milk Properties and Processes”. Marcel Dekker, 1999
- 4 Spreer, Edgar “Milk and Dairy Product Technology”. Marcel Dekker, 2005.

**Reference Books / Web links:**

- 1 Tufail Ahmed., “Dairy Plant Engineering and Management”, KitabMahal Publishers, Allahabad, 1997.
- 2 Lampert, Lincoln M. “Modern Dairy Products: Composition, Food Value, Processing, Chemistry, Bacteriology, Testing, Imitation Dairy Products”. Chemical Publishing Company, 1998.
- 3 Selia, Jane dos Reis Coimbra and Jose A. Teixeira “Engineering Aspects of Milk and Dairy Products”. Jane Selia dos Reis Coimbra & Jose A. Teixeira, CRC Press, 2009.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4	
CO1	3	3	3	2	3	3	3	3	3	3	2	3	2	2	1	3	
CO2	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3	
CO3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3	
CO4	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3	
CO5	3	3	2	2	3	2	1	3	3	2	3	2	2	3	1	2	
Average	3	3	2.8	2	3	2.2	2.6	3	3	2.8	2.8	2.8	2.6	2.8	1	2.8	
Subject Code		Subject Name										Category		L	T	P	C
FT 17603		FRUIT AND VEGETABLE PROCESSING TECHNOLOGY										PC		3	0	0	3

**Objectives:**

- To understand the basic agricultural aspects of fruits and vegetables.
- To get familiarize with processing of fruits and vegetables.

●	To understand the importance of freezing and dehydration in preservation of excess produce.
●	To highlight the role of thermal processing methods in fruit and vegetable technology.
●	To get familiarize with manufacturing of fruit and vegetable products.

<b>UNIT-I</b>	<b>BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS</b>	<b>9</b>
<p>Ability to identify all commercially important fruits and vegetables with their names in important Indian languages, important regions, season, Morphology, structure and composition of fruit and vegetable.</p> <p>Production and processing scenario of fruits and vegetable: India and World. Scope of Fruit and Vegetable Preservation Industry in India. Present status, constraints and prospectus.</p>		
<b>UNIT-II</b>	<b>FRESH FRUITS AND VEGETABLES</b>	<b>9</b>
<p>Physical, Textural characteristics, structure and composition. Maturity standards; Importance, Methods of maturity determinations maturity indices for selected fruits and vegetables. Harvesting of important fruits and vegetables. Fruit ripening- chemical changes, regulations, methods. Storage practices: Control atmospheric, Bead atmosphere, hypotactic storage, cold store, zero emerge cool chamber, stores striation. Commodity pre-treatment's - chemicals, wax coating, pre-packaging, phytonutrients in fruits and vegetables, grading, cleaning, Physiological post-harvest diseases chilling injury and disease. Handling and packaging of fruits and vegetables.</p>		
<b>UNIT-III</b>	<b>FREEZING &amp; DEHYDRATION OF FRUITS AND VEGETABLES</b>	<b>9</b>
<p>General pre-processing, different freezing methods and equipment's, problems associated with specific fruits and vegetables; Dehydration – General pre-processing, different methods of drying including sun, tray, spray drying and low temperature, osmotic dehydration and other modern methods; Indian Food Regulation and Quality assurance.</p>		
<b>UNIT-IV</b>	<b>CANNING, PUREES AND JUICES</b>	<b>9</b>
<p>Canning- General pre-processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality Assurance.</p> <p>Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance, Vegetable Purees/ pastes - General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance</p>		
<b>UNIT-V</b>	<b>FRUIT AND VEGETABLE PRODUCTS</b>	<b>9</b>
<p>Ready to eat fruit and vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colours, Fruit and Vegetable Fibres- General and specific processing, different packing including aseptic, Dried Onion, Powder. Garlic: Dried Garlic, Powder, Oil. Potato: Wafer; starch, Papad, Carrot: Preserve, candy, Pickle, Jam. Cauliflower and cabbage: Dried cauliflower and cabbage, Sauerkraut, Pickle Leafy vegetables; Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Bitter gourd: Pickle, Dried bitter gourd. Indian Food Regulation and Quality Assurance.</p>		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Assess the basic agricultural aspects of fruits and vegetables.
- Demonstrate the processing of fruits and vegetables.
- Apply the freezing and dehydration technology in preservation of excess produce.
- Apply thermal processing methods in fruit and vegetable technology.
- Demonstrate the of manufacturing of fruit and vegetable products.

**Text Books:**

- 1 Hosahalli S. Ramaswamy. "Post-harvest Technologies of Fruits & Vegetables" DES tech publications, 2015.
- 2 L.R. Verma & V.K. Joshi. "Post-harvest Technology of fruits and vegetables: General concepts and Principles." Indus publishing, 2000.

**Reference Books / Web links:**

- 1 Salunke, D. K and S. S Kadam "Hand Book of Fruit Science and Technology: Production, Composition, Storage and Processing". Marcel Dekker, 1995.
- 2 Wim Jogen. "Fruit and Vegetable Processing: Improving Quality". Taylor & Francis, 2002

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4
CO1	3	3	3	2	3	3	3	3	3	3	2	3	2	2	1	3
CO2	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO4	3	3	3	2	3	2	3	3	3	3	3	3	3	3	1	3
CO5	3	3	2	2	3	2	1	3	3	2	3	2	2	3	1	2
Average	3	3	2.8	2	3	2.2	2.6	3	3	2.8	2.8	2.8	2.6	2.8	1	2.8

Subject Code	Subject Name	Category	L	T	P	C
FT 17611	FRUIT AND VEGETABLE PROCESSING TECHNOLOGY LABORATORY	PC	0	0	4	2

**Objectives:**

- To learn the manufacturing process associated with fruit based RTS products.
- To get familiar with Canning and osmotic dehydration process.
- To learn the manufacturing process associated with vegetable based RTS products.
- To gain knowledge on quality evaluation of fruit and vegetable products.
- To learn the fermentation process associated with vegetable based products.

List of Experiments			
1	Preparation of orange squash and cordial.		
2	Preparation of canned peas / pine apple.		
3	Preservation and processing of certain vegetables by drying and dehydration		
4	Preparation of Jam/Jelly and its preservation by sugar		
5	Preparation of pickles		
6	Osmotic dehydration of certain fruits and vegetables using concentrated sugar and salt solutions		
7	Preparation of malt based drink.		
8	Preparation of fruit juice/pulp and its preservation by chemical Preservatives/ thermal processing.		
9	Preparation of tomato puree/ketchup and its preservation by chemical preservatives		
10	Preparation of fruit bar.		
11	Preparation of Ready to serve beverages.		
12	Quality evaluation of fruit beverages.		
13	Fermented fruit and vegetable preparation and its quality evaluation		
14	Visit to Fruit/vegetable Processing Industry		
			<b>Total Contact Hours : 60</b>

**Course Outcomes:**
**The students will be able to**

- Demonstrate the manufacturing process associated with fruit based RTS products.
- Apply the Canning and osmotic dehydration process to preserve the fruits and vegetables
- Demonstrate the manufacturing process associated with vegetable based RTS products.
- Assess the quality of prepared fruit and vegetable products.
- Apply the fermentation process to produce RTS fruit and vegetable based products.

**References:**

1. W. V. Cruess. "Laboratory Manual of Fruit and Vegetable Products" Fb&C Ltd., 2018
2. L.R. Verma & V.K. Joshi. "Post-harvest Technology of fruits and vegetables: General concepts and Principles." Indus publishing, 2000.
3. Hosahalli S. Ramaswamy. "Post-harvest Technologies of Fruits & Vegetables" DES tech publications, 2015.

**LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS**

Equipment Required		
S.No.	Name of the equipment	Quantity

1.	Mixer	1
2.	Canning unit	2
3.	Metal can sealer	1
4.	Tray dryer	1
5.	Hand held Refractometer	5
6.	Jelly cups/moulds	10
7.	Cooking vat	1
8.	Gas stove	1
9.	Stainer	2
10.	Blender	2
11.	Retort processor	1
12.	Laminar air flow chamber	1
13.	Incubator	1
14.	Viscometer	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	3	1	-	-	-	2	2	2	2	-	3
CO2	2	2	2	3	2	2	2	-	-	-	2	2	3	3	-	3
CO3	1	2	1	2	2	3	1	-	-	-	2	2	2	2	-	3
CO4	1	2	2	-	-	-	1	-	-	-	2	3	2	2	-	3
CO5	2	2	2	3	2	2	2	-	-	-	2	2	3	3	-	3
Average	3	2.4	2.4	2.4	2.4	0	0	2	0	0	0	3	2.8	3	0	2

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT 17612	DAIRY PROCESS TECHNOLOGY LABORATORY	PC	0	0	4	2

Objectives:	
●	To learn the manufacturing process associated with Dairy products.
●	To get familiar with sampling techniques and microbiological analysis of milk.
●	To study the detect the adulterants and preservatives in milk.
●	To learn the manufacturing process of milk products.
●	To study the unit operations associated with dairy industry.

<b>List of Experiments</b>			
<b>1</b>	Sampling, chemical and microbial examination of pasteurized, sterilized and UHT processed milk.		
<b>2.</b>	Determination of viscosity, density and specific gravity of milk		
<b>3.</b>	Platform test – MBRT and clot on boiling test.		
<b>4.</b>	Determination of water activity and sorption isotherms of milk products.		
<b>5.</b>	Detection of adulterants and preservatives in milk.		
<b>6.</b>	Batch pasteurization of milk – study on Different controls on pasteurizer.		
<b>7.</b>	Continuous pasteurization of milk – study on Different controls on pasteurizer.		
<b>8.</b>	Construction and operation of Spray dryer for the production of milk powder.		
<b>8.</b>	Construction and operation of Butter Churning and working of accessories.		
<b>9.</b>	Standardization of milk by Pearson Square method		
<b>10.</b>	Construction and operation of Homogenizer for size reduction of fat globules in milk		
<b>11.</b>	Problem solving – Skimming efficiency of cream separator		
<b>12.</b>	Preparation of Ice- Cream		
<b>13.</b>	Visit to Dairy Processing Industry		
			<b>Total Contact Hours : 60</b>

**Course Outcomes:****The students will be able to**

- Demonstrate the manufacturing process associated with dairy products
- Perform quality analysis of milk
- Examine the microbiological properties of milk.
- Demonstrate the unit operations associated with dairy processing.
- Standardize the milk containing different fat percentage.

**References:**

1. R.K. Robinson, “Modern dairy technology Vol. I Advances in Milk processing”. Elsevier Applied Science Publishes, London, 1986
2. Gerrit Smit, “Dairy processing Improving quality”, Published by Woodhead Publishing Limited, CRC PRESS, 2000.
3. H.G. Kessler, “Food engineering and dairy technology”, Verlag A. Kessler, Freising, (F.R.Germany.) 1981



### LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	Name of the equipment	Quantity
1.	Homogenizers	1
2.	Continuous Pilot scale pasteurizer	1
3.	Vat Pasteurizer	1
4.	Water bath	2
5.	Viscometer	1
6.	Density meter	2
7.	Spray dryer	1
8.	Butter churner	1
9.	Cream Separator	1
10.	Ice Cream Freezer	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO5	3	3	3	1	1	3	3	3	2	2	3	3	3	3	-	3
Average	3	2.4	2.6	1.8	2.6	2	2.2	2.4	1.2	2	2.4	2.2	2.6	2.4	-	3

Subject Code	Subject Name	Category	L	T	P	C
FT 17701	FOOD SAFETY, QUALITY AND REGULATION	PC	3	0	0	3

Objectives:	
•	To gain the knowledge on hazards associated with the food industry
•	To know the quality attributes of the food and its control
•	To understand the role of HACCP & ISO 22000 in food safety management
•	To gain knowledge on international laws for trade practices
•	To familiarize with CODEX commission and its regulation

UNIT-I	INTRODUCTION TO FOOD SAFETY	9
Definition of food safety and concept of safe food; characterization of food hazards- physical, chemical and biological; Hygienic design of food plants and equipment's, Food Contaminants (Microbial, Chemical,		

Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection.		
<b>UNIT-II</b>	<b>FOOD QUALITY</b>	<b>9</b>
Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.		
<b>UNIT-III</b>	<b>HAZARDS AND QUALITY CONTROL</b>	<b>9</b>
Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication. ISO 22000 – Importance and Implementation.		
<b>UNIT-IV</b>	<b>RECENT TRENDS IN FOOD SAFETY REGULATIONS &amp; STANDARDS</b>	<b>9</b>
Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC).		
Food Safety and Standards Authority of India- Regulation on Licensing and Registration of Food Businesses, Regulation on Import of foods, Regulation on Food Recall Procedure, Regulation on Prohibition and Restriction of Sales.		
<b>UNIT-V</b>	<b>CODEX COMMISSION</b>	<b>9</b>
Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Identify the hazards associated with foods.
- Carry out quality control analysis of food.
- Develop HACCP plan for food industry.
- Apply international laws for fair trade practices.
- Gain knowledge on international laws.

**Text Books:**

- 1 The food safety information handbook by Cynthia A. Robert, 2009
- 2 Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003.

**Reference Books / Web links:**

- 1 Handbook of food toxicology by S. S. Deshpande, 2002
- 2 Nutritional and safety aspects of food processing by Tannenbaum S. R, Marcel Dekker Inc., New York 1979.

<b>3</b>	Microbiological safety of Food by Hobbs BC, 1973.
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PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	0	2	0	3	0	1	3	2	2	1	2	1	0	2	0	1
CO2	2	0	0	3	0	1	3	3	2	1	2	1	1	2	0	1
CO3	1	2	0	0	0	0	1	3	1	1	1	1	1	2	1	1
CO4	1	0	0	0	0	0	1	1	0	1	0	1	0	2	1	1
CO5	1	0	0	0	0	0	1	1	0	1	0	1	0	2	1	1
Average	1	2	0	3	0	1	1.8	2	2	1	1.6	1	1	2	1	1

Subject Code	Subject Name	Category	L	T	P	C
FT 17702	FOOD PACKAGING TECHNOLOGY	PC	3	0	0	3

Objectives:	
●	To learn basics of food packaging & testing its performance.
●	To gain knowledge on different food grade packaging materials.
●	To understand the functions of novel packaging system.
●	To develop suitable packaging system for different food matrix.
●	To understand the Regulatory aspects of packaging.

UNIT-I	BASICS OF PACKAGING	9
Introduction of Food Packaging-Need of food packaging, Role of packaging, Designing of package materials, Testing of package materials & its performance- WVTR, GTR, bursting strength, tensile strength, tearing strength, drop test, puncture test, impact test etc., Principles in the development of safe and protective packing, Safety assessment of food packaging materials: Studies on migratory chemicals from food packages and its toxic effects.		
UNIT-II	PACKAGING MEDIA & MATERIALS	9
Introduction of packaging materials, Types of packaging materials their characteristics and uses; Use of paper as a packaging material-Pulping, Fibrillation, Beating, Types of papers ,Testing methods; Use of glass as a packaging material-Composition, Properties, Types, Methods of bottle making; Use of metals as a packaging material- Tinplate containers, Tinning process, Components of tinplate, Tin free steel (TFS), Types of cans, Aluminium containers, Lacquers; Use of plastics as a packaging material-Types of plastics, Plastic films, laminated plastic materials, Co-extrusion.		
UNIT-III	PACKAGING SYSTEMS AND METHODS	9
Vacuum packaging, Gas flush packaging - CAP & MAP, Aseptic packaging, Retort packaging, box in box, Packages for microwave ovens, Biodegradable plastics, Edible packaging & Coatings- Coating on paper &		

films, types of coatings. Need of coating, methods of coatings; Active packaging systems and their food applications.			
<b>UNIT-IV</b>	<b>PAKAGING REQUIREMENTS OF DIFFERENT COMMODITIES</b>	<b>9</b>	
Food packaging systems, Product characteristics and package requirements, Different forms of packaging- Rigid, semi-rigid, flexible forms of packaging. Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods, Eggs, Breakfast cereals & baked food products, Beverages, Snacks.			
<b>UNIT-V</b>	<b>REGULATORY ASPECTS OF PACKAGING</b>	<b>9</b>	
Food Packaging Laws and Regulations, Food Labelling, coding and marking including bar coding. Packaging requirements under FSSAI regulations- Declaration and Labelling, Specification of Display panels, Statutory Requirements on Packages.			
		<b>Total Contact Hours</b>	<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Demonstrate the packaging functions and evaluate its performance in food preservation.
●	Utilize the various food grade materials for packaging of food.
●	Comprehend the functions of advanced packaging methods.
●	Design the packaging system for different food matrix
●	Apply the packaging and labelling regulations while designing the packaging system.

<b>Text Books:</b>	
1	Robertson, G.L. "Food Packaging: Principles and Practice". 3 <sup>rd</sup> Edition. Taylor & Francis, 2013.
2	Robertson, G.L. "Food Packaging and Shelf-life: A Practical Guide, CRC Press, 2009.
3	Food Safety and Standards (Packaging and Labelling) Regulation, 2011
4	Food Safety and Standards (Packaging) Regulation, 2018

<b>Reference Books / Web links:</b>	
1	Ahvenainen, Raija. "Novel Food Packaging Techniques". Wood Head Publishing, 2003.
2	Han, Jung H. "Innovations in Food Packaging". Elsevier, 2005.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4
CO1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO5	3	3	3	1	1	3	3	3	2	2	3	3	3	3	-	3
Average	3	2.4	2.6	1.8	2.6	2	2.2	2.4	1.2	2	2.4	2.2	2.6	2.4	-	3

Subject Code	Subject Name	Category	L	T	P	C
FT 17703	REFRIGERATION AND COLD CHAIN MANAGEMENT	PC	3	0	0	3

Objectives:	
●	To learn the fundamental principles and methods of refrigeration
●	To study various refrigeration cycles and evaluate its performance
●	To study the different refrigerants with respect to properties, applications and environmental issues.
●	To highlight the use of predictive modelling as a tool in shelf life assessment
●	To understand the key aspects of food supply chains from a management and social perspective

<b>UNIT-I</b>	<b>REFRIGERATION PRINCIPLES</b>	<b>9</b>
Refrigeration – principles - refrigeration effect – coefficient of performance – units of refrigeration - simple vapor compression cycle – T-S diagram – p-h chart - application of refrigeration		
<b>UNIT-II</b>	<b>VAPOR COMPRESSION REFRIGERATION AND COMPONENTS</b>	<b>9</b>
Vapour compression system - refrigeration components – compressor and condenser – types, construction and working - expansion device and evaporators – types, construction and working.		
<b>UNIT-III</b>	<b>REFRIGERANTS AND VAPOR ABSORPTION CYCLE</b>	<b>9</b>
Refrigerants – properties – classification – comparison and advantages – chloroflouro carbon (CFC) refrigerants - effect on environmental pollution - alternate refrigerants - vapour absorption cycle – theoretical - deviation in practice - Electrolux refrigerator – construction and principles.		
<b>UNIT-IV</b>	<b>SHELF-LIFE OF FOOD PRODUCTS</b>	<b>9</b>
Defining overall Shelf-life, remaining shelf life in the context of Chilled & Frozen foods; - Deterioration modes of food items; Models of quality deterioration- Kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf – life; General procedure for shelf – life testing – the 11 steps procedure. Storage of frozen foods; - Basic design requirements of storage to uphold the shelf –life – size, Insulation, entry –exit position, palletization, proper disk-space for air-circulation, automatic door – closing, proper lighting, temperature monitoring and recording facility; stacking systems, emergency exits, material handling devices like fork-lifts, pallet trucks, etc. floor heaters, vapor barriers.		
<b>UNIT-V</b>	<b>COLD CHAIN</b>	<b>9</b>

What is cold chain? Need for the chain for chilled / frozen food item, various links of the chain; importance of shelf- life; just – in-time deliveries; Temperature limits;-in various countries-Europe, US, Australia etc.; Chilling and freezing;- Chilling injury, cook-chilling systems; cold – shortening; PPP and TTT concepts; Temperature monitoring; -Critical temperatures; Temperature –time indicators(TTI); Time –temperature – correlation-the kinetic approach, effective temperature; Transportation regulations; Role of packaging in cold chain– MAS, MAP, CAS, CAP etc.; Thaw indicators.															
														<b>Total Contact Hours</b>	<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

●	Illustrate the fundamental principles and applications of refrigeration system.
●	Obtain cooling capacity and coefficient of performance by conducting test on vapour compression system
●	Present the properties, applications and environmental issues of different refrigerants
●	Demonstrate the predictive modelling for shelf life assessment of foods
●	Identify challenges to the future of food retailing as well as challenges in international food supply chains

**Text Books:**

1	Anand, M.L. “Refrigeration& Air-Conditioning”. Asian Books Pvt., Ltd., 2002.
2	Sun, Da-Wen. “Advances in Food Refrigeration”. Leatherhead Publishing, 2001.
3	Kennedy, Christopher J. “Managing Frozen Foods”. CRC / Wood head Publishing, 2000.
4	James, S.J. and C. James. “Meat Refrigeration”. CRC / Wood head Publishing, 2002.
5	Stringer, Mike and C. Dennis. “Chilled Foods: A Comprehensive Guide”. 2nd Edition, CRC/Wood head Publishing, 2002.

**Reference Books / Web links:**

1	Evans, Judith. “Frozen Food Science and Technology”. Wiley-Blackwell, 2008.
2	Hui, Y.H. <i>et al.</i> , “Handbook of Frozen Foods”. Marcel Dekker, 2004.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	3	-	-	-	3	3	3	-	3	3
CO2	3	3	2	2	2	2	2	-	-	-	-	3	3	-	-	-
CO3	3	3	3	2	3	2	2	-	-	-	3	3	3	-	3	3
CO4	3	3	2	2	3	2	2	-	-	-	3	3	3	-	3	3
CO5	3	3	3	3	3	3	3	-	-	-	3	3	3	-	3	3
Average	3	2.8	2.4	2.2	2.6	2.4	2.4	0	0	0	3	3	3	-	3	3

Subject Code	Subject Name	Category	L	T	P	C
FT 17711	TESTING OF PACKAGING MATERIALS LABORATORY	PC	0	0	4	2

Objectives:	
●	To describe testing methods for packaging material
●	To get familiar with detect the type of plastic packaging material
●	To gain experience with universal testing machine for analysis of different parameters of packaging material.
●	To learn the operation of WVTR & OTR testing machines.
●	To learn the testing methods for migration of chemicals from packaging material.

List of Experiments	
1	Identification of different types of packaging and packaging materials
2	Measurement of thickness of packaging films, papers and boards
3	Measurement of water absorption of paper, paper boards
4	Measurement of bursting strength of paper of paper boards
5	Determination of tensile/compression strength of given material
6	Destructive and non-destructive test on glass container, drop test
7	Determination of wax weights, tensile strength of papers, bursting strength
8	Determination of WVTR of various packaging materials
9	Determination of Oxygen Transmission Rate of various packaging materials
10	Determination of coating on package materials
11	Evaluation of residue migration from package to food
12	Tests for identification of plastic films.
Total Contact Hours : 60	

Course Outcomes:	
The students will be able to	
●	Demonstrate the testing methods for packaging materials.
●	Identify the type of packaging material
●	Operate the food package testing equipment's.
●	Analyse the WVTR and OTR of different packaging films.
●	Evaluate the properties of food packaging materials

References:	
1.	Robertson, G. L. Food Packaging Principles and Practices, (Marcel Decker, 2006)
2.	Han, J.H. Innovation in Food Packaging, (Elsevier Publications, 2005)

### LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	Name of the equipment	Quantity
1.	Caliper Thickness Gauge	2
2.	Universal Testing machine for packaging material	2
3.	Pouch Burst Tester	1
4.	Drop Tester	1
5.	COBB Tester	1
6.	Water Vapour Transmission Rate testing equipment	2
7.	Oxygen Transmission Rate testing equipment	5
8.	Densimeter for packaging material	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO5	3	3	3	1	1	3	3	3	2	-	3	3	3	3	-	3
Average	3	2.4	2.6	1.8	2.6	2	2.2	2.4	1.2	-	2.4	2.2	2.6	2.4	-	3

### PROFESSIONAL ELECTIVES – I

Subject Code	Subject Name	Category	L	T	P	C
<b>FT 17E51</b>	<b>BIOLOGY AND CHEMISTRY OF FOOD FLAVOURS</b>	PE	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
•	To describe flavour and its classification.					
•	To comprehend the chemical compounds responsible for flavour in food processing.					
•	To establish the knowledge about anatomy of chemical sense and receptor mechanism					
•	To distinguish the various techniques for the analysis of flavour compounds.					
•	To identify the flavour chemical reaction in food.					

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Different flavour in food – classification of food flavours; chemical compounds responsible for flavour		
<b>UNIT-II</b>	<b>FLAVOUR COMPOUNDS</b>	<b>9</b>
Chemical compound classes and their flavour responses; flavour development during biogenesis, flavour development during food processing; use of biotechnology to develop flavours.		
<b>UNIT-III</b>	<b>THE CHEMICAL SENSES</b>	<b>9</b>
Anatomy of the chemical senses; neural development of the chemical senses; receptor mechanisms, neural coding; the control of eating		



<b>UNIT-IV</b>	<b>FLAVOUR ANALYSIS</b>	<b>9</b>
Subjective versus Objective methods of analysis; psychophysics and sensory evaluation and its types, ENOSE, ETONGUE; Instrumental analysis; sample handling and artefacts; data handling		
<b>UNIT-V</b>	<b>TEACHING FLAVOUR CONCEPTS</b>	<b>9</b>
Problem based learning; tongue and nose; Onion-Beverage-Maillard reaction-Thio-stench		
		<b>Total Contact Hours : 45</b>
<b>Course Outcomes:</b> On completion of course students will be able to		
●	Illustrate flavour and its classification.	
●	Understand the chemical compounds responsible for flavour during food processing.	
●	Interpret about anatomy of chemical sense and receptor mechanism	
●	Distinguish the various techniques for the analysis of flavour compounds.	
●	Identify the flavour chemical reaction in food	
<b>Text Books:</b>		
1	Fisher, Carolyn and Thomas R. Scott. “Food Flavours: Biology and Chemistry”. The Royal Society of Chemistry, 1997	
2	Heath, H.B. and G. Reineccius. “Flavour Chemistry and Technology”. CBS Publishers,1996	
3	Reineccius, Gary. “Flavour Chemistry and Technology”. II Edition, Taylor & Francis, 2006.	
4	Shahidi, Fereidoon and Chi-Tang Ho. “Flavour Chemistry of Ethnic Foods”. Kluwer Academic / Plenum, 1999.	
5	Ashurst, Philip R. “Food Flavourings”. III Edition, Aspen Publications, 1999.	
<b>Reference Books / Web links:</b>		
1	Hofmann, Thomas. “Challenges in Taste Chemistry and Biology”. American Chemical Society Publications, 2004.	
2	Charalambous, G. “Food Flavours: Generation, Analysis and Process Influence”. Elsevier,1995.	

Subject Code	Subject Name	Category	L	T	P	C
<b>FT 17E52</b>	<b>PULSE AND OIL SEED TECHNOLOGY</b>	PE	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
●	To establish the knowledge about classification and chemical composition of pulse and oilseed					
●	To learn about the chemical compounds responsible for flavour during food processing.					
●	To gain knowledge about soya and its by-products processing					
●	To establish the knowledge about classification and chemical composition of oilseed					
●	To understand the different type of oil processing					

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
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Present status and future prospectus of Pulse and Oil seeds, Morphology of legume. Classification and types of legumes and pulses. Chemical composition and nutritional value. Anti-nutritional factors, their chemistry, methods of removal of anti-nutritional factors			
<b>UNIT-II</b>	<b>LEGUMES</b>		<b>9</b>
Processing of legumes: Home scale, Cottage Scale and commercial methods of dehulling. Modern techniques in Dal mills. Processing of Red gram, Bengal gram, Green gram, Black gram. Dal milling – Principle, methods, equipment's and effect on quality. Principle products, Dry and Wet milling of pulses, Fermented Products of legumes. Soaking – Principles, Methods of soaking -Sprouting, Puffing, Roasting & Parboiling of Legumes, Physical and Bio-chemical changes during these processes. Cooking quality of dhal – methods, factors affecting quality of dhal and cooking of dhal. Quick cooking dhal, Instant dhal.			
<b>UNIT-III</b>	<b>SOYA PROCESSING</b>		<b>9</b>
Soya as a source of protein and oil; Processing of Soya - soya milk, soy protein Isolate, soya paneer, soya sauce; extrusion technology and production of textured vegetable proteins.			
<b>UNIT-IV</b>	<b>OIL SEEDS</b>		<b>9</b>
Chemical composition and characters of oil seed and Oils, Anti-nutritional factors, elimination Methods. Post-Harvest Technology of Oil seeds, Handling Drying, Storage, and Grading, Pre-treatments, cleaning, Dehulling, Size reduction and flaking. Oil extraction: Traditional Methods, Ghani, Power Ghanis, Expellers - Principle of Expeller, structure design of expeller. Solvent extraction process: Principle, Pre-treatment - Breaking, Cracking, flaking.			
<b>UNIT-V</b>	<b>OIL SEED PROCESSING</b>		<b>9</b>
Extraction principles, factors affecting the extraction process. Desolventization. Refining of Oils - Degumming, neutralization, bleaching, filtration, deodorization, their Principles and process controls. New Technologies in oil seed processing, utilization of oil seed meals of different food uses. High protein Product, like protein concentrate and isolates.			
		<b>Total Contact Hours</b>	<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

●	Interpret the chemical and biological structure of pulses.
●	Comprehend different processing of legumes and its by product
●	Infer soya and its by-products processing
●	Identify chemical composition of oilseed and its classification
●	Understand oil processing technologies and factors affects oil extraction process

**Text Books:**

1	Lawson, Harry "Food Oils and Fats: Technology, Utilization, and Nutrition". CBS Publishers, 1997.
2	Hamm, Wolf and Richard J Hamilton "Edible Oil Processing" Blackwell Publishing, 2004
3	Gunstone, Frank D. "The Chemistry of Oils and Fats: Sources, Composition, Properties and uses" Blackwell Publishing, 2004.

Reference Books / Web links:	
1	Rajah, Kanes K. "Fats in Food Technology", Blackwell / Ane Books, 2004.
2	Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.

Subject Code	Subject Name	Category	L	T	P	C
FT 17E53	TRADITIONAL FOODS	PE	3	0	0	3
<b>Objectives:</b>						
<ul style="list-style-type: none"> <li>To acquire a knowledge about historical, cultural and diversities of food in India</li> <li>To learn about the traditional method of food processing and its health benefits.</li> <li>To gain knowledge about food pattern followed traditionally and IPR issued to traditional food</li> <li>To establish the knowledge about different commercial traditional food processing</li> <li>To understand the consumption of traditional foods and its health benefits</li> </ul>						

<b>UNIT-I</b>	<b>HISTORICAL AND CULTURAL PERSPECTIVES</b>	<b>9</b>
Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture -variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts – festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.		
<b>UNIT-II</b>	<b>TRADITIONAL METHODS OF FOOD PROCESSING</b>	<b>9</b>
Traditional methods of milling grains – rice, wheat and corn – equipment's and processes as compared to modern methods. Equipment's and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sun drying, osmotic drying, brining, pickling and smoking.		
<b>UNIT-III</b>	<b>TRADITIONAL FOOD PATTERNS</b>	<b>9</b>
Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods		
<b>UNIT-IV</b>	<b>COMMERCIAL PRODUCTION OF TRADITIONAL FOODS</b>	<b>9</b>
Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.		
<b>UNIT-V</b>	<b>HEALTH ASPECTS OF TRADITIONAL FOODS</b>	<b>9</b>

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments/illnesses.					
			<b>Total Contact Hours</b>	<b>:</b>	<b>45</b>
<b>Course Outcomes:</b>					
On completion of course students will be able to					
●	Understand the historical and traditional perspective of foods and food habits				
●	Distinguish the wide diversity and common features of traditional Indian foods and meal patterns				
●	Grasp the knowledge about food pattern followed traditionally and IPR issued to traditional food				
●	Apply the knowledge in the production of commercial traditional food processing				
●	Infer the health aspects of traditional foods.				
<b>Text Books:</b>					
1	Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.80.				
2	Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.				

Subject Code	Subject Name	Category	L	T	P	C
<b>FT 17E54</b>	<b>BEVERAGES TECHNOLOGY</b>	PE	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
●	To learn the formulation of beverages using selected ingredients					
●	To understand the unit operations involved in the carbonated beverage manufacturing					
●	To explain the various production techniques in non-carbonated beverages					
●	To evaluate the quality parameters of fermented beverages					
●	To implement the food laws and regulations of beverages					

<b>UNIT-I</b>	<b>INGREDIENTS IN BEVERAGES</b>	<b>10</b>
Beverage: Introduction, Global and Indian scenario. Classification of beverages. Ingredients- water, quality evaluation, raw and processed water, bulk and intense sweeteners, water miscible and water dispersible flavouring agents, Micro and Nano-emulsions of flavours, colour natural and artificial, preservatives, clouding agents emulsifiers and stabilizers.		
<b>UNIT-II</b>	<b>CARBONATED BEVERAGES</b>	<b>9</b>
Preparation of Syrup making, blending, Carbonation of soft drinks, filling, packaging, containers, closures. Powdered dry mix; Energy drinks and sports drinks; Fruit based carbonated beverages, carbonated water. Equipment's used in the manufacture of carbonated beverages.		
<b>UNIT-III</b>	<b>NON-CARBONATED BEVERAGES AND BOTTLED WATER</b>	<b>9</b>
Beverages based on tea, coffee, cocoa, spices, herbs, dairy based beverages, Fruit based non-carbonated beverage - RTS beverages, Squash, Nectar, Cordial and Fruit concentrate. Flash pasteurization, Canning and Aseptic Packaging of beverages. Bottled water, mineral water, spring water, flavoured water.		

UNIT-IV	FERMENTED BEVERAGES	9
Alcoholic beverages- Classification. Fermented alcoholic beverage - Beer - ale type beer, lager type beer, the role of yeast in beer, technology of brewing process. Wine, Cider, Perry and Sake. Distilled spirits - Whisky, Brandy, Vodka, Rum, Tequila and gin. Equipment used for brewing and distillation		
UNIT-V	SANITATION AND QUALITY CONTROL	8
Quality control in beverage industry- System quality control Product quality control and microbial quality control. CIP. Sanitation and hygiene in beverage industry. Standards and regulations of beverages.		
		Total Contact Hours : 45
Course Outcomes:		
On completion of course students will be able to		
●	Organize the formulation of beverages using selected ingredients 3. 4. 5.	
●	Apply Unit operations involved in the carbonated beverage manufacturing	
●	Explain the various production techniques in non-carbonated beverages	
●	Evaluate the quality parameters of fermented beverages	
●	Implement the food laws and regulations of beverages	
Text Books:		
1	L.Jagan Mohan Rao and K.Ramalakshmi, Recent trend in Soft beverages, Woodhead Publishing India Pvt Ltd.,New Delhi 2011.	
2	Woodroof, Jasper Guy, and G. Frank Phillips. Beverages: carbonated and noncarbonated. AVI Pub. Co., 1981	

<b>Reference Books / Web links:</b>		
1	Mitchell, Alan J. Formulation and Production Carbonated Soft Drinks. Springer Science & Business Media, 1990.	
2	Richard Coles and Mark Kirwan Food and Beverage Packaging Technology Second Edition Blackwell Publishing Ltd., 2011.	
3	Hui, Yiu H., et al., eds. Handbook of food and beverage fermentation technology. Vol. 134. CRC Press, 2004.	
4	Boulton, Christopher, and David Quain. Brewing yeast and fermentation. John Wiley & Sons, 2008.	

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	1	-	-	1	2	2	2	2	1
CO2	3	2	2	3	3	3	2	-	-	-	1	3	3	3	1	1
CO3	3	3	3	1	3	3	1	-	-	-	1	3	2	2	2	1
CO4	2	3	2	3	3	2	2	1	-	-	1	2	2	2	1	1
CO5	2	2	1	2	1	2	2	1	-	-	1	2	2	1	3	1
Average	2.4	2.4	2.0	2.2	2.4	2.4	1.8	1	0	0	1	2.4	2.4	2.2	1.8	1

Subject Code	Subject Name	Category	L	T	P	C
FT 17E55	BIOCHEMICAL ENGINEERING	PC	3	0	2	4

Objectives:	
●	To familiarize with the basics of enzyme, properties, types and its mode of action
●	To understand the various kinetic mechanisms of enzyme action, deactivation and their regulation
●	To gain knowledge on methods, kinetics characteristics and applications of immobilized enzymes.
●	To learn the nutritional requirements of microbial cells for media formulation and its sterilization kinetics.
●	To get a practical knowledge about running the fermenter and its scale – up and modes of operation.

UNIT-I	INTRODUCTION TO ENZYME	9
Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.		
UNIT-II	KINETICS OF ENZYME ACTION	9
Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions-mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod –changeux-wyman model, pH and temperature effect on enzymes & deactivation kinetics.		
UNIT-III	ENZYME IMMOBILIZATION	9
Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages.		
UNIT-IV	OVERVIEW OF FERMENTATION PROCESSES	9
Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes.		
UNIT-V	RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS	9
Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods		
Total Contact Hours		60

List of Experiments	
1	Growth of bacteria – estimation of biomass, calculation of specific growth rate, yield coefficient
2	Medium optimization – Plackett Burman design, response surface methodology
3	Enzyme kinetics – Michelis Menton parameter, effect of temperature and pH
4	Enzyme immobilization – gel entrapment, cross linking

5	Preparation of bioreactor, utilities for bioreactor operation
6	Thermal death kinetics
7	Batch sterilization design
8	Batch cultivation with exhaust gas analysis – carbon balancing, gas balancing
9	Fed batch cultivation with exhaust gas analysis – carbon balancing, gas balancing
10	Estimation of $k_L a$ – sulphite oxidation method
11	Estimation of overall heat transfer coefficient

**Course Outcomes:**

On completion of course students will be able to

- Demonstrate the basic enzymes and its reaction kinetics
- Interpret the mechanism of enzyme action
- Analyse the options for applying enzymes and its inhibitors in area of food processing
- Design culture medium based on requirement and criteria for medium sterilization
- Design bioreactor based on targets, constraints, and physical properties.

**Text Books:**

- 1 Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals”, 2nd Edition, McGraw Hill, 1986.
- 2 Blanch, H.W. and D.S. Clark “Biochemical Engineering”, Marcel Dekker, Inc., 1997.
- 3 Lee, James M. “Biochemical Engineering”, Prentice – Hall, 1992.

**Reference Books / Web links:**

- 1 Palmer, Trevor “Enzymes: Biochemistry, Biotechnology, Clinical Chemistry”, Affiliated East West Press Pvt.Ltd., 2004.
- 2 Stanbury, P.F., A. Whitaker and S.J. Hall “Principles of Fermentation Technology”, 2<sup>nd</sup> Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
- 3 Wiseman, Alan “Handbook of Enzyme Biotechnology”, 3<sup>rd</sup> Edition, Ellis Harwood Publications, 1999
- 4 Hartmeier, Winfried “Immobilized Biocatalysts: An Introduction”, Springer –Verlag, 1986

**LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS****Equipment Required**

S.No.	Name of the equipment	Quantity
1.	Laboratory scale Bioreactor	1
2.	Shaker incubator	2
3.	Microbiological incubator	1
4.	UV-Vis Spectrophotometer	1

5.	Table top centrifuge	2
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### **PROFESSIONAL ELECTIVES II & III**

Subject Code	Subject Name	Category	L	T	P	C
FT 17E61	FUNCTIONAL FOODS AND NUTRACEUTICALS	PE	3	0	0	3

**Objectives:**

•	To establish the knowledge about importance and classification of functional foods and nutraceuticals
•	To familiarize with different qualitative and quantitative methods of phytochemical analysis
•	To recognize the <i>in vivo</i> and <i>in vitro</i> techniques used for antioxidant assessment
•	To be acquainted with knowledge of functional foods and nutraceuticals in treatment of specific disease
•	To understand the National and International health Claims, regulations and safety issues regarding functional foods and nutraceuticals

<b>UNIT-I</b>	<b>INTRODUCTION AND SIGNIFICANCE</b>	<b>9</b>
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Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoo chemicals and microbes in food, plants, animals and microbes.

<b>UNIT-II</b>	<b>ANALYSIS OF PHYTOCHEMICALS</b>	<b>10</b>
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Qualitative and quantitative methods: phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, Chitin; Carotenoids - Factors affecting bioavailability, chemical and histochemical characterization of cell wall polysaccharides in almond seed in relation to lipid bioavailability.

<b>UNIT-III</b>	<b>ASSESSMENT OF ANTIOXIDANT ACTIVITY</b>	<b>10</b>
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In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different In Vitro methods to evaluate the antioxidant, Prediction of the antioxidant activity of natural phenolics from electro topological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

<b>UNIT-IV</b>	<b>ROLE IN HEALTH AND DISEASE</b>	<b>10</b>
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Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and symbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

<b>UNIT-V</b>	<b>SAFETY ISSUES</b>	<b>6</b>
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Health Claims, regulations and safety issues- International and national.

	<b>Total Contact Hours</b>	<b>:</b>	<b>45</b>
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**Course Outcomes:**

On completion of course students will be able to



●	Grasp the knowledge about importance and classification of functional foods and nutraceuticals
●	Infer the different qualitative and quantitative methods of phytochemical analysis
●	Analyze the antioxidant compounds by different methods
●	Understand the role of functional foods and nutraceuticals in treatment of specific disease
●	Identify the National and International health Claims, regulations and safety issues regarding functional foods and nutraceuticals

**Text Books:**

1	Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, II Edition, CRC, 2001
2	Wildman, Robert “Handbook of Nutraceuticals and Functional Foods”. CRC, 2006
3	Webb, P P. “Dietary Supplements and Functional Foods”. Blackwell, 2006
4	Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005
5	Tipnis, H.P. “Bioavailability and Bioequivalence: An Update” New Age International, 1996

**Reference Books / Web links:**

1	Shi, John, Fereidoon Shahidi and Chi-Tang Ho “Asian Functional Foods”. CRC/Taylor & Francis, 2007.
2	Watson, Robald Ross “Functional Foods and Nutraceuticals in Cancer Prevention”. Blackwell Publishing, 2007.
3	Gibson, G.R. and C.M. Williams. “Functional Foods: Concept to Product”. Woodhead, 2000.
4	Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

Subject Code	Subject Name	Category	L	T	P	C
FT 17E62	FOOD TOXICOLOGY AND ALLERGY	PE	3	0	0	3

**Objectives:**

●	To understand allergic mechanism and immune response to the hazards.
●	To understand chemistry of food allergens and food disorders.
●	To empathize toxicity mechanism and factors influence the toxicity and absorption.
●	To learn quantitative and qualitative analysis of toxicants in food.
●	To identify the different toxicants formed during food processing.

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Definition and need for understanding food toxicology; Hazards - Microbiological, nutritional and environmental. Basics of immune resources - humoral and cell media resources. Allergen and mechanism of allergic resources.		

<b>UNIT-II</b>	<b>FOOD ALLERGY AND SENSITIVITY</b>	<b>9</b>
Chemistry of food allergens, celiac disease, food disorders associated with metabolism, lactose intolerance, and asthma.		
<b>UNIT-III</b>	<b>PRINCIPLES OF TOXICOLOGY</b>	<b>9</b>
Natural food toxicants - toxicity of mushroom alkaloids, seafood, vegetables, fruits, pulses, and anti nutritional compounds. Biological factors that influence toxicity, toxin absorption in the GI. track, Industrial microflora, blood, brain barrier, storage and excretion of toxins.		
<b>UNIT-IV</b>	<b>DETERMINATION OF TOXICANTS IN FOOD SAMPLING</b>	<b>9</b>
Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants. Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagen city and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.		
<b>UNIT-V</b>	<b>TOXICANTS FORMED DURING FOOD PROCESSING</b>	<b>8</b>
Intentional direct additives, preservatives, nitrate, nitrite, and N- nitroso compound flavour enhancers, food colours, indirect additives, residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N - nitrosamines, Acrylamide and their mode of action.		
		<b>Total Contact Hours : 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Understand the hazards causing the toxicity and allergic response to the hazard
- Comprehend the chemistry of food allergens and food disorders related metabolism.
- Infer toxicity mechanism and absorption takes place throughout the gut
- Analyse the various types of toxicants in food
- Interpret various toxicants formed during food processing

**Text Books:**

- |          |   |
|----------|---|
| <b>1</b> | Helferich, William and Carl K. Winter “Food Toxicology”, CRC Press, 2001  |
| <b>2</b> | Alluwalla, Vikas “Food Hygiene and Toxicology” Paragon International Publishers, 2007.                            |
| <b>3</b> | Shibamoto, Taka yuki and Leonard F. Bjeldanzes “Introduction to Food Toxicology” II Edition. Academic Press, 2009 |
| <b>4</b> | Maleki, Soheila J. A.Wesley Burks, and RickiM.Helm “Food Allergy” ASM Press, 2006                                 |

**Reference Books / Web links:**

- |          |   |
|----------|---|
| <b>1</b> | Labbe, Ronald G. and Santos Garcia “Guide to Food Borne Pathogens” John Wiley & Sons, 2001.         |
| <b>2</b> | Cliver, Dean O. and Hans P.Riemann “Food Borne Diseases” II Edition., Academic Press/Elsevier, 2002 |

3	Riemann, Hans P. and Dean O. Cliver “Food Borne Infections and Intoxications” III Edition., Academic Press/Elsevier, 2006.
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Subject Code	Subject Name	Category	L	T	P	C
FT 17E63	SPICES AND PLANTATION TECHNOLOGY	PE	3	0	0	3
<b>Objectives:</b>						
•	To gain knowledge about processing conditions of spices from farm to table.					
•	To understand chemistry in the production of coffee and tea.					
•	To be acquainted with knowledge of cocoa and its by-products processing.					
•	To familiarize with plantation crops production, processing and preservation.					
•	To understand quality specification needed for packaging and grading of spices.					

<b>UNIT-I</b>	<b>IMPORTANCE AND PROCESSING OF SPICES</b>	<b>9</b>
<b>A. Major Spices</b> Post-Harvest Technology, composition, processed products of - Pepper, Cardamom, onion, ginger and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles –Enzymatic synthesis of flavour identical - Quality control, Flavour of major spices – Spice oil and oleoresins.		
<b>B. Minor Spices</b> Post-Harvest Technology, composition, processed products of - Cumin, Coriander, Cinnamon, fenugreek, pepper, Garlic, Clove and Vanilla - Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – flavours, Quality control, Present trends in synthesis of volatiles – micro-organisms, plant suspension cultures		
<b>UNIT-II</b>	<b>PROCESSING OF COFFEE AND TEA</b>	<b>9</b>
<b>A. Coffee</b> - Occurrence – chemical constituents – harvesting – fermentation of coffee beans –changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, methods, process and equipment involved–Chicory chemistry - Quality grading of coffee		
<b>B. Tea</b> - Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC– Chemistry and technology of CTC tea – Manufacturing process and equipment involved – Green tea manufacture – Instant tea manufacture – Grading of tea, Processing and quality control		
<b>UNIT-III</b>	<b>CHEMISTRY AND TECHNOLOGY OF COCOA AND COCOA PRODUCTS</b>	<b>9</b>
Occurrence - Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates		
<b>UNIT-IV</b>	<b>PROCESSING OF COCONUT, OILPALM, ARECANUT AND CASHEW</b>	<b>9</b>
Processing of plantation crops – production and importance – processing of coconut, oil palm, arecanut, cashew– harvesting and stages of harvest – drying, cleaning and grading – production of value added products – packaging and storage of produces.		

UNIT-V	PACKAGING, GRADING AND QUALITY ANALYSIS OF SPICES		8
Cleaning and grading of spices - packaging and storage of spices – grading specifications –Agmark, ASTA, ESA specifications - processes involved in the manufacture of oleoresins and essential oils – quality analysis of spices and their derivatives			
			Total Contact Hours : 45
<b>Course Outcomes:</b>			
On completion of course students will be able to			
●	Interpret the major and minor spices processing from farm to table		
●	Grasp the knowledge in the processing of coffee and tea		
●	Infer the chemical constituents and processing of cocoa and its by products		
●	Understand the processing and preservation of plantation crops		
●	Comprehend specifications required for packaging and grading of spices		
<b>Text Books:</b>			
1	Pandey, P. H. 2002. Post-Harvest Engineering of Horticultural Crops through Objectives.SarojPrakasam, Allahabad.		
2	Pruthi, J.S. 1998. Major Spices of India – Crop Management and Post-Harvest Technology. Indian Council of Agricultural Research, Krishi Anusandhan Bhavan, Pusa, NewDelhi.PP. 514.		
<b>Reference Books / Web links:</b>			
1	ASTA, Official analytical methods of the American Spice Trade Association, IV Edition,1997		
2	Purseglove, J.W., E.G. Brown, G.L. Green and S.R.J. Robbins. 1981.		
3	Cardamom – Chemistry. Spices, Vol. I, Tropical Agricultural Series, Longman, London,1981		
4	Pruthi, J.S. Spices and Condiments: Chemistry, Microbiology and Technology. First Edition. Academic Press Inc., New York, USA. 1980		

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	1	2	1	-	-	-	1	2	2	2	1	2
CO2	3	2	2	3	2	3	2	-	-	-	2	3	1	3	1	1
CO3	3	2	2	2	1	3	3	-	-	-	2	3	2	2	1	1
CO4	2	2	3	3	2	2	2	-	-	-	1	2	2	3	2	1
CO5	2	3	2	2	2	2	3	-	-	-	2	2	2	2	2	1
Average	2.4	2.0	2.0	2.4	1.6	2.4	2.2	0	0	0	1.6	2.4	1.8	2.4	1.4	1.2

<b>Code</b>					
<b>FT 17E64</b>	<b>FOOD PROCESS EQUIPMENT DESIGN</b>	PE	<b>3</b>	<b>0</b>	<b>0 3</b>

<b>Objectives:</b>		
•	To gain knowledge about requirements for the construction of equipment	
•	To understand the properties of different construction material	
•	To design of process vessels with closure and pipe fittings	
•	To help students in fabrication of process equipment's with flanges and support	
•	To understand construction and working of process equipment's	
<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Material of construction: Introduction to material selection; Material properties; Environmental effects on material selection; Mechanical properties & strength of materials.		
<b>UNIT-II</b>	<b>CONSTRUCTION REQUIREMENTS</b>	<b>9</b>
Design basis: Design code; Design pressure, stress & factor of safety; Corrosion allowance; Weld joint efficiency factor; Design loadings; Criteria of failure.		
<b>UNIT-III</b>	<b>DESIGN OF PIPES AND PRESSURE VESSELS</b>	<b>9</b>
Design of pipe and pipe fittings. Process vessels under internal and external pressure; Design of attachments and closures.		
<b>UNIT-IV</b>	<b>DESIGN OF SUPPORTS</b>	<b>9</b>
Design of flange connections & threaded fasteners; Design of supports; Bracket or Lug supports, Leg Supports, Skirt Supports		
<b>UNIT-V</b>	<b>DESIGN OF PROCESS EQUIPMENTS</b>	<b>8</b>
Process Design of double pipe heat exchanger; Shell & Tube Heat Exchanger. Design of Evaporator; Agitation Vessels and centrifugal separator. Design of Rotary Dryer.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
•	Grasp knowledge about mechanical properties of construction material
•	Design a basic process equipment
•	Apply the knowledge construction of new process equipment
•	Understand the various features of food process equipment
•	Identify the different process equipment and elaborate the working

<b>Text Books:</b>	
<b>1</b>	B.C.Bhattacharya.—Introduction to Chemical Equipment Design — Mechanical Aspects,CBS Publishers, Delhi.1991.
<b>2</b>	Anantha krishnan.C.P.and M.N.Sinha.—Technology and Engineering of Dairy Plant Operations, Laxmi Publications, New Delhi,1997

<b>Reference Books / Web links:</b>	
<b>1</b>	Groff, Gane K. and Muthu, JohnF.,—Operations Management Selected Readings, D.B.Taraporevala Sons and Co, Bombay,1975.
<b>2</b>	Thuesen,H.G., Febrycky,W.J. and Thuesen,G.J.,—Engineering Economy, Prentice–Hall Inc., NewJersey,1978
<b>3</b>	Stoner,A.F.James.—Management,Prentice-HallofIndia,NewDelhi,1994.

Subject Code	Subject Name	Category	L	T	P	C
FT 17E65	CEREAL TECHNOLOGY	PE	3	0	0	3

<b>Objectives:</b>	
●	To understand the structure of the cereal grain, and the components of commercial flour
●	To familiarize with cereal grain production and quality categorisation systems
●	To learn the important quality attributes and quality indicators for cereal grains
●	To gain knowledge on components of cereal grains which define product suitability and quality
●	To understand the flour requirements for bread, biscuits, pastry and cake, and the additional processing and additives commonly employed

<b>UNIT-I</b>	<b>PRODUCTION, STRUCTURE AND COMPOSITION</b>	<b>6</b>
Status, major growing areas and production of cereals and millets in India and the world, structure, Physical properties; Density, Bulk density, Angle of repose, Hardness, asperity, porosity, stack of milling and moisture on physical properties. Chemical composition, Distribution of nutrients and Aroma of cereals and millets; anti-nutritional factors.		
<b>UNIT-II</b>	<b>WHEAT AND RICE</b>	<b>15</b>
Wheat: Morphology, Physicochemical properties, Wheat Quality, Wheat Milling, quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products – Bread, Biscuit, Cakes, Extruded products, Pizza, Chapattis, malting and malt products; Milling of rice: Conventional Milling, Modern milling, Advantages and disadvantages of milling machineries, By-products of rice milling, Parboiling of rice: Aging of rice: Enrichment: - Need of Enrichment, Methods of enrichment, Enrichment levels, fortification of amino acids. -Processed Foods from rice: Breakfast cereals, flakes, puffing, canning and instant rice.		
<b>UNIT-III</b>	<b>OTHER CEREALS</b>	<b>9</b>
Corn - Morphology, Physico-chemical properties, Corn milling - Wet and dry milling, Milling fractions and		

modify starches Corn Products – Corn flakes, Corn starch, canned corn products, puffed product; HFCS; Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking; Rye bread; Traditional and Fermented cereal products.			
<b>UNIT-IV</b>	<b>MILLETS</b>		<b>6</b>
Sorghum, Pearl Millet, Finger millet, Foxtail millet, Kodo Millet - storage, insect control; processing- Pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.			
<b>UNIT-V</b>	<b>BAKED AND EXTRUDED PRODUCTS</b>		<b>9</b>
Baked foods - chemical dough development, mechanical dough development, sheeting extrusion, other rapid methods; Bread staling – theory, manifestation, retardation measures; Indian Confectionery. Extrusion processing – methods and products.			
<b>Total Contact Hours</b>			<b>45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Explain the structure of the cereal grain, and the components of commercial flour
●	Demonstrate the cereal grain production and quality categorisation systems
●	Assess the important quality attributes and quality indicators for cereal grains
●	Analyse the effect of cereal grains components on product suitability and quality
●	List and explain flour requirements for bread, biscuits, pastry and cake, and the additional processing and additives commonly employed

<b>Text Books:</b>	
1	Matz, Samuel A. “The Chemistry and Technology of Cereals as Food and Feed” II Edition, CBS, 1996.
2	Delcour, Jan A. and R. Carl Hoseney. “Principles of Cereal Science and Technology”. III Edition. American Association of Cereal Chemists, 2010

<b>Reference Books / Web links:</b>	
1	Kulp, Karel “Handbook of Cereal Science and Technology”. II Edition, CRC Press, 2000.
2	Morris, Peter C. and James H Bryce “Cereal Biotechnology”. CRC / Woodhead, 2000

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	2	2	2	2	-	-	-	1	3	2	3	2	1
CO2	2	3	2	3	2	3	2	-	-	-	1	2	1	3	1	2
CO3	2	2	2	2	1	3	3	-	-	-	1	3	2	2	2	2
CO4	3	2	1	3	2	2	2	-	-	-	1	3	2	3	1	1
CO5	2	3	2	2	3	2	3	-	-	-	2	2	2	2	2	1
Average	2.4	2.2	1.8	2.4	2.0	2.4	2.4	0	0	0	1.2	2.6	1.8	2.6	1.6	1.4

Subject Code	Subject Name	Category	L	T	P	C
<b>FT 17E66</b>	<b>INSTRUMENTATION AND PROCESS CONTROL</b>	PE	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
•	To gain insights into basic instrumentation.					
•	To develop a understanding on open loop systems.					
•	To develop a understanding in closed loop systems.					
•	To Know the frequency response in control system.					
•	To Know about the advanced control systems.					

<b>UNIT-I</b>	<b>INSTRUMENTATION</b>	<b>9</b>
Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.		
<b>UNIT-II</b>	<b>OPEN LOOP SYSTEMS</b>	<b>9</b>
Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.		
<b>UNIT-III</b>	<b>CLOSED LOOP SYSTEMS</b>	<b>9</b>
Closed loop control systems, development of block diagram for feed-back control systems servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.		
<b>UNIT-IV</b>	<b>FREQUENCY RESPONSE</b>	<b>9</b>
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings.		
<b>UNIT-V</b>	<b>ADVANCED CONTROL SYSTEMS</b>	<b>9</b>
Introduction to advanced control systems, cascade control, feed forward control, Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes		
		<b>Total Contact Hours : 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Gain insights into basic instrumentation.
- Develop a understanding on open loop systems.
- Develop a understanding on closed loop systems.
- To Know the frequency response in control system.
- Know about the advanced control systems.

**Text Books:**

- 1 Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.



2	Coughnowr, D., “Process Systems Analysis and Control”, 3rd ed., McGraw Hill, 2008.
<b>Reference Books :</b>	
1	Marlin, T. E., “ Process Control “, IInd Edn, McGraw Hill, New York, 2000.
2	Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, II Edition, John Wiley, New York, 1997.

Subject Code	Subject Name	Category	L	T	P	C
BT 17E63	BIOLOGICAL SPECTROSCOPY	PE	3	0	0	3
<b>Objectives:</b>						
•	To gain insights into Optical rotatory dispersion.					
•	To develop a understanding on NMR.					
•	To develop a understanding in Mass spectroscopy					
•	To Know the X-ray diffraction techniques.					
•	To Know about the special topics and applications.					

<b>UNIT-I</b>	<b>OPTICAL ROTATORY DISPERSION</b>	<b>9</b>
Polarized light – optical rotation – circular dichroism – circular dichroism of nucleic acids and proteins.		
<b>UNIT-II</b>	<b>TYPES OF NUCLEAR MAGNETIC RESONANCE</b>	<b>9</b>
Chemical shifts – spin – spin coupling – relaxation mechanisms – nuclear over Hauser effect – ESR multidimensional NMR spectroscopy – determination of macromolecular structure by NMR – magnetic resonance imaging.		
<b>UNIT-III</b>	<b>TYPES OF MASS SPECTROMETRY</b>	<b>9</b>
Ion sources sample introduction – mass analysers and ion detectors – bimolecular mass spectrometry – peptide and protein analysis – carbohydrates and small molecules – specific applications.		
<b>UNIT-IV</b>	<b>X-RAY DIFFRACTION</b>	<b>9</b>
Scattering by x- rays – diffraction by a crystal – measuring diffraction pattern – Bragg reflection – unit cell – phase problem – anomalous diffraction – determination of crystal structure – electron and neutron diffraction.		
<b>UNIT-V</b>	<b>SPECIAL TOPICS AND APPLICATIONS</b>	<b>9</b>
Electron microscopy – transmission and scanning electron microscopy – scanning tunneling and atomic force microscopy – combinatorial chemistry and high throughput screening methods.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
•	Gain insights into basics of optical rotary dispersion methods
•	Familiarize with the concept of nuclear magnetic resonance
•	Apply Principles and applications of mass spectrometry and X-ray diffraction

●	Understand Microscopic techniques and its applications
●	Understand Spectroscopic techniques for various biological applications

<b>Text Books:</b>	
<b>1</b>	Banwell, Colin N. and E.M. McCash. “Fundamentals of Molecular Spectroscopy” IV Edition, Tata McGraw-Hill, 2017.
<b>2</b>	Aruldas, G. “Molecular Structure and Spectroscopy”. II Edition, Prentice Hall of India, 2007.
<b>3</b>	Pavia, D.L., G.M. Lampman and G.S. Kriz. “ Introduction to Spectroscopy:” III Edition, Thomson, Brooks/ Cole, 2001.
<b>4</b>	Williams, Dudley H. and Ian Fleming. “Spectroscopic Methods in Organic Chemistry”. VI Edition, Tata McGraw-Hill, 2007.

<b>Reference Books :</b>	
<b>1</b>	Siuzdak, Gary. “Mass Spectrometry for Biotechnology”. Academic Press / Elsevier, 1996.
<b>2</b>	Hammes, Gordon G. “Spectroscopy for the Biological Sciences”. John Wiley, 2005.
<b>3</b>	Campbell I.D and Dwek R.A., “ Biological Spectroscopy “, Benjamin Cummins and Company, 1986.
<b>4</b>	Atkins P.W., “Physical Chemistry “, 10th Edition, Oxford University Press India, 2014.

<b>Subject Code</b>	<b>Subject Name</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>FT 17E67</b>	<b>MEAT, FISH AND POULTRY PROCESSING TECHNOLOGY</b>	<b>PE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

<b>Objectives:</b>	
●	To study about basics of meat processing.
●	To gain knowledge in basic meat processing operations.
●	To gain insights into basics of fish processing.
●	To understand the basics of poultry processing.
●	To gain knowledge in egg processing and its related aspects.

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Recent trends in meat processing. Types of Meat and its sources, composition, structure, of meat and meat products. Ante mortem handling, slaughtering of animals, Mechanical deboning, inspection and grading of meat. Post-mortem changes of meat. Color, flavours, microbiology and spoilage factors of meat and meat products.		
<b>UNIT-II</b>	<b>MEAT PROCESSING</b>	<b>9</b>
Factors affecting post-mortem changes, properties and shelf-life of meat. Meat tenderization and Meat quality evaluation. Modern abattoirs, slaughter house and its features. Preservation of meat- aging, pickling, smoking. Dried and Cured meat. Canned meat, Frozen meat, Cooked and Refrigerated meat, Sausages.		
<b>UNIT-III</b>	<b>FISH PROCESSING</b>	<b>9</b>

Types of fish, composition, structure and spoilage factors of fish. Post-mortem changes in fish. Handling and transportation of fish. Bacteriology of fish, chilling of fish, Freezing and Individual quick freezing. Canning and smoking operations, Salting and drying of fish, pickling. Radiation processing of fish and fish products. Seafood quality Assurance, Advances in fishery by products technology.			
<b>UNIT-IV</b>	<b>POULTRY</b>		<b>9</b>
Introduction, Types and characteristics of poultry products, composition, nutritive value, calculation of nutritive value of poultry products. Unit operation involved in poultry processing.			
<b>UNIT-V</b>	<b>EGG PROCESSING</b>		<b>9</b>
Structure, composition, nutritive value, calculation of nutritive value and functional properties of eggs, Factor affecting egg quality and measures of egg quality. Preservation of egg by different methods. Egg powder processing.			
		<b>Total Contact Hours</b>	<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Understand different variety of meats.
- Familiarize with the concept of meat processing.
- Get insights into basics of fish processing.
- Understand the basics of poultry processing.
- Gain knowledge in egg processing and its related aspects.

**Text Books:**

- 1 Govindan. T.K, "Fish Processing Technology", Oxford and IBH Publishers, New Delhi, 1985.
- 2 Lawrie, R.A. "Meat Science", Second Edition. Pergamon Press, Oxford, UK. 1975.

**Reference Books / Web links:**

- 1 Stadelmen, W.J. and Cotterill, O.J., "Egg Science and Technology", Second Edition, AVI, Westport, 1977.
- 2 Mead, G. "Poultry Meat Processing and Quality", Woodhead Publishing, England, 2004.
- 3 Wheaton, F.W. and Lawson, T.B., "Processing of Aquatic Food Products", John Wiley & Sons, NY.

Subject Code	Subject Name	Category	L	T	P	C
GE 17451	TOTAL QUALITY MANAGEMENT	PE	3	0	0	3

**Objectives:**

- To understand the concept of Quality
- To understand the Implication of Quality on Business
- To Implement Quality Implementation Programs

●	To have exposure to challenges in Quality Improvement Programs
●	To know how ISO9000:2000 works

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.		
<b>UNIT-II</b>	<b>TQM PRINCIPLES</b>	<b>9</b>
Leadership - Quality Statements, Strategic quality planning, Quality Councils – Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen – Supplier partnership - Partnering, Supplier selection, Supplier Rating.		
<b>UNIT-III</b>	<b>TQM TOOLS AND TECHNIQUES I</b>	<b>9</b>
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.		
<b>UNIT-IV</b>	<b>TQM TOOLS AND TECHNIQUES II</b>	<b>9</b>
Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.		
<b>UNIT-V</b>	<b>QUALITY MANAGEMENT SYSTEM</b>	<b>9</b>
Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration--ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

●	Implement and use quality systems
●	Demonstrate the importance of significance of quality
●	Manage quality improvement teams
●	Identify requirements of quality improvement programs
●	Apply Quality management systems in real time.

**Text Books:**

1	Dale H. Besterfield, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised
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	Third Edition, Indian Reprint, Sixth Impression, 2013.
<b>Reference Books / Web links:</b>	
1	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2	Janakiraman. B and Gopal.R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3	Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4	ISO9001-2015 standards

Subject Code	Subject Name	Category	L	T	P	C
FT 17E69	SPECIALITY FOODS	PE	3	0	0	3
<b>Objectives:</b>						
•	To understand the scope of speciality foods.					
•	To classify speciality foods on basis of sources.					
•	To know about the Genetically modified foods.					
•	To familiarize with the concept of therapeutic foods.					
•	To gain insights into consumer requirements in area of speciality foods.					

<b>UNIT-I</b>	<b>Need and scope of specialty foods</b>	<b>9</b>
Need and scope of specialty foods: Specialty food based on ease in preparation cost health benefits; Functional foods, Convenience food, Health care and medical benefits, Nutritional status, Low cost foods.		
<b>UNIT-II</b>	<b>Specialty foods based on sources</b>	<b>9</b>
Cereals and millets, Legumes and pulses, Fruits and vegetables, Animal food sources, By-product based, Non-conventional foods. Innovative process technology, Food additives basis, Bioactive components, Novel nutraceuticals products, Packaging techniques, Adaptable technology basis, Fast and PET foods. organic, inorganic farming.		
<b>UNIT-III</b>	<b>Specialty food based on genetics</b>	<b>9</b>
Genetically modified foods, Transgenic foods, Biotechnological aspects of detoxification. Proprietary foods. Supplementary foods.		
<b>UNIT-IV</b>	<b>Therapeutic foods</b>	<b>9</b>
Modification of diets in disorders, feeding purposes Disease oriented of different organs ex: digestive tract, liver, cardiovascular system, kidney, metabolic disorders, allergy, endocrine disorders.		
<b>UNIT-V</b>	<b>Specific consumer oriented foods</b>	<b>9</b>
Defense persons, Space / astronaut, High altitude mountain climbers, Disaster situation – crises, care, maintenance		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to	
●	Understand the scope of speciality foods.
●	Classify speciality foods on basis of sources.
●	Know about the Genetically modified foods.
●	Familiarize with the concept of therapeutic foods.
●	Gain insights into consumer requirements in area of speciality foods.

<b>Text Books:</b>	
1	Yanyun Zhao “Specialty Foods: Processing Technology, Quality, and Safety”, CRC Press, 2012

<b>Reference Books / Web links:</b>	
1	Steve Taylor, “Advances in Food and Nutrition Research”, Volume 49, Elsevier Inc. ,2005
2	Parvinder S. Bali, “Food Production Operation”, Oxford University, 2014

Subject Code	Subject Name	Category	L	T	P	C
GE 17E52	ENTREPRENEURSHIP DEVELOPMENT	PE	3	0	0	3

<b>Objectives:</b>	
●	To know the basics of Entrepreneurship.
●	To understand the purpose of Business objective,
●	To understand the concept of operational management.
●	To understand the concept of Financial management.
●	To Explore the concept of business ethics.

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
<ul style="list-style-type: none"> <li>Should You Become an Entrepreneur?</li> <li>What Skills Do Entrepreneurs Need?</li> <li>Identify and Meet a Market Need</li> <li>Entrepreneurs in a Market Economy</li> <li>Select a Type of Ownership</li> </ul>		
<b>UNIT-II</b>	<b>BUSINESS OBJECTIVE</b>	<b>9</b>
<ul style="list-style-type: none"> <li>Develop a Business Plan</li> </ul>		
<b>UNIT-III</b>	<b>OPERATIONAL MANAGEMENT</b>	<b>9</b>
<ul style="list-style-type: none"> <li>Choose Your Location and Set Up for Business</li> <li>Market Your Business</li> <li>Hire and Manage a Staff</li> </ul>		
<b>UNIT-IV</b>	<b>FINANCIAL MANAGEMENT</b>	<b>9</b>
<ul style="list-style-type: none"> <li>Finance, Protect and Insure Your Business</li> <li>Record Keeping and Accounting</li> </ul>		

<ul style="list-style-type: none"><li>Financial Management</li></ul>					
<b>UNIT-V BUSINESS ETHICS</b>			<b>9</b>		
<ul style="list-style-type: none"><li>Meet Your Legal, Ethical, Social Obligations</li><li>Growth in Today’s Marketplace</li></ul>					
			<b>Total Contact Hours</b>	<b>:</b>	<b>45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Know the basics of Entrepreneurship.
●	Understand the purpose of Business objective,
●	Understand the concept of operational management.
●	Understand the concept of Financial management.
●	Explore the concept of business ethics.

<b>Text Books:</b>	
1	Entrepreneurship Ideas in Action—South-Western, 2000.

### **PROFESSIONAL ELECTIVES IV, V & VI**

Subject Code	Subject Name	Category	L	T	P	C
FT 17E71	POST-HARVEST TECHNOLOGY	PE	3	0	0	3

<b>Objectives:</b>						
•	To establish the knowledge about importance of loss reduction					
•	To familiarize with different cleaning, threshing and grading equipments.					
•	To recognize the various conveyors used in material handling					
•	To be acquainted with principle of storage systems for various commodities.					
•	To understand the pest control and management methods.					

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Post-harvest engineering of crops – objectives - post harvest systems and losses in agricultural commodities structure, engineering properties of agricultural materials, optimum stage of harvest, importance of loss reduction; Post-Harvest Handling operations. Pre-drying operation- Moisture content, RH measurement, air-grain measurement.		
<b>UNIT-II</b>	<b>CLEANING, THRESHING AND GRADING</b>	<b>9</b>
Threshing and shelling operation - principles and operation - various decorticators/dehullers/shellers.		

Cleaning and grading: Aspiration, scalping, size separators, screens, sieve analysis, capacity and effectiveness of screens, various types of separators (specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorters, cyclone separator), shape graders.			
UNIT-III	MATERIAL HANDLING		9
Conveying equipment- Belt conveyor, Chain conveyor, Screw conveyor, Bucket elevator, Pneumatic conveying system, Gravity conveyor: Principle of operation, advantages, disadvantages, capacity and speed.			
UNIT-IV	PRINCIPLES AND PRACTICE OF STORAGE		9
Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables. Damages: Direct damages, indirect damages, causes of spoilage during storage, sources of infestation and control. Storage structures: Traditional & Modern; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos. 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			
UNIT-V	PEST CONTROL		9
Primary and secondary insect pests, rodents and microorganisms of stored food grains and their control, integrated pest management, Fumigation and controlled atmosphere storage of food grains, Rodent Control.			
		Total Contact Hours	: 45
Course Outcomes:			
On completion of course students will be able to			
●	Apply the post-harvest technologies to prevent loss.		
●	Infer the different cleaning, threshing and grading operations involved in food industry.		
●	Utilize the conveyors in the food industry		
●	Apply the storage principles in extending the shelf-life of commodity.		
●	Identify the suitable pest control and management method for agricultural produce.		
Text Books:			
1	K.P.Sudheer & V.Indira “Post-harvest technology of Horticultural Crops’, New India publishing,2007		
2	Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy, “Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices”, Marcel Dekker,2003		
3	Sahay, K. M. and K.K. Singh, “Unit operation of Agricultural Processing”, Vikas Publishing House Pvt. Ltd., New Delhi, 2004.		
4	Birewar, B.R., Krishnamurthy, K., Girish, G.K., Varma, B.K. and Kanjilal, S.C. 1983. Modern Storage Structures. Indian Grain Storage Institute, Hapur		
5	Hosahalli S. Ramaswamy, “Post-harvest Technologies of Fruits & Vegetables”, DEStech publications, 2015.		



Reference Books / Web links:	
1	Amalendu Chakraverty, R. Paul Singh, "Postharvest Technology and Food Process Engineering", CRC Press, 2014
2	George D. Saravacos, Athanasios E. Kostaropoulos, "Handbook of Food Processing Equipment", Springer, 2002
3	WA Gould, "Unit Operations for the Food Industries", CTI Publications, 1996

Subject Code	Subject Name	Category	L	T	P	C
FT 17E72	MILLING TECHNOLOGY	PE	3	0	0	3

**Objectives:**

•	To understand importance of milling technology
•	To understand milling process of rice
•	To empathize unit operations involved in wheat milling
•	To evaluate the efficiency of equipments in corn milling
•	To evaluate the extraction and milling methods of pulses

<b>UNIT-I</b>	<b>INTRODUCTION TO MILLING OPERATIONS</b>	<b>9</b>
<p>Cleaning/Separation: Classification of Separation Methods; Separation according to Aerodynamic Properties, Specific Gravity, Magnetic Properties, Electrostatic Properties, Colors (Electronic Separators), Surface Properties (Frictional Separators); Effectiveness of the Separation.</p> <p>Husking/Scouring/Hulling of Grain: Methods of Husking; Concave-Type; Rubber Rolls; Under Runner Disk Husker (Disk Sheller); Scourers and Blade-Type Huskers; Abrasive Drum in a Cylindrical Steel Shell; Factors influencing; Effectiveness of Hulling/Husking/Scouring.</p> <p>Grinding; Effectiveness of Grinding; Machinery Used in Cereal Grinding; Grinding of Grain in Roller Mills; Grinding Grain in Hammer Mills.</p>		
<b>UNIT-II</b>	<b>RICE MILLING</b>	<b>9</b>
<p>Milestones in the development of rice milling machinery, Unit operations and equipment in rice milling: Cleaning Equipments- Scalper; Paddy cleaner; Drum-type cleaner, Destoner- Pressure-type; Suction (vacuum)-type, Magnetic separator, Thickness grader, Dehusking/husking/shelling- Disc sheller; Centrifugal sheller; Rubber-roll sheller, Husk separation- Plansifter with husk aspirator; Rubber-roll sheller with husk aspirator, Paddy separation- Compartment-type separator; Tray-type separator, Shelling of return paddy, Debranning/whitening/polishing- Abrasive polishers; Friction polishers; Combined abrasive and friction polisher; Water jet polisher, Bran separation, Grading- Oscillating sieve; Plansifter, Effect of grain properties on milling.</p>		
<b>UNIT-III</b>	<b>WHEAT MILLING</b>	<b>9</b>

Wheat milling operations - Milling of Hard Wheat, Durum Wheat, Soft Wheat; Cleaning, conditioning, grinding, Components of wheat mill- Sifters, Roller milling - Break rolls and reduction rolls, purifying. Equipments - Destoner, Entoleters, Parboiling of wheat, Efficiency of milling process.		
<b>UNIT-IV</b>	<b>CORN MILLING</b>	<b>9</b>
Corn: Grain quality for dry milling; Different methods of milling of corn: Dry milling; Full fat milling; Bolted Milling Process; Tempering-Degerming Milling Process: Beall Degerminating System; Buhler Degerminating System; Satake Degerminating System, Efficiency of milling process and effect of grain characteristics on milling quality.		
<b>UNIT-V</b>	<b>PULSE MILLING</b>	<b>9</b>
Unit operations of pulse milling, Dehulling losses and effect on nutritive value, Milling Methods of pulses. Problems of Pulse milling industry, Factors affecting Pulse milling outturn, Pulse milling Efficiency.		
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Assess the structure, nutritional value and storage of cereals and legumes
- Apply the milling techniques, parboiling methods and equipment used in rice milling
- Analyze the milling efficiency in milled wheat products
- Compare the efficiency of dry milling techniques in corn milling
- Evaluate the extraction and milling methods of pulses

**Text Books:**

<b>1</b>	Chakraverty, A. - Post Harvest Technology of Cereals, Pulses and Oil Seeds, Third Edition, Oxford & IBH publishing & Co., New Delhi, 2000.
<b>2</b>	Sahay, K.M. and Singh. K.K - Unit operations of Agricultural Processing, Vikas Publishing House, New Delhi, 1996.
<b>3</b>	Harry Lawson - Food Oils and Fats, Technology, Utilization and Nutrition, CBS Publishers and Distributors, New Delhi, 1997.

**Reference Books / Web links:**

<b>1</b>	Kulp K and Pont J G, - Handbook of Cereal Science and Technology, Second Edition, Chips Ltd. USA, 2000.
<b>2</b>	Khader, Vijaya and Vimala, V., - Grain Quality and Processing, Agrotech Publishing, Udaipur, 2007.

Subject Code	Subject Name	Category	L	T	P	C
FT 17E73	<b>CREATIVITY, INNOVATION AND NEW FOOD PRODUCT DEVELOPMENT</b>	PE	2	0	1	3

**Objectives:**

•	To gain knowledge on market surveys methods to study consumer preferences.
•	To understand new product development methodologies.
•	To be acquainted with knowledge on standardisation & large scale production.
•	To familiarize with regulatory aspects of Proprietary products.
•	To understand advertising and marketing strategies through case study.

<b>UNIT-I</b>	<b>FOOD NEEDS &amp; CONSUMER PREFERENCE</b>	<b>9</b>
Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept; advantages of processed foods in urbanised Modern Society; why people buy processed foods. Developing a Product to Meet the Requirements.		
<b>UNIT-II</b>	<b>DESIGNING NEW PRODUCTS</b>	<b>9</b>
New Food Product Development (NPD) - process and activities, success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe Development; use of traditional recipe and modification; recent developments in food ingredients/additives; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel processing technologies.		
<b>UNIT-III</b>	<b>STANDARDIZATION &amp; LARGE SCALE PRODUCTION</b>	<b>9</b>
Process design: establishing process parameters for optimum quality; Sensory Evaluation; Lab requirements; different techniques and tests; statistical analysis; application in product development and comparison of market samples; stages of the integration of market and sensory analysis.		
<b>UNIT-IV</b>	<b>QUALITY, SAFETY &amp; REGULATORY ASPECTS</b>	<b>9</b>
Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness; interaction of package with food; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product.		
<b>UNIT-V</b>	<b>ADVERTISEMENT, MARKETING &amp; CASE STUDIES</b>	<b>9</b>
Product performance testing; market positioning, Marketing: developing test market strategies; various tools and methodologies to evaluate consumer attitudes, preferences and market acceptance factors; Case Studies of some successes and failures- Factors that influence NPD success, innovation case studies to highlight best practice in terms of the integration of technological and marketing approaches to NPD; food choice models and new product trends.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Interpret the consumer preferences through market surveys
●	Develop the new product from gained knowledge
●	Apply pilot scale production principles to extend it for large scale processing.
●	Apply the regulations for marketing of newly developed products.
●	Comprehend Advertising and marketing strategies.
<b>Text Books:</b>	
1	Brody, A. L. and John B. L. “Developing New Food Products for a Changing Marketplace”, 2nd Edition, CRC / Taylor & Francis, 2008
2	Fuller, G.W. “New Food Product Development: From Concept to Marketplace”, CRC, 2004
3	Macfie, H. “Consumer-led Food Product Development”, CRC/Wood Head, 2007
<b>Reference Books / Web links:</b>	
1	Side, C. “Food Product Development: Based on Experience”, Iowa State Press/Blackwell, 2002.
2	Gupta, R. “Food Retailing: Emerging Trends”, ICFAI University, Press, 2005
3	Chakraborty, A. “Food Processing: Opportunities and Challenges”, ICFAI University Press, 2006

Subject Code	Subject Name	Category	L	T	P	C
BT 17701	DOWNSTREAM PROCESSING	PE	3	0	0	3

<b>Objectives:</b>	
•	To demonstrate the downstream processing, Pre-treatment and stabilization of bio products.
•	To apply the basic principles of filtration and centrifugation.
•	To familiarize with the fundamental ideas about Extraction and membrane separation techniques and will learn how to develop models for precipitation technique.
•	To work on chromatographic techniques and able to do Scaling up of chromatography.
•	To demonstrate the fundamental concept and operational principles of Crystallization, Drying and Lyophilisation and to do research.

<b>UNIT-I</b>	<b>DOWNSTREAM PROCESSING</b>	<b>9</b>
Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre-treatment and stabilisation of bio-products.		
<b>UNIT-II</b>	<b>PHYSICAL METHODS OF SEPARATION</b>	<b>9</b>
Unit operations for solid-liquid separation - filtration and centrifugation.		
<b>UNIT-III</b>	<b>ISOLATION OF PRODUCTS</b>	<b>9</b>
Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.		

<b>UNIT-IV</b>	<b>PRODUCT PURIFICATION</b>	<b>9</b>
Chromatography – principles, instruments and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.		
<b>UNIT-V</b>	<b>FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS</b>	<b>9</b>
Crystallization, Drying and Lyophilisation in final product formulation.		
		<b>Total Contact Hours : 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Demonstrate the downstream processing, Pre-treatment and stabilization of bio products.
- Apply the basic principles of filtration and centrifugation.
- Familiarize with the fundamental ideas about Extraction and membrane separation techniques and will learn how to develop models for precipitation technique.
- Able to work on chromatographic techniques and able to do Scaling up of chromatography.
- Demonstrate the fundamental concept and operational principles of Crystallization, Drying and Lyophilisation and to do research.

**Text Books:**

- 1 Belter, P.A., E.L. Cussler and Wei-Houhu —Bio separations – Downstream Processing for Biotechnology, John Wiley, 1988.
- 2 Sivasankar, B. —Bio separations: Principles and Techniques. PHI, 2005.
- 3 Asenjo, Juan A. —Separation Processes in Biotechnology. CRC / Taylor & Francis, 1990.

**Reference Books / Web links:**

- 1 Ghosh, Raja –Principles of Bio Separations Engineering. World Scientific, 2006
- 2 Product Recovery in Bioprocess Technologyl. (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

Subject Code	Subject Name	Category	L	T	P	C
<b>FT 17E74</b>	<b>NANOTECHNOLOGY IN FOOD APPLICATIONS</b>	<b>PE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Objectives:**

- To understand the techniques associated with nanoparticle preparation.
- To familiarize with characterization techniques.
- To learn the applications of nanotechnology in food processing
- To learn the applications of nanotechnology in food packaging
- To learn the applications of nanotechnology in development of sensors

<b>UNIT-I</b>	<b>NANOPARTICLES- INTRODUCTION AND PREPARATION</b>	<b>9</b>
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Classifications of nanostructured materials- Nanoparticles and nanofibers- quantum dots, nanowires, Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic, Biological and Thermal properties. General methods of preparation- Bottom-up Synthesis-Top-down Approach: Co- Precipitation, Ultra sonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.		
<b>UNIT-II</b>	<b>CHARACTERIZATION TECHNIQUES</b>	<b>9</b>
X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nano indentation.		
<b>UNIT-III</b>	<b>NANOTECHNOLOGY IN FOOD PROCESSING</b>	<b>9</b>
Nano encapsulation & microencapsulation- flavour & aroma encapsulation- Nano formulations for the delivery of bioactive compounds- Nano carriers- Lipid Nano carriers for Phytochemical Delivery in Foods- Nano-emulsions- Nano-dispersions Characterization & stability- Bioavailability studies- limitations- Electrospinning and Electro spraying Technologies- Applications in the food Industry, Nano-filtration, Nanoclusters, Nano chelates.		
<b>UNIT-IV</b>	<b>NANOPACKAGING</b>	<b>9</b>
Nano packaging for enhanced shelf life- Potential of nanomaterials in food packaging- Nano polymers, Nanocomposites, Nano laminates and Nanostructured Coatings in Food Packaging- Smart/Intelligent packaging- Nano antimicrobials in enhancement of shelf-life of foods.		
<b>UNIT-V</b>	<b>NANO SENSORS</b>	<b>9</b>
Nanotechnology in Microbial Food Safety & bio-security- Electrochemical sensors for food analysis and contaminant detection- Monitoring and separation of food-borne pathogens using nanoparticles- Safety Assessment for Use of Nanomaterials in Food and Food Production- Efficacy Evaluation and Risk Assessment- Regulatory Framework for Food Nanotechnology		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Prepare the nanomaterials using different techniques
●	Characterize the synthesized nanomaterials
●	Apply the nanotechnology in food processing techniques
●	Apply the nanotechnology in food packaging
●	Develop Nano based sensors for food applications

<b>Text Books:</b>	
1	V. Ravishankar Rai, Jamuna A Bai, "Nanotechnology applications in the food industry", CRC Press, 2018.
2	Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).

3	Lynn J. Frewer, Willehm Norde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri-food sector, Wiley-VCH Verlag, (2011).
4	Alexandra Elena Oprea & Alexandru Mihai Grumezescu,” Nanotechnology applications in food: Flavour, stability, Nutrition & Safety”, Academic Press, 2017.

**Reference Books / Web links:**

1	Michael Wilson, Kamali Kannangara, Geoff smith, “Nanotechnology: Basic Science & emerging technologies”, CRC press, 2014.
2	W. Goddard, “Handbook of Nanoscience Engineering & Technology”, CRC Press, 2007.
3	Erika – Rogers and Christopher J B, 2001, “Instrumentation and Sensors for Food Industry”, CRC press.

Subject Code	Subject Name	Category	L	T	P	C
FT 17E75	MANAGEMENT OF FOOD WASTE	PE	3	0	0	3

**Objectives:**

•	To classify and characterize the food industry waste
•	To familiarize with the waste treatment methods
•	To learn the methods for waste utilization from fruits, vegetables, meat, dairy and sea food product industry.
•	To learn the methods for waste utilization from milling industry.
•	To understand the regulatory issues with food industry waste.

<b>UNIT-I</b>	<b>CLASSIFICATION &amp; CHARACTERIZATION OF FOOD INDUSTRY WASTE</b>	<b>9</b>
Sources of waste and pollutants, Classification and characterization of Solid, Liquid and Gaseous wastes from food industry (Dairy industry, agro processing industry, meat industry, bakery industry) and its treatment.		
<b>UNIT-II</b>	<b>TREATMENT METHODS OF WASTE FROM FOOD INDUSTRY</b>	<b>9</b>
Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological oxidation, trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand filtration, activated carbon filters, ion exchange, membrane filtration and UV treatment.		
<b>UNIT-III</b>	<b>UTILIZATION OF WASTE PRODUCT FROM PLANT &amp; ANIMAL BASED FOOD PRODUCTS</b>	<b>9</b>
Utilization of Fruit and Vegetable Wastes: Types of wastes in fruits and vegetable processing industries. Processes for waste utilization from fruit and vegetable industries – Fermentation for production of alcohol		

& vinegar, oil & flavouring components, pigment extraction from waste, acid production from fruit waste.			
Fish, Meat and Poultry industry’s waste utilization: Type of waste from Fish, Meat and Poultry industries,			
Utilization of waste from these industries to produce various value added products- Fish silage, Chitin,			
Chitosan from fish waste, Keratin from poultry feather and its applications in targeted delivery of active			
components, Extraction of cellulase enzyme from sausage industry waste.			
Utilization of by-products from dairy industry-whey utilization, ghee residue, butter milk, lactose utilizations.			
UNIT-IV	UTILIZATION OF WASTE PRODUCT FROM CEREAL, PULSES & OIL SEED MILLING		9
Utilization of by-products from Wheat, rice, corn and dal mills: By products of wheat milling- germ and bran,			
rice milling-paddy husk, broken, rice bran, corn dry milling-tip cap, corn cob, germ, corn peel, corn wet			
milling-steep water, pulses milling - husk, germ, broken, powder.			
Utilization of by- products from oil milling industry- husk, oil cake for protein extraction and cattle feed, by			
products from oil refining-wax, pigment, gums, lecithin, free fatty acids.			
UNIT-V	REGULATORY ISSUES WITH FOOD INDUSTRY WASTE		9
International and national scenario on disposal of waste from food industries; Regulatory issues with food			
industry waste			
		Total Contact Hours	: 45
Course Outcomes:			
On completion of course students will be able to			
●	Classify and Characterize the food industry waste.		
●	Apply the various methods to treat the food industry waste.		
●	Utilize the waste and convert into value added product.		
●	Recover the waste and utilize its by-products.		
●	Apply the regulations with respect to food industry waste.		
Text Books:			
1	Rocio Campos-Vega, B. Dave Oomah, Hayde Azeneth Vergara-Castaneda, “Food Wastes and By-products: Nutraceutical and Health Potential”, Wiley Blackwell, 2020.		
2	Maria R. Kosseva, “Food Industry Wastes”, Second edition, Academic Press, 2020.		
3	V.K .Joshi, “Food Processing Waste Management: Treatment & Utilization Technology”, New India Publishing Agency, 2011.		
Reference Books :			
1	Ioannis S. Arvanitoyannis. “Waste Management for the Food Industries”. Academic Press, 2008.		
2	H. Panda, “The Complete Book on Managing Food Processing Industry Waste”, Asia pacific Business Press.		

Subject Code	Subject Name	Category	L	T	P	C
FT 17E76	GENETIC ENGINEERING AND GENETICALLY MODIFIED FOODS	PE	3	0	0	3



<b>Objectives:</b>	
•	To gain insights into genetic material
•	To develop a understanding on genetic recombination
•	To develop a understanding in Recombinant DNA Technology
•	To Know the DNA sequencing techniques
•	To Know about the transgenic technologies

<b>UNIT-I</b>	<b>INTRODUCTION TO GENETIC MATERIAL</b>	<b>9</b>
Genetic material: Chemical nature, properties, and functions of the genetic material, Overview of bacterial DNA replication: Origin of replication, Enzymes and proteins required for DNA replication, Overview of replication Bacterial transcription: Types of RNA and overview of bacterial transcription, Bacterial translation: Genetic code and overview of bacterial translation, Mutation and DNA repair: Types of mutation, mechanisms of repair of damaged DNA (photo reactivation, excision repair, recombination repair, SOS repair and mismatch repair).		
<b>UNIT-II</b>	<b>OVERVIEW OF GENETIC RECOMBINATION IN BACTERIA</b>	<b>9</b>
Bacterial transformation: Griffith experiment, Avery, MacLeod & McCarty experiment and Mechanism of bacterial transformation. Bacterial Conjugation: Lederberg & Tatum experiment, Bernard & Devis ('U' tube experiment), F factor and mechanism of bacterial conjugation. Bacterial Transduction: Structure of bacteriophage, replication cycle of bacteriophage and Mechanism of bacterial transduction. Regulation of gene expression in prokaryotes: Fine structure of gene (Operator, Promoter, Structural and regulatory gene sequence) and Mechanism of bacterial gene expression regulation - Lac operon.		
<b>UNIT-III</b>	<b>INTRODUCTION TO RECOMBINANT DNA &amp; RNAi TECHNOLOGY</b>	<b>9</b>
Introduction to RNAi Technology (Gene silencing technique) and DNA modifying enzymes: Restriction enzymes and other modifying enzymes, cloning vectors: Introduction, plasmid and other vectors, steps of gene cloning: Isolation and purification of insert DNA, selection and isolation of vector DNA, construction of recombinant DNA, and introduction of recombinant DNA into host cell, identification and selection of cells containing cloned genes.		
<b>UNIT-IV</b>	<b>DNA LIBRARIES, SEQUENCING AND AMPLIFICATION OF DNA</b>	<b>9</b>
DNA Library: Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Screening of DNA libraries using nucleic acid probes and antisera. DNA Amplification: Maxam Gilbert's and Sanger's methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.		
<b>UNIT-V</b>	<b>TRANSGENIC TECHNOLOGY &amp; APPLICATIONS IN FOODS</b>	<b>9</b>
DNA microinjection, Retroviral vectors, Transgenic animals – Knock in and knock out animals, Transgenic plants – Ti plasmid. Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered		

bacteria: Chymosin Lite beer; Tryptophan; Transgenic plants: CalgeneFlavrSavr™ tomato, Monsanto Round-Up™ Ready, Ciba Geigy Basta™ resistant crops; Edible vaccines: Cholera vaccine in potatoes; Transgenic Fish: Atlantic salmon.

**Total Contact Hours : 45**

### Course Outcomes:

On completion of course students will be able to

- Comprehend the types of genetic material
- Demonstrate the genetic recombination in bacteria
- Apply Principles and applications of Recombinant DNA Technology
- Analyse the DNA sequences by different techniques
- Apply transgenic technology in food applications

### Text Books:

- 1 B.D. Singh. "Biotechnology - Expanding Horizons", Kalyani Publishers, 2014.
- 2 Meenakshi Paul. "Biotechnology and Food Processing Mechanics", Gene-Tech Books, 2007.
- 3 James D. Watson. "Molecular Biology of the Gene", 7th Ed., Benjamin Cummings, 2013.
- 4 Oliver Brandenburg, Zephaniah Dhlamini, Alessandra Sensi, Kakoli Ghosh and Andrea Sonnino. "Introduction to Molecular Biology and Genetic Engineering". FAO, 2011.
- 5 S.B. Primrose and R.M. Twyman. "Principles of Gene Manipulation and Genomics", 7th Ed., Blackwell Publishing, 2006.

### Reference Books :

- 1 Bains W. "Biotechnology from A to Z", Oxford Univ. Press., 1993
- 2 Joshi VK & Pandey A. "Biotechnology: Food Fermentation", Vols. I, II. Education Publ., 1999.
- 3 Knorr D. "Food Biotechnology", Marcel Dekker., 1982
- 4 Perlman D. "Annual Reports of Fermentation Processes", 1979
- 5 Lee BH. "Fundamentals of Food Biotechnology", VCH., 1996

Subject Code	Subject Name	Category	L	T	P	C
FT 17E77	STORAGE ENGINEERING	PE	3	0	0	3
<b>Objectives:</b>						
●	To study about basics of food grain storage					
●	To gain knowledge in design of grain storage system					
●	To gain insights into CAS & MAS of fruits and vegetables					
●	To understand the basics of precooling and cooling load calculations for different commodities.					

•	To gain knowledge in design of cold storage and transportation system for different commodities.
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<b>UNIT-I</b>	<b>FOOD GRAIN STORAGE</b>	<b>9</b>
Grain storage principles- factors- changes during storage. indoor storage system- Bag storage, bulk storage, bunkers, cap storage bags outdoor storage system – cold storage, hermetic storage, vacuum and gas storage - moisture movement during bulk storage of grains – pressure distribution in storage bins - grain storage structures - location and material selection for storage building - types - traditional, modern, temporary and permanent storage structures, factors affecting qualities of grains during packaging and storage, functional requirements of storage structures - traditional storage structures in India and their improvements.		
<b>UNIT-II</b>	<b>DESIGN OF GRAIN STORAGE SYSTEM</b>	<b>9</b>
Grain storage ecosystem- biotic and abiotic factors- Moisture and temperature migration- Cold spots and hot spots. Aeration – Cooling- dehydration in grain storage, Grain storage in silos, bins and godowns – RCC and steel structures - aeration system for various storage structures, grain pressure theories - design of bulk storage structures, bag storage, godowns, Theory and nature of grain flow, pressure distribution, flow patterns- hoppers and ducts – design - Loading and unloading mechanism, management and maintenance of grain storage, code of practices for safe storage of food grains.		
<b>UNIT-III</b>	<b>STORAGE OF FRUITS AND VEGETABLES</b>	<b>9</b>
Harvest and pre-harvest factors, pre-storage treatments, Controlled and modified atmosphere storage - principles, methods - optimization of storage gas composition, rate of supply, control systems for O <sub>2</sub> and CO <sub>2</sub> , effect of nitrogen, oxygen, and carbon dioxide on durable and perishable commodities, Effect of storage temperature on shelf life in CAS and MAS, Storage of Intermediate moisture Foods -storage of dehydrated fruits and vegetables.		
<b>UNIT-IV</b>	<b>COLD STORAGE SYSTEM</b>	<b>9</b>
Precooling methods of fruits & vegetables- Ventilation, Forced air cooling, Hydrocooling, Evaporative cooling, Vacuum cooling, Cold storage of fruits & vegetables – Preliminaries for estimation of cooling load for optimum shelf-life of fruits & vegetables.		
<b>UNIT-V</b>	<b>DESIGN OF COLD STORAGE</b>	<b>9</b>
Design of small capacity cold storage- Dimensions, Layout, stacking methods for cold storage, Transportation of fruits & vegetables – Types, stacking patterns, guidelines for best use of refrigerated transport.  Design of cold storage for food products– Meat product, Fishery Product, Dairy Products. Storage of food commodities - biochemical changes during storage - storage factors affecting losses, storage requirements, thermal design of structures.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
•	Demonstrate the principles of grain storage
•	Design storage system for cereal grains & pulses.
•	Apply the principles of CAS & MAS for extending the shelf-life of foods
•	Utilize the precooling techniques and estimate cooling load for various commodities.

●	Design cold storage and transportation system for various commodities.
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<b>Text Books:</b>	
1	Chakravarty, “Post-Harvest Technology of Cereals, Pulse and Oilseeds”, IBH Publications, 2005.
2	Ojha TP and Michael A.M., “Principles of Agricultural Engineering”, Jain Brothers.2010.
3	A. Ciobanu and G. Lasku, V. Bersescu, “Cooling Technology in the Food Industry”, Abacus Press, 1976.

<b>Reference Books / Web links:</b>	
1	Multon, J.L., “Preservation and storage of grains, seeds and their by – products”, CBS Publishers and Distributors, 1989.
2	Elhadi M. Yahia, “Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities”, Taylor & Francis Group, 2009.
3	Mascheroni. R.H., “Operations in Food Refrigeration”, CRC Press, 2012.

<b>Subject Code</b>	<b>Subject Name</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>FT17E78</b>	<b>EMERGING TECHNOLOGIES IN FOOD PROCESSING</b>	<b>PE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

<b>Objectives:</b>	
●	To understand the principles of high pressure treatment
●	To gain knowledge on pulsed electric field & light technology
●	To understand the applications of ohmic heating of foods.
●	To analyse the effectiveness of ultrasound and ozone technology
●	To gain knowledge on applications of non-ionizing radiations

<b>UNIT-I</b>	<b>PRESSURE AND HEAT TREATMENT</b>	<b>9</b>
Non-thermal technologies in preservation of foods – necessity and advantages – Status and trends of non-thermal technologies in preservation of foods - High pressure treatment of food – Governing Principles – Process equipment, processing and effect on microorganisms - Combined Pressure-Heat treatment on quality attributes of foods.		
<b>UNIT-II</b>	<b>ULTRASOUND, LIGHT AND MICROWAVE</b>	<b>9</b>
Ultrasound – Principle of operation – mechanism of inactivation of microorganisms and enzymes– UV light and pulsed light preservation – Principles of operation – microbial inactivation mechanism, Microwave Technology- principle – application – sterilization, tempering, drying, puffing, coagulation and other processing applications.		
<b>UNIT-III</b>	<b>PULSED ELECTRIC FIELD AND OHMIC HEATING</b>	<b>9</b>

Pulsed Electric Field – Principles of operation – Equipment – processing - control parameters – Microbial Inactivation Mechanism – Effects on Food nutritional and Quality parameters, Ohmic Heating – Principle – Equipment – Effect on Food quality and microbes inactivation.			
UNIT-IV	MAGNETIC FIELD AND RADIATION PROCESSING		9
Introduction to irradiation technologies – general mode of action – Equipment and operational parameters – Food safety and shelf life of irradiated liquid foods - Oscillating Magnetic Fields-Magnetic fields- Generation – Mechanisms- Inactivation of Microorganisms – Magnetic fields in food preservation, Infra-red – Mechanism of IR absorption by food – IR emitters and spectral bands – applications.			
UNIT-V	OZONE, COLD PLASMA AND RADIO FREQUENCY PROCESSING		9
Generation of ozone – batch and continuous process of Ozone for inactivation – Factors affecting efficacy of ozone processing – Effect on food quality –Methods of generation of cold plasma – Control parameters – batch and continuous method of cold plasma treatment for decontamination. Radio wave Frequency – principle – factors influencing RF heating process – applications			
			Total Contact Hours : 45

**Course Outcomes:**

On completion of course students will be able to

●	Understand the concepts and effects of high pressure processing
●	Apply the pulsed electric field and pulsed light technology for food processing
●	Comprehend the role of ultrasound and ozone techniques for foods
●	Apply ohmic heating principle in food processing
●	Utilize the non-ionizing radiations for food preservation.

**Text Books:**

1	Cullen, P.J., Tiwari, B.K. and Valdramidis V.P. 2012. Novel thermal and non-thermal technologies for fluid foods. Academic press, 32 Jamestown Road, London NW1 7BY, UK.
2	Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, 2005. Novel Food Processing Technologies, CRC Press. ISBN: 0-8247-5333-X
3	Sun, D. Emerging Technologies for Food Processing, (Academic Press, 2005)
4	Ohlsson, T. and Bengtsson, N. Minimal Processing technologies in the food industry, (Woodhead Publishing Limited, 2002)

**Reference Books / Web links:**

1	Ioannis S. Boziaris, 2014. Novel Food Preservation and Microbial Assessment Techniques, CRC Press
2	Gaurav Tewari and Vijay K. Juneja, 2007. Advances in Thermal and Non-Thermal Food Preservation, Blackwell Publishing

3	Gustavo C Barbosa-Canovas, Q Howard Zhang, 1999. Pulsed Electric Fields in Food Processing Lancaster Pa: Techonomic Publishing Co. ISBN 1566767830.
4	Gustavo V. Barbosa- Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. 1998. Nonthermal Preservation of Foods. Marcel Dekker Inc. New York.

Subject Code	Subject Name	Category	L	T	P	C
FT 17E68	FOOD PLANT DESIGN	PE	3	0	0	3
<b>Objectives:</b>						
•	To teach students regarding the overall structure of an enterprise.					
•	To understand the steps involved in preparation of a plant layout.					
•	To develop the skills in layout presentation.					
•	To study the quantitative analysis for the plant layout.					
•	To understand the concept of practical layouts.					

<b>UNIT-I</b>	<b>OVERALL DESIGN OF AN ENTERPRISE</b>	<b>9</b>
Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout: location factors, plant site selection. Location theory and models, industrial buildings and grounds. Classification of Dairy and Food Plants, farm level collection and Chilling center. Space requirement.		
<b>UNIT-II</b>	<b>PREPARATION OF A PLANT LAYOUT</b>	<b>9</b>
Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant Layout. Advantages of good layout. Organizing for Plant Layout, Data forms.		
<b>UNIT-III</b>	<b>DEVELOPMENT AND PRESENTATION OF LAYOUT</b>	<b>9</b>
Development of the pilot layout, constructing the detailed layout: Functional design: Sitting of different sections in a plant, Layout installations.		
<b>UNIT-IV</b>	<b>QUANTITATIVE ANALYSIS FOR PLANT LAYOUT</b>	<b>9</b>
Engineering economy. Linear programming. Queing theory. Common Problems in Plant Layout and Process scheduling. Siting of Process sections, Equipment selection and capacity determination, Arrangement of process, and service equipment. Estimation of Services and Utilities. Office layout, line balancing, Flexibility.		
<b>UNIT-V</b>	<b>PRACTICAL LAYOUTS</b>	<b>9</b>
PRACTICAL LAYOUTS: Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Illumination and ventilation, Cleaning & sanitization, painting and colour coding, Fly and insect control.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
•	Gain knowledge regarding the overall structure of an enterprise.
•	Understand the steps involved in preparation of a plant layout.
•	Develop the skills in layout presentation.

●	Study the quantitative analysis for the plant layout.
●	Understand the concept of practical layouts.

<b>Text Books:</b>	
1	M Moore, Mac Millan, “Plant Layout & Design”. Lames, New York, 1971
2	H.S. Hall & Y.S. Rosen, “Milk Plant Layout”. FAO Publication, Rome, 1963.

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
FT 17E79	COMPREHENSION IN FOOD TECHNOLOGY	PE	3	0	0	3

<b>Objectives:</b>	
●	To highlight the role of preservation techniques in extending the shelf-life of foods.
●	To understand the food engineering principles
●	To assimilate the technology for storage and manufacturing of fruit and vegetable products.
●	To comprehend the technology for processing of milk and milk products
●	To understand the key aspects of ingredients and technology in production of Bakery & confectionary products

UNIT-I	FOOD PRESERVATION TECHNIQUES	9
Principles of Food Preservation, Thermal preservation techniques: Blanching, Pasteurization, Commercial Sterilization, Preservation by the use of Low temperatures: Refrigeration, Freezing & Controlled Atmospheric Storage, Technology to control of water Activity: Dehydration, Osmotic dehydration & Membrane Technology, Non-thermal preservation techniques- Salting; Curing; Fermentation; Smoking; High Pressure Processing; Irradiation Technology; Ultrasound Technology; Hurdle Technology, Novel preservation techniques: Ohmic heating, Non-ionising radiation (Microwave; Radio-frequency; Infra-red), Ozone Processing, Dense-Phase CO <sub>2</sub> Processing, Pulse Electric field processing, Pulsed X-Ray, Pulsed light Technology.		
UNIT-II	PRINCIPLES OF FOOD ENGINEERING	9
Engineering Properties of Food- Rheological and textural Properties, Thermal Properties, surface and gas exchange properties, Thermodynamic properties, electric and dielectric properties, Heat transfer: heat transfer by conduction, convection, radiation, heat exchangers. Mass transfer: molecular diffusion and Flick’s law, conduction and convective mass transfer, permeability through single and multilayer films. Mechanical operations: Size reduction of solids, Extraction & Leaching, High pressure Homogenization, Filtration, Centrifugation, Settling, Sieving, Mixing & Agitation of liquid, Extrusion.  Thermodynamics- Basic concepts, First law of thermodynamics, Entropy, Second & third law of thermodynamics, Gibbs energy, Governing equations for mass, energy and entropy in closed and open systems.		
UNIT-III	FRUIT & VEGETABLE PRODUCTS TECHNOLOGY	9

Agricultural Aspects of Fruits & Vegetables: Morphology, Structure, Composition, Quality Factors for Processing: Maturity Indices of Fruits & Vegetables and Methods of Maturity Determination, Principles of Storage of Fruits and Vegetables, Processing Techniques for Fruits and Vegetables, Fruits & Vegetable Products Manufacturing and Quality Control: Fruit and Vegetable Juices, Preparation of Syrups, Cordials and Nectars, Juice Concentrates, Pectin and Related Compounds, Jams, Jellies, Marmalades, Preserves, Pickles, Chutneys and Vinegar Production and Production of Natural Colours, Standards and Regulations of Fruit & Vegetable products.		
<b>UNIT-IV</b>	<b>TECHNOLOGY OF MILK AND MILK PRODUCTS</b>	<b>9</b>
Sources and Composition of Milk, Processing of Market Milk, Standardization, Toning of Milk, Homogenization, Pasteurization, Sterilization, Storage, Transportation and Distribution of Milk. Milk Product Processing-Cream, Butter Oil, Cheese, Cheese Spread, Condensed Milk, Evaporated Milk, Whole and Skimmed Milk Powder, Ice Cream, Khoa, Channa, Paneer, Fermented Milk Products: Yoghurt, Dahi Shrikhand and Similar Products, Instantization of Milk and Milk Products, Judging and Grading of Milk and Its Products, In-Plant Cleaning System, Standards and Regulations of Milk and Dairy products.		
<b>UNIT-V</b>	<b>BAKING AND CONFECTIONERY TECHNOLOGY</b>	<b>9</b>
Introduction to Bakery Ingredients: Varieties and Types; Quality and Grades; Chemical Constituents; Physiological and Rheological Properties; Role and Functions of Bakery Products, Principles of Baking: Baking Reactions; Baking Operations; Manufacturing Process for Bread, Cake, Biscuits, Cookies, Pastry, Buns, Crackers and Quick Bread.  Introduction to Confectionery: Traditional Confectionery Goods; Types of Confectionary and Classification; Manufacturing Process for Confectionery: Khoa based, Channa based, Flour and Fat based Confectionery, Standards and Regulations of Bakery and Confectionery products.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
●	On completion of course, students will be able to: Demonstrate the food preservation techniques.
●	Analyse the engineering properties of food and apply to processing techniques.
●	Demonstrate the of manufacturing of fruit and vegetable products.
●	Apply basic properties of milk for product manufacturing.
●	Assess the quality of ingredients and its impact on bakery and confectionery products

<b>Text Book (s):</b>	
<b>1</b>	Fellows, P.J. "Food Processing Technology: Principles and Practice". 2 <sup>nd</sup> Edition, CRC/Wood Head Publishing, 2000.
<b>2</b>	Toledo, Romeo T. "Fundamentals of Food Process Engineering" II Edition. CBS Publishers, 2000.
<b>3</b>	Hosahalli S. Ramaswamy. "Post-harvest Technologies of Fruits & Vegetables" DES tech publications, 2015.
<b>4</b>	Walstra, P., "Diary Technology: Principles of Milk Properties and Processes". Marcel Dekker, 1999



5	Matz, Samuel A., "Bakery Technology and Engineering", III Edition, Chapman & Hall London.
6	Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.

Reference Books(s) / Web links:	
1	Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2	Berk, Zeki. "Food Process Engineering and Technology". Elsevier, 2009.
3	Wim Jogen. "Fruit and Vegetable Processing: Improving Quality". Taylor& Francis, 2002
4	Selia, Jane dos Reis Coimbra and Jose A. Teixeir "Engineering Aspects of Milk and Dairy Products". Jane Selia dos Reis Coimbra & Jose A. Teixeir, CRC Press, 2009.
5	Edwards W.P. "Science of bakery products", RSC, UK,2007
6	Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K