RAJALAKSHMI ENGINEERING COLLEGE

An AUTONOMOUS Institution

Affiliated to ANNA UNIVERSITY, Chennai

25 years OF ACADEMIC EXCELLENCE

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS

(2021-25 & 2022-2026 Batch)

B.TECH. FOOD TECHNOLOGY

REGULATION – 2019 (Revised)

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS

B.TECH. FOOD TECHNOLOGY

REGULATION 2019 (Revised)

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**
I	√	√			√							√
II		√	√	√	√				√	√		
III		√	√	√		√		√	√	√	√	
IV						√	√	√				
V		√				√	√				√	

5. MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
I SEM-THEORY																
HS19151 Technical English	-	-	-	1.0	-	1.0	-	-	1.6	3.0	1.0	-	-	-	-	-
MA19153 Applied calculus	2.2	2.0	1.0	-	-	-	-	-	-	-	1.0	1.0	1.0	-	-	-
PH19142 Physics for Biosciences	2.4	1.6	1.4	-	-	1.0	1.0	-	-	-	-	-	-	1.0	-	-
GE19101 Engineering graphics	2	-	-	-	-	-	-	-	-	1	-	2	1.8	-	-	-
GE19121 Engineering practices-(Civil & Mechanical)	1	-	-	-	-	1	-	-	-	-	-	1	1.4	-	-	-
II SEM-THEORY																
MA19251 Differential equations and vector calculus	2.8	2.0	1.0	-	-	-	-	-	-	-	-	1.0	-	-	-	-
EE19242 Basic Electrical and Electronics Engineering	3	3	2	3	3	1.4	1.6	1	1	1	2	2	2	1.5	1	-
CY19141 Chemistry for Technologists	2.4	1.6	1.5	-	-	-	-	-	-	-	-	1.0	1.0	-	-	-
GE19211 Problem Solving and Programming in Python	1.8	1.6	2.2	1.6	1.8	-	-	-	0.2	0.2	1.4	1	2.4	2.4	2	1.8
FT19201 Food	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

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
chemistry																
II SEM-PRACTICALS																
FT19211 Food Chemistry Laboratory	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
III SEM-THEORY																
MA19353 Transform and Numerical Methods	3.0	2.0	1.0	-	-	-	-	-	-	-	-	-	1.0	-	-	3.0
FT19301 Food Microbiology	2	2.2	2.2	2.2	2.8	2.4	-	-	-	2.2	1.4	2.2	2	2.2	2	3
FT19302 Biochemistry and Nutrition	1.2	1.4	2	1	-	2.2	2.2	2	-	2	-	1.2	1.4	1.8	2	1
FT19303 Food Process Calculation	2.6	2.8	2.2	2.4	2	-	-	2.8	1.4	1.2	2.8	2.4	2.8	2.6	1	1
FT19304 Fluid Mechanics in Food Processes	2.8	2.4	2.8	2.2	1.2	1	1	-	-	-	1	1	2.8	2.4	1	1
FT19305 Food Additives	3	3	3	2.6	2	1	1.2	1	-	-	-	1.4	1.8	2	-	2
III SEM-PRACTICALS																
FT19311 Food Microbiology Laboratory	1.8	2	2	2.5	2	1.5	1.6	-	-	-	1.8	2	2	1.8	-	3
FT19312 Biochemistry & Nutrition Laboratory	1.6	1.4	2	2	3	1	1.3	1.5	2	1	1	1.8	1.6	2	1	1.6

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
IV SEM-THEORY																
MA19453 Probability and Statistics	3.0	2.0	2.0	2.0	-	-	-	-	-	-	-	1.0	-	1.0	-	-
FT19401 Heat and Mass Transfer in Food Processes	2.8	3	2.4	3	1	1	1	-	-	-	1	1	3	2.8	-	1
FT19402 Unit operations in Food processes	3	3	3	2.2	1.2	2	1.6	1	-	-	-	3	2	2	-	-
FT19403 Food Processing and Preservation Technology	3	2.8	2.8	3	3	2.2	2	2	2	2	2	2	3	2.8	3	2
GE19304 Fundamentals of Management for Engineers	1	-	-	-	-	-	-	1	2	-	2	2	2	2	-	2
CS19411 Python Programming for Machine learning	2	2	2	1	2	-	-	-	1	1	-	1	2	2	3	2
IV SEM-PRACTICALS																
FT19411 Chemical Engineering laboratory	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
FT19412 Food Processing and Preservation Laboratory	3	2.4	3	2.6	2.2	2.4	2	2	2	2	1.6	2.6	3	2.8	3	3

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
GE19421 Soft Skills- I	-	-	-	-	1	-	-	-	2	3	1	3	-	-	3	2
V SEM-THEORY																
FT19501 Food Analysis	3	3	2.8	2	3	2	2.6	3	3	2.8	2.8	2.8	2.6	2.6	1	2.8
FT19502 Fruit and Vegetable Technology	3	2.4	2.4	2.4	2.4	-	-	2	-	-	-	3	2.8	3	-	2
FT19503 Thermodynamics for Food Technologists	2.6	3	2.8	2.8	1	1	1	-	-	-	1	1	2.8	3	1	1
FT19P55 Beverages Technology	2.4	2.4	2.0	2.2	2.4	2.4	1.8	1	-	-	1	2.4	2.4	2.2	1.8	1
FT19P56 Functional food and Nutraceuticals	2.6	3	2.8	2.8	1	1	1	-	-	-	1	1	2.8	3	1	1
OME1901 Supply chain management	2	1	1	1	1	1	-	-	1	-	-	1	-	2	-	-
OME1902 Basics of 3D Printing and additive Manufacturing	1	2	2	-	-	-	1	-	-	-	-	2	2	-	1	-
OGE1901 German language	1	2	0	1.4	0	1.2	1	2.75	2	3	1	1.25	-	-	1	1
V SEM-PRACTICALS																
FT19511 Food Analysis Laboratory	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
FT19512 Fruit and Vegetable	1.4	2	1.6	2.5	2	2.5	1.4	-	-	-	2	2.2	2.4	2.4	-	3

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Technology Laboratory																
GE19521 Soft skills - II	-	-	-	-	1	-	-	-	2	3	1	3	-	-	2	2
VI SEM-THEORY																
FT19601 Food Process Engineering	2.8	2.2	2.8	2.6	2.8	2.8	1.4	-	1	1.2	2.2	2.6	2.4	2.6	1.4	2.8
FT19602 Refrigeration and Cold Chain Management	3	2.8	2.4	2.2	2.6	2.4	2.4	-	-	-	3	3	3	-	3	3
FT19603 Baking and Confectionery Technology	3	2.6	2.8	1.8	3	1.6	2.4	1.4	-	-	2.4	1.8	2.6	2.4	-	1.2
FT19604 Dairy Process Technology	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
FT19P63 Technology of plantation crops and Spices	2.4	2.0	2.0	2.4	1.6	2.4	2.2	-	-	-	1.6	2.4	1.8	2.4	1.4	1.2
VI SEM-PRACTICALS																
FT19611-Baking and Confectionery Technology Laboratory	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
FT19612 Dairy Process Technology Laboratory	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
CR19P62 Microfluidics Laboratory	1	1	2	3	2	0	2	2	2	0	1	2	3	1	1	0
GE19621	2.7	2.7	2.0	2.7	1.0	1.0	-	-	-	-	1.0	1.0	2.0	1.0	-	1.0

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Problem Solving Techniques																
VII SEM-THEORY																
FT19701 Food Packaging Technology	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
FT19702 Livestock and Marine Technology	2.6	2.2	2.8	2.8	2.8	2.4	2	1.2	1	1.4	2.8	2.8	3	2.8	1.8	1.6
FT19703 Food Safety, Quality and Regulation	1.3	2.0	-	3.0	-	1.0	1.8	2.0	1.7	1.0	1.7	1.0	1.0	2.0	1.0	1.0
FT19704 Professional Ethics	1	1	1	1	1	3	1.2	3	3	3	3	3	2	2	3	3
FT19715 Innovation and Design thinking for Food Technologists	1	3	3	2	2	1	1	1	1	2	2	2	2	3	3	2
FT19716 Problem solving using Artificial Intelligence and Machine Learning for Food Technologist	2.2	1.6	1.2	1.6	2.2	1	1	1	1	1	1.4	1	2.4	2.4	1.6	1.8
FT19P74 Cereals, Pulses and oil seed technology	2.4	2.2	1.8	2.4	2.0	2.4	2.4	-	-	-	1.2	2.6	1.8	2.6	1.6	1.4
FT19P79 Comprehension in food technology	2.4	3	3	2.4	2.4	2.8	1.8	2	1.6	2	1.6	3	3	2.8	3	2.4

COURSE CODE & COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
VII SEM-PRACTICALS																
FT19711 Food Packaging Technology Laboratory	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
FT19712 Livestock and Marine Technology Laboratory	2.6	2.2	2.8	2.8	2.8	2.4	2	1.2	1	1.4	2.8	2.8	3	2.8	1.8	1.6
VIII SEM-THEORY																
FT19801-Project work	3	1.8	1.8	2	2.2	2.4	2.4	2.2	2.6	1	0	3	3	2.8	2	2

CURRICULUM & SYLLABUS

B.TECH. FOOD TECHNOLOGY REGULATION 2019 (Revised)

BATCH: 2021-25&2022-26

SEMESTER – I

Sl. No	COURSE CODE	COURSE TITLE	L	T	P	Total Hours	Total Credits	Category
THEORY& PRACTICALS								
1	HS19151	Technical English	2	1	0	3	3	HS
2	MA19153	Applied calculus	3	1	0	4	4	BS
3	PH19142	Physics for Biosciences	3	0	2	5	4	BS
4	GE19101	Engineering graphics	2	2	0	4	4	ES
5	GE19121	Engineering practices-(Civil & Mechanical)	0	0	2	2	1	ES
6	MC19101	Environmental Science and Engineering (Non-Credit course)	3	0	0	3	0	MC
TOTAL			**12**	**1**	**10**	**21**	**16**	

SEMESTER – II

Sl. No	COURSE CODE	COURSE TITLE	L	T	P	Total Hours	Total Credits	Category
THEORY& PRACTICALS								
1	MA19251	Differential equations and vector calculus	3	1	0	4	4	BS
2	EE19242	Basic Electrical and Electronics Engineering	3	0	2	5	4	ES
3	CY19141	Chemistry for Technologists	3	0	2	5	4	BS
4	GE19211	Problem Solving and Programming in Python	1	0	4	5	3	ES
5	FT19201	Food chemistry	3	0	0	3	3	PC
6	MC19102	Indian Constitution and Freedom Movement (Non-credit course)	3	0	0	3	0	MC
7	FT19211	Food Chemistry Laboratory	0	0	4	4	2	PC
TOTAL			**17**	**1**	**12**	**29**	**20**	

SEMESTER –III

S.no	COURSE CODE	COURSE TITLE	L	T	P	Total Hours	Total Credits	Category
	THEORY							
1	MA19353	Transform and Numerical Methods	3	1	0	4	4	BS
2	FT19301	Food Microbiology	3	0	0	3	3	PC
3	FT19302	Biochemistry & Nutrition	3	0	0	3	3	PC
4	FT19303	Food Process Calculations	3	0	0	3	3	ES
5	FT19304	Fluid Mechanics in Food Processes	3	0	0	3	3	ES
6	FT19305	Food Additives	3	0	0	3	3	PC
	PRACTICALS							
7	FT19311	Food Microbiology Laboratory	0	0	4	4	2	PC
8	FT19312	Biochemistry & Nutrition Laboratory	0	0	4	4	2	PC
	TOTAL		**18**	**1**	**8**	**27**	**23**	

SEMESTER –IV

Sl. No	COURSE CODE	COURSE TITLE	L	T	P	Total Hours	Total Credits	Category
THEORY								
1	MA19453	Probability and statistics	3	1	0	4	4	BS
2	FT19401	Heat and Mass Transfer in Food Processes	3	0	0	3	3	ES
3	FT19402	Unit operations in Food Industries	3	0	0	3	3	ES
4	FT19403	Food Processing and Preservation Technology	3	0	0	3	3	PC
5	MC19301	Essence of Indian Traditional Knowledge (Non-Credit course)	2	0	0	2	0	MC
6	GE19304	Fundamentals of Management for Engineers	3	0	0	3	3	HS
7	CS19411	Python Programming for Machine learning	1	0	4	5	3	ES
PRACTICALS								

8	FT19411	Chemical Engineering Laboratory	0	0	4	4	2	ES
9	FT19412	Food Processing and Preservation Laboratory	0	0	4	4	2	PC
10	GE19421	Soft Skills - I	0	0	2	2	1	EEC
TOTAL			**17**	**1**	**10**	**27**	**24**	

SEMESTER – V

Sl. No	**COURSE CODE**	**COURSE TITLE**	L	T	P	Total Hours	Total Credits	Category
THEORY								
1	FT19501	Food Analysis	3	0	0	3	3	PC
2	FT19502	Fruit and Vegetable Technology	3	0	0	3	3	PC
3	FT19503	Thermodynamics for Food Technologists	3	0	0	3	3	ES
4		Professional Elective I	3	0	0	3	3	PE
5		Professional Elective II	3	0	0	3	3	PE
6		Open Elective I	3	0	0	3	3	OE
PRACTICALS								
7	FT19511	Food Analysis Laboratory	0	0	4	4	2	PC
8	FT19512	Fruit and Vegetable Technology Laboratory	0	0	4	4	2	PC
9	GE19521	Soft Skills II	0	0	2	2	1	EEC
TOTAL			**18**	**0**	**10**	**28**	**23**	

SEMESTER – VI

Sl. No	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**Total Hours**	**Total Credits**	**Category**
THEORY3								
1	FT19601	Food Process Engineering	3	0	0	3	3	PC
2	FT19602	Refrigeration and Cold Chain Management	3	0	0	3	3	PC
3	FT19603	Baking and Confectionery Technology	3	0	0	3	3	PC
4	FT19604	Dairy Process Technology	3	0	0	3	3	PC
5		Professional Elective III	3	0	0	3	3	PE
6		Open Elective II	3	0	0	3	3	OE

PRACTICALS								
7	FT19611	Baking and Confectionery Technology Laboratory	0	0	4	4	2	PC
8	FT19612	Dairy Process Technology Laboratory	0	0	4	4	2	PC
9	GE19621	Problem Solving Techniques	0	0	2	2	1	EEC
10	CR19P62	Microfluidics Laboratory	0	0	2	2	1	PE
TOTAL			**18**	**0**	**10**	**28**	**24**	

SEMESTER – VII

Sl. No	COURSE CODE	COURSE TITLE	L	T	P	Total Hours	Total Credits	Category
THEORY								
1	FT19701	Food Packaging Technology	3	0	0	3	3	PC
2	FT19702	Livestock and Marine Technology	3	0	0	3	3	PC
3	FT19703	Food Safety, Quality and Regulation	3	0	0	3	3	PC
4	FT19704	Professional Ethics	3	0	0	3	3	PC
5	FT19715	Innovation and Design thinking for Food Technologists	0	1	2	3	1	EEC
6	FT19716	Problem solving using Artificial Intelligence and Machine Learning for Food Technologist	0	0	4	0	2	EEC
7		Professional Elective IV	3	0	0	3	3	PE
8		Professional Elective V	3	0	0	3	3	PE
PRACTICALS								
9	FT19711	Food Packaging Technology Laboratory	0	0	4	4	2	PC
10	FT19712	Livestock and Marine Technology Laboratory	0	0	4	4	2	PC
11	FT19713	Industry training during vacation	1	0	0	0	1	EEC
TOTAL			**19**	**1**	**10**	**29**	**26**	

SEMESTER – VIII

Sl. No	COURSE CODE	COURSE TITLE	L	T	P	Total Hours	Total Credits	Category
PRACTICALS								
1	FT19801	Project Work	0	0	20	20	10	EEC
TOTAL					**20**	**20**	**10**	

TOTAL CREDITS: 166

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Check-list based on for AICTE curriculum -- B. TECH FOOD TECHNOLOGY

1. Total number of credits for a programme: 166
2. Credit distribution across semesters I to VIII
3. Contact hours' semester-wise: 16, 20, 23, 24, 23, 24, 26, 10
4. Category-wise credits for a programme
5. Number of Professional Electives: **5**
6. Number of Open Electives: **2**
7. Mandatory (Non-credit) courses: **3**
8. Courses to be taught by other departments: 20 (Open elective)
9. Courses to be taught for other departments: **2** (Open elective)
10. Common courses with other branch/discipline: **Nil**

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	**8**	**8**	**4**	**4**					**24**
3.	ES	**5**	**7**	**6**	**11**	**3**				**32**
4.	PC		**5**	**13**	**5**	**10**	**16**	**16**		**65**
5.	PE					**6**	**4**	**6**		**16**
6.	OE					**3**	**3**			**6**
7.	EEC				**1**	**1**	**1**	**4**	**10**	**17**
8	MC	*	*		*					
Total		**16**	**20**	**23**	**24**	**23**	**24**	**26**	**10**	**166**

OPEN ELECTIVE OFFERED BY DEPARTMENTOF FOOD TECHNOLOGY

S. No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	FT19O31	Emerging Techniques in Food Processing	OEC	3	3	0	0	3
2	FT19O32	Food Safety	OEC	3	3	0	0	3
3	FT19O33	Crop Process Engineering	OEC	3	3	0	0	3
4	FT19O34	Food Supply Chain Management	OEC	3	3	0	0	3

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVE – I & II (SEMESTER-V)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	FT19P51	Biology and Chemistry of Food Flavors	PE	3	3	0	0	3
2	FT19P52	Minimal Processing of Foods	PE	3	3	0	0	3
3	FT19P53	Post-Harvest Technology	PE	3	3	0	0	3
4	FT19P54	Specialty Foods	PE	3	3	0	0	3
5	FT19P55	Beverages Technology	PE	3	3	0	0	3
6	FT19P56	Functional Foods and Nutraceuticals	PE	3	3	0	0	3
7	FT19P57	Food Allergy and Toxicology	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – III (SEMESTER-VI)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	FT19P61	Process Economics and Industrial Management	PE	3	3	0	0	3
2	FT19P62	Nanotechnology in Food Applications	PE	3	3	0	0	3
3	FT19P63	Technology of Plantation crops and Spices	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – IV & V (SEMESTER-VII)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	FT19P71	Food Plant Design and Layout	PE	3	3	0	0	3
2	FT19P72	Food Product Design and Development	PE	3	3	0	0	3
3	FT19P73	Management of Food Waste	PE	3	3	0	0	3
4	FT19P74	Cereal, Pulses and Oil Seed Technology	PE	3	3	0	0	3
5	FT19P75	Storage Engineering	PE	3	3	0	0	3
6	FT19P76	Food Safety Management systems	PE	3	3	0	0	3
7	FT19P77	Food Plant Equipment Design	PE	3	3	0	0	3
8	FT19P78	Sensory Evaluation of Foods	PE	3	3	0	0	3
9	FT19P79	Comprehension in Food Technology	PE	3	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
HS19151	**TECHNICAL ENGLISH** **Common to all branches of B.E./ B.Tech programmes – I semester**	HS	**2**	**1**	**0**	**3**

Objectives:	
□	To enable learners to acquire basic proficiency in English reading and listening.
□	To write in English precisely and effectively.
□	To speak flawlessly in all kinds of communicative contexts.

UNIT-I	**VOCABULARY BUILDING**	**9**

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT-II	**BASIC WRITING SKILLS**	**9**

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. **Reading & Writing** – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. **Speaking:** Everyday situations – conversations and dialogues, speaking for and against.

UNIT-III	**GRAMMAR AND LANGUAGE DEVELOPMENT**	**9**

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc,).

UNIT-IV	**WRITING FOR FORMAL PRESENTATION**	**9**

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. **Reading & Writing –** Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. **Speaking-** Formal Presentations – Debate on social issues/taboos and solutions.

UNIT-V	**EXTENDED WRITING AND SPEAKING**	**9**

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.

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

Course Outcomes:	
On completion of course students will be able to	
□	Discuss and respond to the listening content.
□	Read and comprehend different texts and appreciate them
□	Understand structures and techniques of precise writing
□	Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures.
□	Write and speak appropriately in varied formal and informal contexts.

Text Books:	
1	1. English for Technologists & Engineers, Orient BlackSwan Publications, Chennai 2012.

Reference Books / Web links:	
1	Technical Communication, Meenakshi Raman &Sangeeta Sharma, Oxford University Press
2	Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3	Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4	Practical English Usage. Michael Swan. OUP. 1995.
5	Remedial English Grammar. F.T. Wood. Macmillan.2007
6	On Writing Well. William Zinsser. Harper Resource Book. 2001
7	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

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**
MA19153	**APPLIED CALCULUS** **Common to I sem. B.Tech. – Biotechnology, Food Technology & Chemical Engineering**	BS	**3**	**1**	**0**	**4**

Objectives:	
□	To gain knowledge in using matrix algebra techniques.
□	To understand the techniques of calculus which areapplied in the Engineering problems.

UNIT-I	MATRICES	12
Symmetric and skew – symmetric matrices , orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.		
UNIT-II	**APPLICATION OF DIFFERENTIAL CALCULUS**	**12**
Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolutes as envelope of normals.		
UNIT-III	**FUNCTIONS OF SEVERAL VARIABLES**	**12**
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.		
UNIT-IV	**APPLICATION OF INTEGRATION AND IMPROPER INTEGRALS**	**12**
Evaluation of area, surface area and volume of revolution - Centre of Gravity – Moment of inertia – Improper integrals: Beta and Gamma integrals and their properties .		
UNIT-V	**MULTIPLE INTEGRAL**	**12**
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.		
	Total Contact Hours : 60	

Course Outcomes:	
On completion of course students will be able to	
	Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems.
	Analyze, sketch and study the properties of different curves.
	Handle functions of several variables and problems of maxima and minima.
	Apply the techniques of integration in engineering problems and to use the concept of improper integrals.
	Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.

Text Books:	
1	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –I , McGraw Hill Education, 2014

Reference Books / Web links:	
1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.

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	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
PH19142	**PHYSICS FOR BIOSCIENCE** **Common to I sem. B.E. – Biomedical Engineering and B.Tech -Biotechnology & Food Technology**	BS	**3**	**0**	**2**	**4**

Objectives:	
□	To enhance the fundamental knowledge of Physical, Quantum, magnetic and dielectric properties of materials
□	To study the behaviour of light, sound and nuclear radiation in materials.

UNIT-I	**PROPERTIES OF MATTER**	**9**
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.		
UNIT-II	**QUANTUMPHYSICS AND SUPERCONDUCTIVITY**	**9**
Introduction to wave function - derivation of Schrodinger wave equation -Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids - Tunneling -scanning tunneling microscope. - Introduction of Superconductivity - Properties of Superconductors - Meissner Effect - BCS theory (qualitative) - Type-I and Type II Superconductors -Magnetic Levitation and SQUID.		
UNIT-III	**MAGNETIC AND DIELECTRIC MATERIALS**	**9**
Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility–types of magnetic materials – microscopic classification of magnetic materials – Ferromagnetism origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory- M versus H behavior – Hard and soft magnetic materials - Introduction electrostatics and EM waves – Tissue as a leaky dielectric - Relaxation processes: Debye model, Cole–Cole model.		
UNIT-IV	**WAVES, OPTICS, AND SOUND**	**9**

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation -Physics of light-Measurement of light and its unit – an overview of limits of vision and colour vision - Physics of sound, Normal sound levels –ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) Non-destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications – Sonogram.		
UNIT-V	**NUCLEAR AND PARTICLE PHYSICS**	**9**
Radioactivity - characteristics of radioactive material – isotopes - probing by isotopes, reactions involved in the preparation of radioisotopes, the Szilard-Chalmer's reaction – radiochemical principles in the use of tracers - nuclear medicines – Interaction of charged particles with matter –Specific ionization, Linear energy transfer, range, Bremsstrahlung, Annihilation. Gamma-Ray Spectrometry- Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters.		
	Contact Hours : 45	

List of Experiments				
1	Determination of Young's Modulus of the given material by Uniform bending			
2	Determination of Young's Modulus of the given material by Non Uniform bending			
3	Determination of Rigidity Modulus of the given material by Torsion pendulum			
4	Determination of Band gap of given Semiconducting material.			
5	To determine the work function and threshold frequency using Einstein's Photoelectric effect.			
6	Experiments on electromagnetic induction – B-HCurve experiment to determine magnetic parameter.			
7	Determination of free space permeability using Helmholtz coil.			
8	Diffraction- Determination of wavelength of diode laser.			
9	Measurement of speed of light using fiber cable.			
10	Spectrometer - Minimum deviation of a prism.			
11	Determination of Resonance frequency of LC circuit and LCR circuits.			
12	Detection of ionizing radiation using Geiger Muller Counter			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course, students will be able to	
	Apply the knowledge of properties of matter, elasticity and bending moments of beam for real time applications.
	Understand and apply the principles of quantum physics and superconductivity in devices.
	Make use of magnetic and dielectric properties of materials in engineering and technology.
	Apply the properties of optics and sound to develop innovating instruments.
	Utilize the concepts of nuclear and particle physics in imaging and irradiation techniques.

Text Books:	
1	Kasap, S.O. “Principles of Electronic Materials and Devices”, McGraw-Hill Education, 2007.
2	Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Narosa Publishing House, 2009.

Reference Books / Web links:	
1	S. O. Pillai, Solid state physics, New Age International, 2015.
2	Arthur Besier and S. RaiChoudhury,Concepts of Modern Physics (SIE), 7th edition, McGraw-Hill Education, 1994.
3	J.B.Rajam, Atomic Physics, 7th edition, S.Chand, 2010.
4	B.L.Theraja, Modern Physics, 16th edition, S.Chand, 2012.
5	Charles Kittel, Introduction to Solid State Physics, 8th Edition, Willey India Pvt.Ltd, 2005.
6	Garcia, N. & Damask, A. “Physics for Computer Science Students”. Springer-Verlag, 2012.
7	Arnikar, H. J., Essentials of Nuclear Chemistry, 4th Edn., New Age International Publishers Ltd., New Delhi, 1995.
8	Umesh K Mishra &Jasprit Singh, “Semiconductor Device Physics and Design”, Springer, 2008.
9	B.H Brown, R.H.Smallwood, D.C Barber . P.V Lawford Medical physics and Biomedical Engineering, CRC Press 1998.

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**	**Category**	**L**	**T**	**P**	**C**
GE19101	**ENGINEERING GRAPHICS**	**ES**	**2**	**2**	**0**	**4**

Objectives:	
	To understand the importance of the drawing in engineering applications
	To develop graphic skills for communication of concepts, ideas and design of engineering products
	To expose them to existing national standards related to technical drawings.
	To improve their visualization skills so that they can apply these skill in developing new products.
	To improve their technical communication skill in the form of communicative drawings

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

Importanceofgraphicsinengineeringapplications–Useofdraftinginstruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I	**PLANECURVES AND FREE HAND SKETCH**	**11**
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. 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		
UNIT-II	**PROJECTION OFPOINTS, LINESAND PLANESURFACE**	**12**
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.		
UNIT-III	**PROJECTIONOFSOLIDS**	**12**
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.		
UNIT-IV	**PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENTOF SURFACES**	**12**
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.		
UNIT-V	**ISOMETRIC AND PERSPECTIVEPROJECTIONS**	**12**
Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.		
	Total Contact Hours : 60	

Course Outcomes: After learning the course, the students should be able	
□	To construct different plane curves and free hand sketching of multiple views from pictorial objects.
□	To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
□	To draw the projection of solids in different views
□	To draw the projection of Sectioned solids and development of surfaces of solids
□	To visualize and prepare Isometric and Perspective view of simple solids

Text Book (s):	
1	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2	Natrajan K.V., "A text book of Engineering Graphics", DhanalakshmiPublishers, Chennai, 2017.

Reference Books(s) / Web links:	
1	Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2	Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
3	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4	BasantAgarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.

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

Special Points Applicable to End Semester Examination on Engineering Graphics	
1	There will be five questions, each of either or type covering all units of the syllabus
2	All questions will carry equal marks of 20 each making a total of 100.
3	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
4	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
GE19121	ENGINEERING PRACTICES LABORATORY – Civil & Mechanical	ES	0	0	2	1

Objectives:

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

List of Experiments				
CIVIL ENGINEERING PRACTICE				
1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.			
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.			
3.	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.			
Carpentry Works:				
4.	Study of joints in roofs, doors, windows and furniture.			
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.			
MECHANICAL ENGINEERING PRACTICE				
6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.			
7	Gas welding practice.			
Basic Machining:				
8	Simple Turning and Taper turning			
9	Drilling Practice			
Sheet Metal Work:				
10	Forming & Bending:			
11	Model making – Trays and funnels			
12	Different type of joints.			
Machine Assembly Practice:				
13	Study of centrifugal pump			
14	Study of air conditioner			
		Total Contact Hours	**:**	**30**

Course Outcomes:

	Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.

	Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
	Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
	Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
	Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

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	-	-	-	-	-	1	1	-	-	-
CO 4	1	-	-	-	-	1	-	-	-	-	-	1	2	-	-	-
CO 5	1	-	-	-	-	1	-	-	-	-	-	1	2	-	-	-
AVG	1	-	-	-	-	1	-	-	-	-	-	1	1.4	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
MC19101	**ENVIROMENTAL SCIENCE AND ENGINEERING**	MC	**3**	**0**	**0**	**0**

Objectives:	
	To understand the importance of natural resources, pollution control and waste management.
	To provide the students about the current social issues and environmental legislations.

UNIT-I	**NATURAL RESOURCES**	**9**

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non-renewableenergy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT-II	**ENVIRONMENTAL POLLUTION**	**9**

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water

treatment-primary, secondary and tertiary treatment. Soil pollution : definition-causes-effects and control of soil pollution.		
UNIT-III	**SOLID WASTE MANAGEMENT**	**9**
Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- Bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management - definition-sources-effects -electronic waste recycling technology.		
UNIT-IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**
Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.		
UNIT-V	**TOOLS FOR ENVIRONMENTAL MANAGEMENT**	**9**
Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle- constitutional provisions- - pollution control boards and pollution control acts- environmental protection act1986- role of non-government organisations-international conventions and protocols.		
	Contact Hours : 45	

Course Outcomes:	
	On completion of the course students will be able to
	Be conversant to utilize resources in a sustainable manner.
	Find ways to protect the environment and play proactive roles.
	Apply the strategies to handle different wastes
	Develop and improve the standard of better living.
	Be conversant with tools of EIA and environmental legislation.

Text Books:	
1	Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi,2008.
2	Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

Reference Books / Web links:	
1	Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi,2007.

2	ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt Ltd, Hydrabad, 2015.,
3	G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, CengageLearning India PVT, LTD, Delhi, 2014.
4	Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rdedition,Oxford University Press,2015.
5	De. A.K., "Environmental Chemistry", New Age International, New Delhi,1996.
6	K. D. Wager, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998.

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	Category	L	T	P	C
MA19251	**DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS**	BS	**3**	**1**	**0**	**4**

Objectives:	
●	To handle practical problems arising in the field of engineering and technology using differential equations.
●	To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT-I	**SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS**	**12**
Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients.		
UNIT-II	**PARTIAL DIFFERENTIAL EQUATIONS**	**12**
Formation of partial differential equations - 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.		
UNIT-III	**VECTOR CALCULUS**	**12**
Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.		
UNIT-IV	**ANALYTIC FUNCTIONS**	**12**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping and Bilinear transformation-Cauchy's integral theorem and Cauchy's integral formula (proof excluded) – Taylor's series and Laurent's series – Singularities – Residues – Residue theorem (without proof), simple problems.		
UNIT-V	**LAPLACE TRANSFORM**	**12**
Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.		
	Total Contact Hours : 60	

Course Outcomes:	
On completion of course students will be able to	
●	Apply various techniques in solving ordinary differential equations.
●	Develop skills to solve different types of partial differential equations
●	Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.
●	Use the concept of Analytic functions, conformal mapping and complex integration for solving Engineering problems.
●	Use Laplace transform and inverse transform techniques in solving differential equations.

Text Books:	
1	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –II , Mc Graw Hill Education, 2018

Reference Books / Web links:	
1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
4	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.

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	-	-	-	-
CO 2	3	2	1	-	-	-	-	-	-	-	-	1	-	-	-	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	1	-	-	-	-	-	-	-	-	1	-	-	-	-
Average	2.8	2	1	-	-	-	-	-	-	-	-	1	-	-	-	-

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
EE19242	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (COMMON TO AERO, CSE, CHEM, CIVIL, FT AND IT)**	ES	3	0	2	4

Objectives:	
●	To introduce electric circuits and provide knowledge on the analysis of circuits using network theorems.
●	To impart knowledge on the phenomenon of resonance in RC, RL and RLC series and parallel circuits.
●	To provide knowledge on the principles of electrical machines and electronic devices.
●	To learn the concepts of different types of electrical measuring instruments and transducers.
●	To teach methods of experimentally analyzing electrical circuits, electrical machines, electronic devices and transducers.

UNIT-I	**DC CIRCUITS**	9
Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff 's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.		
UNIT-II	**AC CIRCUITS**	9
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections		
UNIT-III	**ELECTRICAL MACHINES**	9
Construction, Principles of operation and characteristics of; DC machines, Transformers (single and three phase), Synchronous machines , three phase and single phase induction motors.		
UNIT-IV	**ELECTRONIC DEVICES & CIRCUITS**	9
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.		
UNIT-V	**MEASUREMENTS & INSTRUMENTATION**	9
Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Thermoelectric, piezoelectric, photoelectric, Hall effect - Classification of instruments - PMMC and MI Ammeters and.Voltmeters – Multimeter - Digital Storage Oscilloscope.		
	Contact Hours : 45	

List of Experiments			
1	Verification of Kirchhoff's Laws.		
2	Load test on DC Shunt Motor .		
3	Load test on Single phase Transformer.		
4	Load test on Single phase Induction motor.		
5	Characteristics of P-N junction Diode.		
6	Half wave and Full wave Rectifiers.		
7	Characteristics of CE based NPN Transistor.		
8	Inverting and Non- Inverting Op-Amp circuits.		
9	Characteristics of LVDT, RTD and Thermistor.		
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course, the students will be able to	
●	analyse DC and AC circuits and apply circuit theorems.
●	realize series and parallel resonant circuits.
●	understand the principles of electrical machines.
●	understand the principles of different types of electronic devices, electrical measuring instruments and transducers.
●	experimentally analyse the electric circuits, electrical machines, electronic devices, and transducers.

Text Book (s):	
1	J.B.Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K.Kataria & Sons Publications, 2002.
2	D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education(India) Private Limited, Third Reprint ,2016
3	Thereja .B.L., "Fundamentals of Electrical Engineering and Electronics", S. Chand & Co. Ltd., 2008

Reference Books(s) / Web links:	
1	Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
2	John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2006
3	Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, First Indian Edition, 2006
4	Rajendra Prasad, "Fundamentals of Electrical Engineering", Prentice Hall of India, 2006
5	A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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	-

Subject Code	Subject Name	Category	L	T	P	C
CY19141	**CHEMISTRY FOR TECHNOLOGISTS** **Common to I sem. B.Tech. – Chemical Engineering** **and** **II sem. B.Tech. – Biotechnology & Food Technology**	BS	**3**	**0**	**2**	**4**

Objectives:	
●	To acquire molecular level understanding of matter
●	To understand the basics of surface chemistry and nanomaterials
●	To attain knowledge on natural products and polymers

UNIT-I	**CHEMICAL BONDING**	**9**
Types of chemical bonds - electronegativity - bond polarity and dipole moments, partial ionic character of covalent bonds - VB theory - concept of hybridization. Molecular orbital theory - LCAO - bonding in homonuclear and heteronuclear diatomic molecules. Intermolecular forces - types - hydrogen bonding - importance of hydrogen bonding in biomolecules - van der Waals forces – consequences.		
UNIT-II	**SURFACE CHEMISTRYAND CATALYSIS**	**9**

Adsorption-difference between adsorption and absorption-types-factors influencing adsorption- adsorption from solutions- types of isotherms-Freundlich adsorption isotherm -Langmuir adsorption isotherm -industrial applications of adsorption - applications of surface active agents - detergency-wetting - water repellency-emulsifiers - CMC and defoamers.Catalysis - general characteristics -types of catalysis -acid -base catalysis - enzyme catalysis -characteristics-Michaelis - Menton equation -effect of temperature on enzyme catalysis - Langmuir- Hinshelwood mechanism for heterogeneous catalysis.

UNIT-III	**NANO MATERIALS**	**9**

Basics-distinction between nanoparticles and bulk materials - size-dependent properties - nanoparticles - nanocluster – nanorod - nanotube and nanowire - synthesis of nanoparticles - chemical methods -metal nanocrystals by reduction ,solvothermal synthesis, photochemical synthesis, sonochemical synthesisandchemical vapor deposition -physical methods - ball milling ,electrodeposition - biogenic synthesis - properties and applications.

UNIT-IV	**HETEROCYCLIC COMPOUNDS AND NATURAL PRODUCTS**	**9**

Heterocyclic compounds-synthesis and reactions of pyrrole -furan - thiophene- pyridine- quinoline-isoquinoline. Terpenoids- Isolation - Isoprene rule-structural elucidation of citral and menthol.

UNIT-V	**POLYMERS**	**9**

Polymers-definition - polymerization - types - addition and condensation polymerization - free radical polymerization mechanism - effect of structure on the properties of polymers - strength, plastic deformation, elasticity and crystallinity - plastics - preparation - properties and uses of PVC, teflon, polycarbonate, polyurethane, nylon-6,6, PET,KEVLAR-Green polymers-Introduction –poly lactic acid (PLA)

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

List of Experiments	
1	Estimation of mixture of acids by conductometry
2	Estimation of copper / ferrous ions by spectrophotometry
3	Estimation of acid by pH metry.
4	Estimation of alkalinity by indicator method.
5	Estimation of chloride by argentometric method
6	Determination of total, temporary and permanent hardness by EDTA method.
7	Estimation of DO by winkler's method
8	Estimation of sodium and potassium in water by flame photometry
9	Determination of corrosion rate on mild steel by weight loss method
10	Determination of molecular weight of a polymer by viscometry method.
11	Verification of adsorption isotherms (acetic acid on charcoal)
12	Phase change in a solid.

13	Preparation of simple drug			
14	Determination of rate constant of a reaction			
15	Determination of distribution coefficient			
16	Preparation of Thiokol rubber.			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course students will be able to	
●	Be conversant with basics of molecule formation and interactions
●	measure molecular/bulk properties like absorbance, molecular weight, DO and chloride
●	Apply the knowledge of surface chemistry in practical and industrial applications
●	Be familiar with structure and properties of natural products
●	Be assertive on various types of polymers and their properties including green polymers

Text Books:	
1	P. C. Jain and Monika Jain, "Engineering Chemistry", DhanpatRai Publishing Company (P) LTD, New Delhi, 2015
2	Bahl B. S., and Arun Bahl, "A Text Book of Organic Chemistry", S. Chand, New Delhi, 2016.

Reference Books / Web links:	
1	R.D. Madan, "Modern Inorganic Chemistry", S. Chand, New Delhi, 2012
2	I L Finar "Organic Chemistry" ELBS (1994)
3	Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, ―Polymer Science‖, New Age International (P) Ltd., New Delhi, 2011
4	B.S. Murthy, P.Shankarand others,"Text book of Nano-science and nanotechnology", University Press, IIM.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO1 0	PO11	PO1 2	PS O1	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
GE19211	**PROBLEM SOLVING AND PROGRAMMING IN PYTHON** (with effect from2021 batch onwards) Common to all branches of B.E / B.Tech programmes (except–CSE,CSBS,CSD,IT,AI/ML)	**ES**	**1**	**0**	**4**	**3**

Objectives:	
	To understand computers, programming languages and their generations and essential skills for a logical thinking for Problem solving.
	To write, test, and debug simple Python programs with conditionals ,and loops and functions
	To develop Python programs with defining functions and calling them
	To understand and write python programs with compound data-lists ,tuples, dictionaries
	To search, sort, read and write data from/to files in Python.

List of Experiments				
1.	Study of algorithms, flowcharts and pseudo codes.			
2.	Introduction to Python Programming and Demoon Python IDLE/Anaconda distribution.			
3.	Experiments based on Variables, Data types and Operators in Python.			
4.	Coding Standards and Formatting Output.			
5.	Algorithmic Approach: Selection control structures.			
6.	Algorithmic Approach: Iteration control structures.			
7.	Experiments based on Strings and its operations.			
8.	Experiments based on Lists and its operations.			
9.	Experiments based on Tuples and its operations.			
10.	Experiments based on Sets and its operations.			
11.	Experiments based on Dictionary and its operations.			
12.	Functions: Built-in functions.			
13.	Functions: User-defined functions.			
14.	Functions: Recursive functions.			
15.	Searching techniques: Linear and Binary.			
16.	Sorting techniques: Bubble and Merge Sort.			
17.	Experiments based on files and its operations.			
		Contact Hours	**:**	**75**

Course Outcomes: On completion of the course students will be able to	
	Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
	Write, test, and debug simple Python programs with conditional sand loops.
	Develop Python programs step-wise by defining functions and calling them.
	Use Python lists, tuples, dictionaries for representing compound data.
	Apply searching, sorting on data and efficiently handle data using flat files.

Text Books:	
1	AllenB.Downey,ThinkPython:HowtoThinkLikeaComputerScientist,Secondedition,UpdatedforPython3, Shroff/O'ReillyPublishers,2016(http://greenteapress.com/wp/think-python/)

2	GuidoVanRossumandFredL.DrakeJr,AnIntroductiontoPython-RevisedandupdatedforPython3.2,NetworkTheoryLtd., 2011.

Reference Books / Web links:	
1	JohnVGuttag,IntroductiontoComputationandProgrammingUsingPython,RevisedandexpandedEdition,MIT Press, 2013.
2	RobertSedgewick,KevinWayne,RobertDondero,IntroductiontoProgramminginPython:AnInter-disciplinary Approach, PearsonIndiaEducationServicesPvt.Ltd. 2016.
3	TimothyA. Budd, Exploring Python, Mc-GrawHillEducation(India)PrivateLtd.,2015.
4	KennethA .Lambert, Fundamentals of Python:FirstPrograms,CengageLearning,2012.
5	CharlesDierbach,IntroductiontoComputerScienceusingPython:AComputationalProblemSolvingFocus,Wiley IndiaEdition,2013.
6	PaulGries, Jennifer Campbell and Jason Montojo, Practical Programming:An Introduction to Computer Science using Python3, Second edition, Pragmatic Programmers ,LLC, 2013.

PO/PS OCO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
CO 2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
CO 3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
CO 4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CO 5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	1.8	1.6	2.2	1.6	1.8	0.0	0.0	0.0	0.2	0.2	1.4	1	2.4	2.4	2

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
FT19201	**FOOD CHEMISTRY**	PC	3	0	0	3

Objectives:	
●	To develop the knowledge of students in the basic area of Food Chemistry
●	To understand the composition and properties of food
●	To understand the chemical changes of nutrients during handling, processing, and storage
●	To understand underlying principles of food processing and preservation
●	To appreciate the similarities and complexities of the chemical components in foods.

UNIT-I	**CARBOHYDRATES**	10
The principal carbohydrates in the human diet. Chemical properties of carbohydrates-dehydration, caramelization, Maillard reaction. Types Simple Sugars: mono and disaccharides, solubility; Artificial sweeteners; Glucose syrup, fructose syrup, 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; Structure of glycogen. Fiber- Cellulose & hemicellulose Pectins: Gums & seaweeds- gel formation & viscosity.		
UNIT-II	**PROTEINS**	9
The principal proteins in the human diet. Review of protein structure & conformation; Optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Properties & reactions of proteins in food systems and Food enzymes and its role in food spoilage, application of food enzymes; Texturized proteins; Functional role and uses in foods.		
UNIT-III	**LIPIDS**	9
Review of structure, composition and nomenclature of fats. Properties of fats & oils: Edible oil refining processes, winterization, melting points, plasticity, isomerisation, hydrolysis of triglycerides, Saponification number, iodine value, Reichert-Meissl number. Types of fatty acids; Modification of fats: hydrogenation- cis and trans isomers, inter-esterification, acetylation, Hydrolytic rancidity & oxidative rancidity; Shortening power of fats, tenderization, frying - smoke point, auto oxidation, polymerization, lipids having emulsifying properties, its application in food industry and detergents; Shortening power of fats, chemistry of steroids, types of fat substitute.		
UNIT-IV	**FOOD COMPOSITION, WATER, MINERALS AND VITAMINS**	7
Proximate composition of food, water activity in food, moisture content of food, water quality for food processing. Mineral & vitamin content of foods- stability & degradation during food processing.		
UNIT-V	**AROMA & IMPORTANT PHYTOCHEMICALS IN FOOD**	9
Naturally occurring colours/pigments in food and impact on antioxidant level, Synthetic food grade Colours, enzymatic browning of food, flavour & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; and Naturally similar /artificial flavours, Threshold values, off flavours & food taints. Naturally occurring toxic substances, protease inhibitors, bioactive components: phytates, polyphenols, saponins, phytoestrogens etc.		
	Total Contact Hours : 45	

Course Outcomes:	
●	On completion of course, students will be able to: Explain the structure and components of food systems
●	Analyze the relationships between nutritional health and food selection.
●	Control the major chemical and biochemical (enzymatic) reactions that influence food quality
●	Understand the properties of different food components
●	Understand how the interactions between the components modulate the specific quality attributes of the food

Text Book (s):	
1	Belitz H.-D, Grosch W and Schieberle P. Food Chemistry, 4th Revised Edition, Springer-Verlag, 2009.

2	John M. deMan. "Principles of Food Chemistry". 3rd Edition, Springer, 1999.
3	Chopra, H.K. and P.S. Panesar. "Food Chemistry". Alpha Science International Limited, 2010

Reference Books(s) / Web links:	
1	Meyer, Lillian Hoagland "Food Chemistry". CBS Publishers, 1987.
2	Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 4th Edition, Kluwer-Academic, Springer, 2014.
3	Richard Owusu-Apenten "Introduction to Food Chemistry" CRC Press, 2005.
4	Srinivasan Damodaran, Kirk L. Parkin, "Fennema's Food Chemistry "5th Edition, CRC Press, 2008.
5	Peter Chi Keung Cheung, Bhavbhuti M. Mehta, " Handbook of Food Chemistry" Springer, 2015

PO/PSO CO	PO 1	PO2	PO3	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 O 4
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
Average	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 (Lab oriented Theory Courses)**	**Category**	**L**	**T**	**P**	**C**
MC19102	**INDIAN CONSTITUTION AND FREEDOM MOVEMENT**	MC	3	0	0	0

Objectives:	
●	To inculcate the values enshrined in the Indian constitution
●	To create a sense of responsible and active citizenship
●	To know about Constitutional and Non- Constitutional bodies
●	To understand sacrifices made by the freedom fighters.

UNIT-I	**INTRODUCTION**	**9**
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy		

UNIT-II	**STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT**	**9**
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-III	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	**9**
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials.		
UNIT-IV	**CONSTITUTIONAL FUNCTIONS AND BODIES**	**9**
Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies		
UNIT-V	**INDIAN FREEDOM MOVEMENT**	**9**
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-**Indian Freedom Struggle under Mahatma Gandhi-**Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition		
	Contact Hours :	**45**

Course Outcomes:	
●	Upon completion of the course, students will be able to: Understand the functions of the Indian government
●	Understand and abide the rules of the Indian constitution.
●	Gain knowledge on functions of state Government and Local bodies
●	Gain Knowledge on constitution functions and role of constitutional bodies and non-constitutional bodies
●	Understand the sacrifices made by freedom fighters during freedom movement

Text Book (s):	
1	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013
2	Bipan Chandra, History of Modern India, Orient Black Swan, 2009
3	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016

Reference Books(s) / Web links:

1	Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014
2	P K Agarwal and K N Chaturvedi , Prabhat Prakashan, New Delhi, 1st ed , 2017
3	Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
4	U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

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

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT19211	**FOOD CHEMISTRY LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
●	To recognize the important reactions in food chemistry and their consequences.
●	To get familiar with methods to measure chemical reactions involved in foods
●	To reporting the results in an appropriate format.
●	To design and conduct an experiment to understand a simple food chemistry problem.
●	To understand the complex interactions between the different components of foods.

List of Experiments	
1	Experiment to study the properties of carbohydrates- caramelization, Maillard reaction.
2	Experiment on enzymatic and acid hydrolysis of sucrose
3	Preparation of emulsions and study its stability
4	Determination of Foaming properties of proteins
5	Determination of Solubility, specific gravity and Refractive index of oils
6	Estimation of free fatty acid content of oil
7	Determination of peroxide value and Anisidine value of fats.
8	Experiment to study the effect of heat on proteins.
9	Determination of Iso-electric point of casein & experiment to study effect of rennin on milk proteins
10	Experiments to study the gelling properties of starch
11	Experimental study of gluten formation using wheat flour
12	Experimental study on enzymatic Browning in foods

	Total Contact Hours	**:**	**60**

Course Outcomes:	
●	Students successfully completing this class will be able to: Recognize the important reactions in food chemistry and their consequences.
●	Be familiar with methods to measure these reactions.
●	Be capable of reporting the results in an appropriate format.
●	Be capable of designing and conducting an experiment to understand a simple food chemistry problem.
●	Able to understand the complex interactions between the different components of foods.

References:	
1.	Weaver, C.M, and J.R. Daniel. "The Food Chemistry Laboratory – A Manual for Experimental Foods, Dietetics & Food Scientists." 2nd Edition, CRC Press, 2005.

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
1.	Water bath	2
2.	UV- Visible Spectrophotometer	1
3.	Pycnometer fitted with thermometer	10
4.	Brookfield Refractometer	1
5.	pH meter	5
6.	Light Microscope	5

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
Average	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

Subject Code	Subject Name	Category	L	T	P	C
MA19353	**TRANSFORMS AND NUMERICAL METHODS** **Common to III sem. B.E. Electrical and Electronics Engineering and** **B.Tech. Biotechnology & Food Technology**	BS	**3**	**1**	**0**	**4**

Objectives:	
	To introduce Fourier series and Z transforms to solve problems that arise in the field of Engineering.
	To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.

UNIT-I	**FOURIER SERIES**	**12**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Parseval's identity – Harmonic analysis.		
UNIT-II	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**
Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.		
UNIT-III	**SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**	**12**
Newton Raphson method – secant method – Gauss Jordan method – Iterative method of Gauss Seidel –Eigen value of a matrix by power method and by Jacobi method for symmetric matrix.		
UNIT-IV	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**12**
Curve fitting ($y= a+ bx$, $y = a+bx+cx^2$)-Lagrange's interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's 1/3 rules.		
UNIT-V	**NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS**	**12**
Taylor's series method – Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations – Finite difference methods for solving second order equations- Finite difference solution of one dimensional heat equation by explicit and implicit methods - Two dimensional Laplace equation.		
	Total Contact Hours : 60	

Course Outcomes: On completion of course students will be able to	
	Develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
	Solve difference equations using Z – transforms that arise in discrete time systems.
	Solve algebraic equations and Eigen value problems that arise during the study of engineering problems.

□	Use interpolation methods to solve problems involving numerical differentiation and integration.
□	Solve differential equations numerically that arise in course of solving engineering problems.

Text Books:	
1	Grewal B.S., "Higher Engineering Mathematics", 44rd Edition, Khanna Publishers, Delhi, 2017.
2	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Updated edition, 2018.
3	Kandasamy P., Thilagavathi and K. Gunavathi., "Numerical Methods" , S. Chand & Company Ltd. (2013).

Reference Books / Web links:	
1	Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
2	Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 2016.
3	Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2015.
4	Chapra S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGrawHill, New Delhi, 2015.
5	Veerarajan T., Ramachandran T., 'Numerical Methods with Programs in C and C++' Tata McGraw Hill.,Second Edition 2015.
6	Jain M.K., Iyengar, S.R., and Jain, R.K., 'Numerical Methods for Scientific and Engineering Computation', New Age Publishers. 6th edition, 2007.
7	Rajaraman V., Computer-Oriented Numerical Methods, Third Edition,Published by PHI Learning Private Limited (2019).

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

Subject Code	Subject Name	Category	L	T	P	C
FT19301	FOOD MICROBIOLOGY	PC	3	0	0	3

Objectives:	
□	To learn basic microbial structure and growth requirements
□	To understand the role of microbes in spoilage and pathogenesis.
□	To understand the beneficial role of microbes.
□	To gain knowledge on the methods of isolating and characterizing microbes associated with foods
□	To understand the methods used to detect pathogens in foods.

UNIT-I	MICROBES - STRUCTURE AND MULTIPLICATION	9
Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining. Structural organization and multiplication of bacteria, viruses, algae and fungi; Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.		
UNIT-II	**ROLE OF MICROBES IN SPOILAGE OF FOODS AND THEIR CONTROL**	**9**
Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products. Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, Benzoates, Sorbates / Propionates naturally occurring antimicrobials; Physical methods- Low and high temperatures, drying, radiation and high pressure; Tolerance of microbes to chemical and physical methods in various foods.		
UNIT-III	**BENEFICIAL MICROBES IN FOODS**	**9**
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, idly, soy products, fermented vegetables and meats.		
UNIT-IV	**MICROBIAL AGENTS OF FOOD BORNE ILLNESS**	**9**
Food borne infections and food poisoning, Microbial toxins - types, Gram Negative and Gram positive food borne pathogens – Salmonella, Coliforms, E. coli, Shigella, Vibrio cholera, Staphylococcus aureus;		

Clostridium botulinum; Listeria monocytogenes Toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.		
UNIT-V	**MICROBIAL EXAMINATION OF FOODS**	**9**
Detection & Enumeration of microbes in foods, Most Probable Number calculations; Indicator organisms and microbiological criteria; Rapid and automated microbial methods - development and impact on the detection of food borne pathogens; Applications of immunological, importance of *clostridium botulinum* techniques to food industry; Detection methods for *E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, C. botulinum & Salmonella, Listeria monocytogenes,* Norwalk virus, Rotavirus, Hepatitis A virus from food samples		
	Total Contact Hours : 45	

Course Outcomes:	
	On completion of course students will be able to
	Understand the basics of microbiology
	Identify the various microbes associated with food spoilage and pathogenesis
	Understand and identify the role of these microbes in food preservation.
	Comprehend the various techniques for isolation and characterization of microbes.
	Apply the learnt techniques to detect the pathogens associated with the foods.

Text Books:	
1	Vijaya Ramesh “Food Microbiology”. MJP Publishers, 2007
2	Jay, J.M. “Modern Food Microbiology”. 4th Edition. CBS Publishers, 2003
3	Adams, M.R and M.O. Moss. “Food Microbiology”. New Age International, 2002

Reference Books / Web links:	
1	Pawsey, R.K. “Case Studies in Food Microbiology for Food Safety and Quality”. The Royal Society of Chemistry, 2001.
2	Forsythe, S.J. “The Microbiology of Safe Food”. Blackwell Science, 2000.
3	Harrigan, W.F. “Laboratory Methods in Food Microbiology” 3rd Edition, Academic press, 1998

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

Subject Code	Subject Name	Category	L	T	P	C
FT19302	BIOCHEMISTRY AND NUTRITION	PC	3	0	0	3

Objectives:	
□	To develop knowledge on basics of nutrition for Diet planning based on RDA
□	To understand functional role of carbohydrates and its health effects.
□	To gain knowledge on protein quality assessment and functional role of lipids
□	To understand the physiological role of vitamins and minerals
□	To familiarize with non-communicable diseases associated with lifestyle.

UNIT-I	AN OVERVIEW OF NUTRITION	9

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.

UNIT-II	CARBOHYDRATES	9

Carbohydrates definition,classification and functions: mono and disaccharides, oligosaccharides, Polysaccharides; Digestion and absorption of carbohydrates (mono, di and polysaccharides), physiological functions and metabolism (Glycolysis, Gluconeogenesis, Glycogenolysis), Dietary fibres: Digestion, absorption and metabolism; Glycemic and Non-glycemic carbohydrates, Blood glucose regulation, Recommendations of sugar intake for health, Recommended Dietary Allowances, Health implications of high carbohydrate diets, Dietary recommendations for NIDDM and IDDM.

UNIT-III	PROTEINS & LIPIDS	9

Protein: Chemical Composition, Properties, Classification– nutritional classification of proteins and amino acids, Physiological function, Digestion and Absorption, Quality of proteins, scoring systems, Complementary value of proteins, Requirements, Recommended Dietary Allowances.

Lipid: Chemical composition, Classifications, Fats in body, Fats in food, Physiological functions, Digestion and Absorption, Intestinal resynthesis of triglycerides, Types of fatty acids: Role and nutritional significance (SFA, MUFA, PUFA), Recommended Dietary Allowances, Health implications of high fat diet.

UNIT-IV	VITAMINS & MINERALS	9

Water& Fat Soluble Vitamins- Sources, Functions, absorption and metabolism, Factors affecting absorption of vitamins, Deficiency, Recommended Dietary Allowances.

Macro minerals (Calcium, Phosphorus)- Functions, Absorption and metabolism, Factors affecting bioavailability, Sources, Deficiency, Overdose toxicity, Recommended Dietary Allowances.

Micro minerals (Iron, Iodine) - Functions, Absorption and metabolism, Factors affecting bioavailability, Sources, Deficiency, Overdose toxicity, Recommended Dietary Allowances.		
UNIT-V	**ENERGY METABOLISM**	**9**
Energy Balance: Definition, units, Determination of energy values of foods, Determination of energy requirements, Basal Metabolic Rate, Measurement of basal metabolism, Resting Energy metabolism, Non-caloric methods, Thermic effect of foods, Factors affecting thermic effect of foods, Recommended Dietary Allowances for energy. Health implications of high energy foods: Obesity, 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.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
□	Apply knowledge of nutrition in diet planning.
□	Provide the dietary recommendations for NCD's
□	Asses the quality of proteins and lipids from various sources.
□	Comprehend the physiological and toxicological effects of vitamins and minerals.
□	Apply the learnt techniques to assess the lifestyle related NCD's.

Text Books:	
1	B. Srilakshmi. "Nutrition Science". II Edition, New Age International (P) Ltd., 2002.
2	Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. Oxford University Press, 2007.
3	Gibney, Michael J., et al., "Introduction to Human Nutrition". 2 nd Edition. Blackwell,2009.
4	Gropper, Sareen S. and Jack L. Smith "Advanced Nutrition and Human Metabolism". 5th Edition. Wadsworth Publishing, 2008.

Reference Books / 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". 4th Edition, CRC Press, 2008
3	Belitz,H.-D, Grosch W and Schieberle P. "Food Chemistry", 3rd Rev. Edition, SpringerVerlag, 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	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	2	-	-	-	2	2	2	-	2	-	1	1	1	-	1
CO 2	1	1	-	-	-	3	1	2	-	2	-	1	2	2	-	1
CO 3	1	1	-	-	-	2	3	2	-	2	-	1	1	2	-	1
CO 4	1	1	-	-	-	2	3	2	-	2	-	1	2	2	-	1
CO 5	1	2	2	1	-	2	2	2	-	2	-	2	1	2	2	1
Average	1.2	1.4	2	1	-	2.2	2.2	2	-	2	-	1.2	1.4	1.8	2	1

Subject Code	Subject Name	Category	L	T	P	C
FT19303	**FOOD PROCESS CALCULATIONS**	**ES**	**3**	**0**	**0**	**3**

Objectives:	
	To understand the basic units in food processing.
	To perform basic humidity calculations.
	To perform material balance for process operations.
	To make energy balance in food technology.
	To understand the heat content and enthalpy in food processing.

UNIT-I	**UNITS AND DIMENSIONS**	**9**

Units and Dimensions: Basic and derived units, use of model units in 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-II	**HUMIDITY CALCULATIONS**	**9**

Fundamental food process Calculations and Humidity: Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying of foods - Humidity chart, dew point.

UNIT-III	**STOICHIOMETRY AND MATERIAL BALANCE**	**9**

Basic Principles of Stoichiometry - Importance of material balance and energy balance in a food Industry- Dimensions, Units, conversion factors and their use –Data sources, Humidity and applications. Material Balance: Stoichiometric principles, Application of material balance in food operations like distillation, evaporation, crystallization, drying, extraction, Leaching.

UNIT-IV	**ENERGY BALANCE**	**9**

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 for food products.

UNIT-V	**ENTHALPY**	**9**

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.

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

(Use of Psychometric chart is permitted in the examination)

Course Outcomes:	
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.

Text Books:	
1	Bhatt, B.L and Vora, S.M., ―Stoichiometry, Third Edition, McGraw-Hill, New York, 1996.
2	Gavhane, K.A ―Introduction to Process Calculations (Stoichiometry) NiraliPrakashan Publications, Pune, 2006.

Reference Books / Web links:	
1	Venkataramani, V. and Anantharaman, N., ―Process Calculations, Prentice Hall of India, New Delhi, 2003.
2	Himmelblau, D.M., ―Basic Principles and Calculations in Chemical Engineering, Sixth

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	1	2	0	-	-	3	3	1	3	3	3	3	1	1
CO 2	3	3	1	1	2	-	-	2	1	2	3	3	3	3	-	1
CO 3	3	2	3	3	-	-	-	3	1	1	2	1	3	2	-	1
CO 4	2	3	3	3	-	-	-	3	1	1	3	2	3	3	1	-
CO 5	2	3	3	3	-	-	-	3	1	1	3	3	2	2	1	-
Average	2.6	2.8	2.2	2.4	2	-	-	2.8	1.4	1.2	2.8	2.4	2.8	2.6	1	1

Subject Code	Subject Name	Category	L	T	P	C
FT19304	**FLUID MECHANICS IN FOOD PROCESSES**	**ES**	**3**	**0**	**0**	**3**

Objectives:	
	Provide information about the mechanics of fluids through the properties of the fluids, behaviour of fluids.
	Educate the dynamics of fluids.
	Understand the applications of the conservation laws and flow measurement.
	Gain knowledge in the area of flow through open channel flow (both laminar and turbulent)
	Analyse the dimensions and application of pumps in the field of food technology

UNIT-I	**PROPERTIES OF FLUIDS**	**9**
Properties of fluids – definition – units of measurement - Mass density – specific weight, specific volume – specific gravity, equation of state – perfect gas - Viscosity – vapor pressure– compressibility, elasticity & surface tension – capillarity. Fluid pressure and measurement – simple, differential and micro manometers - Mechanical gauges –calibration. Hydrostatic forces on surfaces – Total pressure and Centre of pressure -Horizontal- vertical and inclined plane surface. Archimedes principles – buoyancy, applications - fluid food - case studies		
UNIT-II	**FLUID FLOW ANALYSIS**	**9**
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– steak 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, applications - fluid food - case studies		
UNIT-III	**FLOW MEASUREMENTS**	**9**
Bernoulli's equation – applications - Venturimeter – orifice meter – nozzle meter & rota meter –pitot tube. Orifice – sharp edged orifice – 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 –-Major and minor losses in pipes. Valves, valve types and characteristics of valves, applications - fluid food- viscosity - case studies		
UNIT-IV	**OPEN CHANNEL FLOW AND FLUID FLOW THROUGH BEDS**	**9**
Types of flow in channel – uniform flow – most economical section of channel – rectangular – trapezoidal. Specific force - critical flow. Flow measurement in channels – notchesrectangular triangular. Float method.Fluid flow through fixed and fluidized beds		
UNIT-V	**DIMENSIONAL ANALYSIS & PUMPS**	**9**

Dimensional analysis – concept of geometric, kinematic and dynamic similarity. Important non-dimensional numbers – Reynolds, Froude, Euler, Mach and Weber. Pump terminology – suctionlift, suction head, delivery head, discharge, water horse power – selection of pump capacity. Centrifugal pumps – components – working – types of pumps and impellers – Priming–cavitation. Turbine and submersible pumps - Jet pump – Other pumps – Air lift pump - reciprocating pump - sludge pump and vacuum pump-Hydraulic ram, applications- fluid food - case studies.

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

Course Outcomes:	
	On completion of course students will be able to
	Understand the properties of fluids.
	Apply the physical laws in addressing problems in hydraulics.
	Interpret the flow measurements and transportation of fluids.
	Analyse the fluid kinematics
	Comprehend the types of dimension and pumps.

Text Books:	
1	Modi, P.N. and Seth S.M. “Hydraulics and fluid mechanics”. Standard Publishers Distributors, New Delhi, 2010.
2	Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. 9th Edition. Tata McGraw-Hill, New Delhi, 1998

Reference Books / Web links:	
1	Bansal, R.K., “A text book of fluid mechanics and hydraulic machinery”, Laxmipublications (P) Ltd., New Delhi, 2002.
2	Grade, RJ., “Fluid mechanics through problems”. Wiley eastern Ltd., Madras,2002
3	Jain A. K. “Fluid Mechanics”. Khanna Publishers 2004.
4	JagadishLal, “Hydraulic machines”. Metropolitan book house, New Delhi, 2000

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	2	3	2	1	1	1	-	-	-	-	1	3	2	-	-
CO 2	3	3	2	2	1	1	1	-	-	-	1	1	3	3	-	-
CO 3	2	3	3	2	2	1	1	-	-	-	1	1	3	2	-	-
CO 4	3	2	3	3	1	0	0	-	-	-	1	1	3	2	-	-
CO 5	3	2	3	2	1	1	1	-	-	-	-	1	2	3	1	1
Average	2.8	2.4	2.8	2.2	1.2	1	1	-	-	-	1	1	2.8	2.4	1	1

Subject Code	Subject Name	Category	L	T	P	C
FT19305	FOOD ADDITIVES	PC	3	0	0	3

Objectives:	
	To learn the Indian laws and regulations pertaining to food additives.
	To familiarize with the safety assessment of food additives
	To gain knowledge on permitted food additives and its functional role.
	To study the effects of food additives on food matrix.
	To understand the role of natural ingredients as food additives.

UNIT-I	ADDITIVES AND FOOD SAFETY	9

Definition, role of food additives, classification of food additives based on their role, Risks and benefits of food additives ,Legal and regulations- INS numbering system, General standards for food additives/Codex standards, safety requirements of food additives- role of JECFA in safety assessment of food additives, Principles of safety assessment- Food additive intake assessment methods, Procedures to fix ADI and maximum levels of food additives, ADI Calculation, Excessive food additive intakes and population risk groups, Case studies on risk assessment of food additives, Status of food additives with respect to Indian laws- GMP and permissible upper levels of food additives under Indian food laws.

UNIT-II	PRESERVATIVES	9

Acidity Regulators – definition, chemical structure, role and importance, pH modulation and taste, acidity profile, permitted acidity regulators, levels of usage and food applications. Antioxidants - Chemistry of oxidative deterioration of food and its constituents and its effect on the quality; defining antioxidant; water soluble and oil soluble antioxidants and their chemical structure, permitted antioxidants; mechanism of action, permitted levels and food application.

Preservatives of chemical and microbial origin; mode of action on spoilage organisms and pathogens, factors affecting the performance of preservatives, active forms of preservatives, necessity in a food and levels of usage; permitted preservatives and food applications. Case studies / illustrations.

UNIT-III	EMULSIFIERS, STABILIZERS AND THICKENERS	9

Emulsion, surface tension, oil in water and water in oil emulsion, Hydrophilic and Lipophilic balance (HLB), role of emulsifiers, different classes of emulsifiers and their chemical structure, their HLB values and role in emulsion stabilization; role of different stabilizers and other substances in emulsion stability; emulsion formation process and equipment; measurement of emulsion stability; permitted emulsifiers and stabilizers and food applications. Optimization of emulsifiers and stabilizers – case study. Thickeners – definition, chemical structure, role in food processing and product end characteristics, list of permitted thickeners and food applications

UNIT-IV	COLOR, FLAVORS, FLAVOR ENHANCERS AND SWEETENERS	9

Color – Natural and synthetic food colors, their chemical structure, shades imparted, stability, permitted list

of colors, usage levels and food application.

Flavoring agents- natural and synthetic flavorings, Flavors from vegetables, cocoa, chocolate, coffee, vanilla beans and Spices. Evaluation tests for flavors. Stability of flavors during food processing, Extraction techniques of flavors, Flavor emulsions; Essential oils and Oleoresins;Flavor enhancers- Chemical properties, Functions in foods, Glutamate in foods, Biochemical properties & Toxicology

Sweeteners – list, structure, taste profile, permitted list, usage levels and food applications.

UNIT-V	OTHER FOOD ADDITIVES & FOOD INGREDIENTS	9

Anticaking agents, Antifoaming, Glazing agents, Bulking agents, Humectants, Firming agents, Softening agents, Crystal modifiers, Flour improvers, Flour treatment agents, Dough conditioners, and Enzymes – definition, role and mode of action, permitted list of agents and food application.

Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods.

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

Course Outcomes:

On completion of course students will be able to

□	Comprehend laws related to food additives.
□	Assess the safety level of food additives.
□	Utilize the additives for novel product development.
□	Analyse the effect of food additives on food matrix.
□	Utilize the proteins and sugars as food additives.

Text Books:

1	Branen, A. L. “Food Additives” 2nd Edition, CRC press, 2002
2	Mahindru, S. N. “Food Additives- Characteristics Detection and Estimation”, TATA McGraw-Hill, 2000
3	Titus A. M. Msagati. “The Chemistry of Food Additives and Preservatives”, Wiley-Blackwell, 2013

Reference Books / Web links:

1	Thomas. E. Furia, “CRC Handbook of food additives” 2nd edition, Volume 1, CRC press, 1978
2	Thomas. E. Furia, “CRC Handbook of food additives” 2nd edition, Volume 2, CRC press, 1980
3	P. Michael Davidson, John N. Sofos, and A. L. Branen, “Antimicrobials in food”, 3rd edition, CRC press 2005
4	Peter A Williams and Glyn O Philips, “Gums and stabilizers for the Food Industry”, RSC,2006.
5	Madhavi, D. L., “Food antioxidants”, CRC Press, 1996
6	Helen Mitchell, “Sweeteners and sugar alternatives in food technology”, Blackwell, 2006
7	Carmen Socaciu, “Food Colorants”, CRC Press, 2008
8	Gary Reineccius, “Flavor chemistry and technology”, 2nd edition, CRC Press, 2005

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	3	1	3	1	-	-	-	2	2	2	-	2
CO 2	3	3	3	3	2	1	1	1	-	-	-	1	2	2	-	2
CO 3	3	3	3	3	2	1	1	1	-	-	-	1	2	2	-	2
CO 4	3	3	3	3	2	1	1	1	-	-	-	1	2	2	-	2
CO 5	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 (Laboratory Course)	Category	L	T	P	C
FT19311	**FOOD MICROBIOLOGY LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
	To learn basic microbiological techniques.
	To learn pure culture isolation techniques.
	To learn culture preservation techniques.
	To understand the principles of microscopy and its operation.
	To isolate and enumerate the microbes associated with the foods.

List of Experiments	
1	Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques; Culture Media-Types and Use; Preparation of Nutrient broth and agar.
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
7	Enumeration of Lactic acid bacteria from fermented foods
8	Enumeration of Yeast &Mold from fruits
9	Enumeration of spores from pepper
10	Inhibitory effect of spices on microbial load in fish & flesh foods
11	Enumeration & Isolation of E. coli from processed meat/chicken
12	Thermal destruction of microbes: TDT & TDP
13	Enumeration & Isolation of Staphylococci from ready to eat street foods
14	Effect of cleaning and disinfection on microbial load

	Total Contact Hours	**:**	**60**

Course Outcomes:	
The students will be able to	
	Prepare the microbial growth media and sterilize it.
	Isolate pure culture and preserve them.
	Operate microscope and use it for detection of microbes.
	Isolate and enumerate spoilage organisms.
	Detect the presence of food borne pathogens.

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.	Laminar Air Flow Chamber	2
2.	Hot Air Oven	1
3.	Autoclave	2
4.	Microbiological Incubator	2
5.	BOD Low Temperature Incubator	1
6.	Refrigerator	1
7.	Deep Freezer (-18˚C)	1
8.	Analytical Weighing balance	5
9.	Homogenizer	1
10.	pH Meter	3
11.	Hot Plate	1
12.	Shaking water bath	1
13.	Quebec Colony counter	3
14.	Magnetic stirrer	2
15.	Vortex mixer	2
16.	Light Microscope	5
17.	Anaerobic Incubator	1

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	2	1	2	2	3	1	-	-	-	2	2	2	2	-	3
CO 2	2	1	2	3	2	2	2	-	-	-	2	2	3	3	-	3
CO 3	1	3	3	-	-	-	2	-	-	-	3	3	1	2	-	3
CO 4	2	2	2	-	-	-	1	-	-	-	1	2	2	1	-	3
CO 5	3	2	2	-	-	-	2	-	-	-	1	1	2	1	-	3
Average	1.8	2	2	2.5	2	1.5	1.6	0	0	0	1.8	2	2	1.8	0	3

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT19312	BIOCHEMISTRY AND NUTRITION LABORATORY	PC	0	0	4	2

Objectives:	
	To learn basic measurement in food biochemistry.
	To learn basic chemical analysis
	To understand basic chemistry involved in food testing.
	To gain knowledge in anthropometry.
	To understand the different clinical requirements.

List of Experiments				
1	Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.			
2	Preparation of buffer –titration of a weak acid and a weak base.			
3	Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars			
4	Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from amino acid.			
5	Protein estimation by Biuret and Lowry's methods			
6	Protein estimation by Bradford and spectroscopic methods.			
7	Extraction of lipids and analysis by TLC.			
8	Enzymatic assay: phosphatase from potato			
9	Nutritional anthropometry - Standards for reference – WHO, Body Mass Index and reference value			
10	Techniques of measuring height, weight, head, chest and arm circumference, waist to hip ratio, skin-fold thickness, Calculation of percent Body fat using skin folds calipers.			
11	Calculation of the calories from nutrient composition of foods			
12	Comparison of Food Composition data bases			
	Total Contact Hours	**:**	**60**	

Course Outcomes:	
The students will be able to	
	Learn basic measurement in food processing.
	Learn the basic chemical analysis
	Apply the learnt basic chemistry involved in food testing.
	Assess the nutritional anthropometry
	Assess the clinical status of the individuals.

Text Books:	
1.	R.C. Gupta and S. Bhargavan. "Practical Biochemistry", CBS Publishers, 1992
2.	David T. Phummer. "Introduction to Practical Biochemistry", II Edition, Tata McGraw-Hill, 1988

3.	Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. Oxford University Press, 2007.

References:	
1.	Thomas M. Devlin. "Textbook of Biochemistry with clinical correlations" VII Edition, Wiley Liss Publishers, 2010
2.	Gibney, Michael J., et al., "Introduction to Human Nutrition". 2nd Edition. Blackwell,2009.

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
1.	Colorimeter	1
2.	UV- Visible Spectrophotometer	1
3.	Weighing Scale	1
4.	Stadiometer	1
5.	Skin Fold Calipers	5
6.	Measuring Tapes	5
7.	Analytical Weighing Balance	4

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	1	-	-	-	1	1	-	2	1	1	2	1	1	1	1
CO 2	2	2	-	2	3	1	-	-	2	1	-	1	2	3	-	2
CO 3	2	1	-	-	3	1	-	-	2	1	1	2	2	2	1	2
CO 4	1	1	-	-	-	-	2	1	2	1	-	3	1	-	1	1
CO 5	1	2	2	2	3	1	1	2	2	1	-	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	Category	L	T	P	C
MA19453	**PROBABILITY AND STATISTICS** **Common to IV sem. B.Tech. Biotechnology and Food Technology**	BS	**3**	**1**	**0**	**4**

Objectives:	
	To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
	To provide the required skill to apply the statistical tools in Engineering problems.

UNIT-I	**ONE – DIMENSIONAL RANDOM VARIABLE**	**12**
Discrete and continuous random variables – Moments – Moment generating function –Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions.		
UNIT-II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**12**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Applications of Central Limit Theorem.		
UNIT-III	**TESTING OF HYPOTHESIS**	**12**
Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, F and Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit.		
UNIT-IV	**DESIGN OF EXPERIMENTS**	**12**
One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2factorial design.		
UNIT-V	**STATISTICAL QUALITY CONTROL**	**12**
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.		
	Total Contact Hours : 60	

Course Outcomes: On completion of course, students will be able to	
	Characterize standard probability distribution by employing basic techniques and methods of probability mass function and probability density function for discrete and continuous random variables.
	Develop skills to solve problems on correlation and regression.
	Obtain statistical data from experiments and able to analyze the same using statistical test.
	Design experiments using suitable ANOVA techniques and draw conclusions.
	Use control charts to study, analyze and interpret problems in statistical quality control.

Text Books:

1	Veerarajan T, 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks', McGraw Hill, 2016.
2	Johnson R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2017.

Reference Books / Web links:	
1	Devore J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.
2	Walpole R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia ,9th Edition, 2013.
3	Ross S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 4th Edition, Elsevier, 2009.
4	Spiegel M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill, 4th Edition, 2013.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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**	**Category**	**L**	**T**	**P**	**C**
FT19401	**HEAT AND MASS TRANSFER IN FOOD PROCESSES**	**ES**	**3**	**0**	**0**	**3**

Objectives:	
□	To understand the basic concepts of heat flow.
□	To understand the mode of heat transfer.
□	To understand the radiation mode of heat transfer.
□	To gain insights into mass transfer operations in food processing.
□	To gain knowledge in distillation operations

UNIT-I	**HEAT TRANSFER – CONDUCTION**	**9**

Basic heat transfer processes - conductors and insulators - conduction – Fourier's law of heat conduction – thermal conductivity and thermal resistance - linear heat flow – heat transfer through homogenous wall, composite walls, radial heat flow through cylinders and sphere – solving problems in heat transfer by

conduction.		
UNIT-II	**HEAT TRANSFER - CONVECTION**	**9**
Heat transfer - convection – free and forced convection - factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in foods.		
UNIT-III	**HEAT TRANSFER – RADIATION AND HEAT EXCHANGER**	**9**
Radiation heat transfer – concept of black and grey body - monochromatic total emissive power– Kirchhoff's law – Planck's law - Stefan-Boltzmann's law –Heat exchangers – parallel, counter and cross flow- Logarithmic Mean Temperature Difference – overall coefficient of heat transfer in shell and tube heat exchanger for food products.		
UNIT-IV	**MASS TRANSFER –DIFFUSION**	**9**
Mass transfer in foods – introduction – Fick's law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of A through non-diffusing B, diffusion coefficients for gases - molecular diffusion in liquids, solids, biological solutions and gels.		
UNIT-V	**MASS TRANSFER - DISTILLATION**	**9**
Vapor liquid equilibria - Raoult's law- Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe -Thiele method.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
□	Apply the basic concepts of heat flow.
□	Assess the mode of heat transfer.
□	Understand the radiation mode of heat transfer.
□	Gain insights into mass transfer operations in food processing.
□	Gain knowledge in distillation operations.

Text Books:	
1	Bellaney, P.L. "Thermal Engineering". Khanna Publishers, New Delhi, 2001
2	Geankoplis C.J. "Transport Process and Unit Operations". Prentice-Hall of India Private Limited, New Delhi, 1999

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

5	McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2003.

PO/RSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	3	1	1	-	-	-	-	1	1	3	2	-	1
CO 2	3	3	3	3	1	1	1	-	-	-	1	1	3	3	-	1
CO 3	2	3	2	3	1	1	1	-	-	-	1	1	3	3	-	0
CO 4	3	3	2	3		1	1	-	-	-	1	1	3	3	-	0
CO 5	3	3	3	3	1	1	1	-	-	-	1	1	3	3	-	1
Average	2.8	3	2.4	3	1	1	1	0	0	0	1	1	3	2.8	0	1

Subject Code	Subject Name	Category	L	T	P	C
FT19402	**UNIT OPERATIONS IN FOOD INDUSTRIES**	**ES**	**3**	**0**	**0**	**3**

Objectives:	
□	To learn basic principles of evaporation.
□	To understand the mechanism of mechanical separators.
□	To gain knowledge on size reduction operations.
□	To familiarize with the contact equilibrium separation.
□	To understand the extraction and crystallization process.

UNIT-I	**EVAPORATION**	**9**

Unit operations in food processing – 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

UNIT-II	**MECHANICAL SEPARATION**	**9**

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 - gas-cyclones – settling under sedimentation and gravitational sedimentation-centrifugal separations – rate of separations – liquid-liquid separation – centrifuge equipment.

UNIT-III	**SIZE REDUCTION**	**9**

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. Closed and open Circuit Grinding.		
UNIT-IV	**CONTACT EQUILIBRIUM SEPARATION**	**9**
Contact equilibrium separation processes – equilibrium concentration relationships – operating conditions – equilibrium processes -gas absorption – rate of gas absorption – stages– absorption equipment -properties of tower packing – types – construction – flow through packed towers. Adsorption: Introduction -Types of adsorption -Nature of adsorbents-types of adsorption operations.		
UNIT-V	**EXTRACTION AND CRYSTALLIZATION**	**9**
Extraction – rate of extraction – Single and multistage extraction operation-equipment for leaching coarse solids – intermediate solids – basket extractor-extraction of fine material – Dorr agitator – continuous leaching – decantation systems – extraction towers. Crystallization– equilibrium -solubility and equilibrium diagram – rate of crystal growth – equilibrium crystallization-crystallization equipment – classification – construction and operation-tank, agitated batch, Swenson-Walker vacuum crystallizers.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
□	Apply the principles of separation methods in process industry.
□	Appreciate the different equipment's developed for separation.
□	Apply the knowledge of contact equilibrium separation process in food industry.
□	Assess the efficiency of the unit operations involved in food industry.
□	Apply basic principles for problem solving.

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

Reference Books / Web links:	
1	Richardson, J.E. etal., "Coulson & Richardson's Chemical Engineering" Vol.2 (Particle Technology & Separation Processes") 5th Edition, Butterworth – Heinemann / Elsevier, 2003.
2	Coulson, J.M and J.F. Richardson, "Chemical Engineering". Volume I to V. The Pergamon Press. New York, 1999

3	McCabe, W.L., J.C. Smith and P. Harriot, "Unit Operations of Chemical Engineering". McGraw-Hill. Inc. Kosaido Printing Ltd. Tokyo, Japan, 2001
4	Sahay, K. M. and K.K. Singh, "Unit operation of Agricultural Processing", Vikas Publishing House Pvt. Ltd., New Delhi, 2004

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	2	1	2	1	1	-	-	-	3	2	2	-	-
CO 2	3	3	3	2	1	2	1	1	-	-	-	3	2	2	-	-
CO 3	3	3	3	2	1	2	2	1	-	-	-	3	2	2	-	-
CO 4	3	3	3	2	1	2	2	1	-	-	-	3	2	2	-	-
CO 5	3	3	3	3	2	2	2	1	-	-	-	3	2	2	-	-
Average	3	3	3	2.2	1.2	2	1.6	1	-	-	-	3	2	2	-	-

Subject Code	Subject Name	Category	L	T	P	C
FT19403	**FOOD PROCESSING AND PRESERVATION TECHNOLOGY**	**PC**	**3**	**0**	**0**	**3**

Objectives:	
□	Provide information about the scope and importance of preservation
□	Educate the different types of processing and preservation
□	Understand the principals of technology in processing of food
□	Understand the applications of technology in processing of food
□	Gain knowledge in the area of novel food techniques and packaging.

UNIT-I	**HIGH TEMPERATURE PROCESSING**	**9**

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

UNIT-II	**PRESERVATION BY LOW TEMPERATURE STORAGE**	**9**

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.		
UNIT-III	**PRESERVATION BY CONTROL OF WATERACTIVITY**	**9**
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.		
UNIT-IV	**NON THERMAL METHODS OF FOOD PROCESSING**	**9**
Non-thermal methods: Chemical Preservatives, Salting and Curing, Smoking, Pickling, Fermentation, Food Irradiation technology, Ultrasound technology, High pressure processing, Hurdle technology.		
UNIT-V	**NOVEL PROCESSING METHODS & FOOD PACKAGING**	**9**
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. Packaging: Definition, Significance, functions, basic packaging materials, and role of different packaging methods in food preservation.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
□	Understand the principles of food processing and preservation.
□	Interpret the role of different methods the processing of different foods.
□	Comprehend the impact on the shelf life, quality, and other physical and sensory characteristics of foods.
□	Familiarize with the recent methods of minimal processing of foods
□	Understand the materials and types of packaging for 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”. 2nd 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-Sarensen, 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	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	3	3	3	2	2	2	2	2	2	2	3	2	3	2
CO 2	3	2	3	3	3	2	2	2	2	2	2	2	3	3	3	2
CO 3	3	3	2	3	3	2	2	2	2	2	2	2	3	3	3	2
CO 4	3	3	3	3	3	3	2	2	2	2	2	2	3	3	3	2
CO 5	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 Code	Subject Name	Category	L	T	P	C
CS19411	**PYTHON PROGRAMMING FOR MACHINE LEARNING** (with effect from 2021 batch onwards) Common to all branches of B.E / B.Techprogrammes (except–CSE,CSBS,CSD,IT,AI/ML)	**ES**	**1**	**0**	**4**	**3**

	List of Experiments
1	Num Py Basics: Arrays and Vectorized Computation
2	Getting Started with pandas
3	Data Loading, Storage, and File Formats
4	Data Cleaning and Preparation
5	Data Wrangling: Join, Combine, and Reshape
6	Plotting and Visualization
7	Data Aggregation and Group Operations
8	Time Series
9	Supervised Learning
10	Unsupervised Learning
11	Representing Data and Engineering Features
12	Model Evaluation and Improvement
	Total Contact Hours : 75

Objectives:	
□	To understand the relationship of the data collected for decision making.
□	To know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
□	To lay the foundation of machine learning and its practical applications.
□	To develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
□	To prepare for real-time problem-solving in data science and machine learning.
Course Outcomes: On completion of course students will be able to	
□	Develop a sound understanding of current ,modern computational statistical approaches and their application to a Variety of datasets.
□	Use appropriate packages for analysing and representing data.
□	Analyze and performance evaluation of learning algorithms and model selection.
□	Compare the strengths and weaknesses of many popular machine learning approaches.
□	Apply various machine learning algorithms in arrange of real-world applications.

Text Books:	
1	Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'ReillyMediaInc,2017.
2	AndreasC.MüllerandSarahGuido,IntroductiontoMachineLearningwithPython-AGuideforDataScientists, FirstEdition,O'ReillyMediaInc,2016.

Reference Books / Web links:	
1	Aurélien Géron, Hands-On Machine Learning with Scikit Learn,Keras,andTensorFlow,2ndEdition,O'ReillyMedia Inc,2019..

PO /PSOCO	PO1	PO2	PO3	PO 4	PO5	PO6	PO 7	PO8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PSO 3
CO 1	2	2	2	2	1	0	0	0	1	2	0	1	3	3	3
CO 2	2	2	1	1	2	0	0	0	0	0	0	1	2	1	3
CO 3	2	3	2	1	2	0	0	0	1	1	0	1	2	3	2
CO 4	1	1	1	0	1	0	0	0	0	1	1	0	1	2	3
CO 5	3	3	2	3	3	0	0	0	2	1	0	1	2	3	3
Average	2	2	2	1	2	0	0	0	1	1	0	1	2	2	3

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT19411	CHEMICAL ENGINEERING LABORATORY	ES	0	0	4	2

Objectives:	
	To learn basic flow measurement in food processing.
	To learn to calculate the efficiencies of evaporator.
	To understand basic operations of filters.
	To gain knowledge in sieve analysis of foods.
	To understand the different energy requirements.

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.		
6	Determination of efficiency of liquid solid separation by filtration.		
7	Determination of absorption efficiency in a packing tower		
8	Determination of porosity, coefficient of friction and angle of repose of grains.		
9	Determination of particle size of granular foods by sieve analysis.		
10	Performance Evaluation of a Sieve Shaker		
11	Determination of performance characteristics in size reduction using burr mill		
12	Determination of energy requirement in size reduction using ball mill and hammer mill		
13	Performance Evaluation of Pin mill and Hammer mill		
14	Performance Evaluation of steam distillation process.		
	Total Contact Hours	**:**	**60**

Course Outcomes: The students will be able to	
	Assess basic flow measurement in food processing.
	Calculate the efficiencies of evaporator.
	Understand basic operations of filters.
	Perform the sieve analysis of foods.
	Understand the different energy requirements

References:	
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

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
1.	Orificemeter	1
2.	Venturimeter	1
3.	Rotameter	1
4.	Packedcolumn	1
5.	Centrifugalseparator	1
6.	Steamdistillationunit	1
7.	Fluidizedbedcolumn	1
8.	Rotaryflashevaporator	1
9.	Cycloneseparator	1
10.	Ballmill	1
11.	Hammermill	1
12.	Burrmill	1
13.	Pinmill	1
14.	Sieve Shaker	1

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	1	1	-	-	3	3	-	3	3	3	-	1
CO 2	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO 3	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO 4	3	3	2	3	1	1	-	-	3	3	-	3	3	3	-	1
CO 5	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

Subject Code	**Subject Name (Laboratory Course)**	**Category**	**L**	**T**	**P**	**C**
FT19412	**FOOD PROCESSING AND PRESERVATION LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
	Develop the knowledge in the basic area of preservation and processing.
	Acquire knowledge on different types of processing and preservation
	Understand the principles of technology in processing of foods.
	Understand the applications of technology in processing of food
	Gain knowledge in the area of novel food techniques and packaging.

List of Experiments	
1	Heat transfer studies in a plate heat exchanger (Parallel and counter flow)
2	Refrigeration and Freezing of vegetables and fruits

3	Drying of vegetables and fruits with and without additives - Drying rate studies including, constant rate and falling rate periods and the effects of various factors on them
4	Osmotic drying of foods with salt and sugar.
5	Canning & bottling of vegetable and fruit products
6	Filtration and concentration of fruit juices
7	Production of extruded products.
8	Spray drying of juices/milk
9	Pasteurization of milk
10	Retort processing of foods
11	Determination of Water vapor transmission rate of different packaging materials
12	Determination of migration characteristics of packaging materials
13	Determination of tensile and burst strength of given packaging material
14	Visit to any Food processing industry
	Total Contact Hours : 60

Course Outcomes:	
The students will be able to	
□	Demonstrate the food processing in terms of unit operations, both conceptually and in the pilot plant
□	Apply themass and energy balances for food processing
□	Operate the food processing equipment's at the pilot plant scale
□	Analyze the effect of processing conditions on safety and quality of resulting food products.
□	Evaluate the properties of food packaging materials

References:	
1.	Rahman, M.S. "Handbook of Food Preservation", Marcel Dekker, 1999.
2.	Ranganna, S. "Handbook of Canning and Aseptic Packaging" Vol. I, II & III, Tata McGraw – Hill, New Delhi, 2000
3.	Pandey, H. et al., "Experiments in Food Process Engineering". CBS Publishers, 2004

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
1.	Plate heat exchanger	1
2.	Refrigerator	2
3.	Deep freezer	1
4.	Tray dryer	1
5.	Hot air oven	5
6.	Refractometer	5
7.	Pilot scale Extruder	1
8.	Ultra Filtration unit	1
9.	Double seamer machine	1
10.	Canning and bottling unit	1
11.	Pilot Scale Pasteurizer	1

12.	Spray dryer	1
13.	Retort unit	1
14.	Thermometer	3
15.	Water vapour permeability tester	1
16.	Oxygen permeability tester	1
17.	Tensiometer	1
18.	Viscometer	1
19.	Desiccator	5
20.	Weighing balance	2
21.	Vegetable chopper	1

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	3	2	2	2	2	2	2	2	1	3	3	2	3	3
CO 2	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3	3
CO 3	3	2	3	3	2	2	2	2	2	2	1	3	3	3	3	3
CO 4	3	2	3	3	2	3	2	2	2	2	2	3	3	3	3	3
CO 5	3	2	3	2	2	3	2	2	2	2	2	2	3	3	3	3
Average	3	2.4	3	2.6	2.2	2.4	2	2	2	2	1.6	2.6	3	2.8	3	3

Subject Code	Subject Name	Category	L	T	P	C
FT19501	**FOOD ANALYSIS**	**PC**	**3**	**0**	**0**	**3**

Objectives:	
□	To learn basic sampling methods for food analysis
□	To understand the techniques for analysis of lipids & proteins
□	To understand the techniques for analysis of carbohydrates
□	To gain knowledge on spectroscopic & chromatographic techniques
□	To understand the methods used for sensory evaluation

UNIT-I	**SAMPLING METHODS FOR FOOD ANALYSIS**	**9**
Introduction, Food Regulations and Standards - Sampling methods - Sample preparation and preservation- Extraction methods and Separation process of food components; Statistical evaluation of analytical data - Official Methods of Food Analysis. Proximate analysis of Foods-Moisture in foods, Ash content of foods - determination by different methods; Titratable Acidity in foods, Determination of dietary fibre and crude fibre.		

UNIT-II	**LIPIDS AND PROTEINS ANALYSIS**	**9**
Determination of Total fat in foods by different methods; Analysis of oils and fats for physical and chemical parameters, Quality standards, and adulterants.		

Determination of Proteins Concentration- Colorimetric methods, Determination of total nitrogen, Spectrophotometric determination; Protein Characterization- Electrophoresis and Isoelectric focussing; Analysis of Protein quality – Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), Biological Value, Protein Digestibility- Corrected Amino acid Score (PDCAAS), *In vitro* Protein digestibility for C-PER; Measurement of Functional properties of proteins- Protein hydration properties, Surface properties of protein, Protein gel properties.		
UNIT-III	**CARBOHYDRATE ANALYSIS, REFRACTOMETRY AND POLARIMETRY**	**9**
Refractometry- Basic Principles and Instrumentation, and Applications-Brix Value of Fruit juices, Total soluble solids in fruit products. Carbohydrate analysis- Colorimetric Quantification methods of Mono and Di-Saccharides, HPLC of Mono and Di-Saccharides using refractive index detection; Starch-Enzymatic quantification and Determination of total amylose content; Cell wall Polysaccharides-Determination of uronic acid content and ß-Glucan content, Degree of Methylation and Acetylation of pectin. Polarimetry- Basic principles, Instrumentation and Applications-Determination of specific rotations of sugars; Estimation of simple sugars and disaccharides.		
UNIT-IV	**SPECTROSCOPIC AND CHROMATOGRAPHIC TECHNIQUES**	**9**
Spectrophotometry: Basic Principles, Spectrophotometric analysis of food additives and food Components -IR Spectroscopy in online determination of components in foods; AAS and ICP-AES in mineral elements and toxic metals analysis; use of fluorimeter in vitamin assay- specific use of Tintometer in Vanaspati analysis. Chromatography: Basic Principles, Types and applications in food analysis: Paper, Thin layer, Column, High Pressure Liquid Chromatography, Gas chromatography, HPTLC; Significance MS detector in HPLC and GC, Ion Exchange Chromatography, Affinity chromatography.		
UNIT-V	**SENSORY EVALUATION TECHNIQUES**	**9**
Introduction to quality attributes of food: Appearance, flavour, textural factors, Gustation: importance of gustation, Mechanism of taste perception, Taste measurement-Electronic Tongue; Olfaction: definition and importance of odour and flavour, Mechanism of odour perception, Odour measurement technique-e- nose; Colour: Perception of colour, Colour Measurement; Texture: Phases of oral processing, Texture perception, Rheology of foods, Texture measurement and recent advances in texture evaluation. Sensory Evaluation: Objectives, Type of food panels, Characteristics of panel member, Layout of sensory evaluation laboratory, Sensitivity tests, Threshold value, Paired comparison test, Duo trio test, Triangle test, Hedonic scale.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of course students will be able to	
□	Adapt the appropriate sampling methods for food analysis
□	Analyse lipids & proteins for its quality & characteristics

□	Analyse carbohydrates for its quality & characteristics
□	Apply spectroscopic & chromatographic techniques for analysis of food components
□	Apply sensory evaluation technique for food quality analysis.

Text Books:	
1	Pomeranz, Yeshajahu, "Food Analysis: Theory and Practice", 3rd Edition, Aspen Publishers / Springer, 2000.
2	Kirk, R.S. and R. Sawyer, "Pearson's Composition and Analysis of Food". 9th Edition, Longman, New York, 1991.
3	Nielsen, S. Suzanne, "Food Analysis". 4th Edition. Springer, 2010.
4	Meilgard, "Sensory Evaluation Techniques", 3rd Edition., CRC Press LLC, 1999.

Reference Books / Web links:	
1	Ronald E. Wrolstad, "Handbook of Food Analytical Chemistry" Vol I, John Wiley & sons, 2005.
2	Magdi M. Mossoba, "Spectral Methods in Food analysis" Marcel & Dekker, 1998.
3	Otles, Semih, "Methods of Analysis of Food Components and Additives". CRC Press,2005.
4	Amerine, Pangborn&Roessler, "Principles of Sensory Evaluation of food", AcademicPress, 1965.

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	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

Subject Code	Subject Name	Category	L	T	P	C
FT19502	FRUIT AND VEGETABLE 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.

UNIT-I	BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS	6

Commercially important fruits and vegetables in India- Morphology, structure and composition of fruit andvegetable, Production and processing scenario of fruits and vegetable: India and World, Scope ofFruit and Vegetable Preservation Industry in India. Present status, constraints and prospectus.

UNIT-II	FRESH FRUITS AND VEGETABLES	9

Harvesting ofimportant fruits and vegetables, Storage practices: Control atmospheric, modified atmospheric storage, Bead atmosphere, Hypotactic storage, Cold store, zeroemerge cool chamber, Stores striation; Maturity Standards-Importance,Methods of maturity determinations, Maturity indices for selected fruits and vegetables; Fruit ripening- chemical changes, regulations, methods.Commodity pre-treatment's - chemicals, wax coating, pre-packaging, phytonutrients in fruits and vegetables, grading, cleaning, Physiological post-harvestdiseases chilling injury and disease.

UNIT-III	FREEZING & DEHYDRATION OF FRUITS AND VEGETABLES	9

General pre-processing, different freezing methods and equipment's, problems associated withspecific fruits and vegetables; Dehydration – General pre-processing, different methods of drying, osmotic dehydration; Indian Food Regulation and Quality assurance.

UNIT-IV	CANNING, PUREES AND JUICES	12

Canning- General pre-processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality Assurance.

Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, Cold Pressing methods, 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.

UNIT-V	FRUIT AND VEGETABLE PRODUCTS	9

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, 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 QualityAssurance.			
	Total Contact Hours	**:**	**45**

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	WimJogen. "Fruit and Vegetable Processing: Improving Quality". Taylor& Francis, 2002

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	2	2	-	-	-	-	-	-	3	2	3	-	-
CO 2	3	2	2	2	2	-	-	-	-	-	-	3	3	3	-	-
CO 3	3	2	2	2	2	-	-	2	-	-	-	3	3	3	-	2
CO 4	3	3	3	3	3	-	-	2	-	-	-	3	3	3	-	2
CO 5	3	3	3	3	3	-	-	2	-	-	-	3	3	3	-	2
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	Category	L	T	P	C
FT19503	**THERMODYNAMICS FOR FOOD TECHNOLOGISTS**	**PC**	**3**	**0**	**0**	**3**

Objectives:

•	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.

UNIT-I	THERMODYNAMIC LAW AND PROPERTIESOF FLUIDS	9
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 andapplications.		
UNIT-II	**SOLUTIONTHERMODYNAMICS**	**9**
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.		
UNIT-III	**PHASEEQUILIBRIA**	**9**
Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.		
UNIT-IV	**CHEMICALREACTIONEQUILIBRIA**	**9**
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.		
UNIT-V	**THERMODYNAMIC DESCRIPTION FOR MICROBIAL GROWTH AND PRODUCT FORMATION**	**9**
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.		
	Total Contact Hours : 45	

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

Reference Books / Web links:	
1	Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley,1989.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	3	1	1	1	0	0	0	1	1	2	3	0	1
CO 2	2	3	3	2	1	1	1	0	0	0	0	1	3	3	0	0
CO 3	3	3	3	3	1	1	1	0	0	0	1	1	3	3	0	0
CO 4	2	3	3	3	1	1	1	0	0	0	1	1	3	3	0	1
CO 5	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 (Laboratory Course)	Category	L	T	P	C
FT19511	**FOOD ANALYSIS LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
	To learn basic analytical techniques
	To learn methods for analysis of macromolecules in foods
	To learn methods for analysis of micronutrients and pigments in foods
	To learn the methods for analysis of adulterants in food products
	To learn the methods for analysis of additives and antioxidants in foods.

List of Experiments	
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. a. Titrimetric method using dichlorophenolindophenol dye b. Spectrophotometric method using dinitrophenyl hydrazine c. HPLC method
5	Extraction and identification 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 antioxidant activity in foods by DPPH assay and ORAC assay.
10	Determination of soluble and insoluble fibre in foods.
11	Detection of adulterants in edible oil and ghee.
12	Column chromatographic separation of carotenoids
13	The identification of sugars in fruit juice using TLC.
	Total Contact Hours : 60

Course Outcomes:	
The students will be able to	
	Analyse the different components of the food using different analytical instruments.
	Determine the amount of macromolecules in foods
	Analyse the presence of micronutrients and pigments in foods
	Detect the presence of adulterants in food products
	Detect the presence of additives and antioxidants in foods.

Text Books:	
1.	ShaliniSehgal, "A laboratory manual of food analysis", I.K. International publishing, 2016.

References:	
1.	Ceirwyn S. James, "Analytical chemistry of foods", Springer, 1995
2.	S. Suzanne Nielsen, "Food analysis laboratory manual", 3rd edition, Springer, 2017
3.	Ronald E. Wrolstad, "Handbook of food analytical chemistry- Water, Proteins, Enzymes, Lipids and Carbohydrates", John Wiley & sons, inc., 2005

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
1.	Soxhletapparatus	5
2.	Kjeldahlapparatus	2
3.	UVspectrophotometer	1
4.	Colourcomparator	1
5.	pHmeter	3
6.	Waterbath	2
7.	Fumehood	1
8.	Deanandstarkapparatus	1
9.	Weighingbalance	1
10.	Hotairoven	1
11.	Simpledistillationunit	2
12.	High Pressure Liquid Chromatography equipment	1
13.	Muffle furnace	1
14.	Chromatography Columns	10
15.	TLCpaperstripsAsrequired	
16.	Whatman Cellulose Paper for chromatography	100 Nos.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO 2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO 3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO 4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO 5	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	Category	L	T	P	C
FT19512	**FRUIT AND VEGETABLE 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	Estimation of pectin levels in fresh fruit, jams & jelly			
2	Determination of methoxyl content of pectin extracted from fruits			
3	Experiment to study the effect of pectin concentration and pH on gel strength of jams and jelly			
4	Determination of Total soluble solids and Fruit content in fruit juices			
5	Experiment on Drying kinetics and Rehydration Characteristics of Vegetables			
6	Determination of Percentage of Solid Gain and Water Loss in Osmotic Dehydrated Fruits and Vegetable			
7	Determination of TSS and Viscosity of prepared ketchups, purees			
8	Determination of shelf – life of chemically preserved fruit juice and pulp			
9	Determination of blanching efficiency on fruit and vegetable by peroxidase assay			
10	Determination of Titratable acidity of freshly pressed fruit juices			
11	Evaluation of microbiological quality of canned fruit/vegetable & RTS beverages			
12	Determination of Sodium Chloride content in pickled vegetable			
13	Experiment on optimization of ingredients for production of fruit products- Squashes, Nectar, Fruit bar			
14	Visit to Fruit/vegetable Processing Industry			
		Total Contact Hours	**:**	**60**

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.	Strainer	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
CO 1	1	2	1	2	2	3	1	-	-	-	2	2	2	2	-	3
CO 2	2	2	2	3	2	2	2	-	-	-	2	2	3	3	-	3
CO 3	1	2	1	2	2	3	1	-	-	-	2	2	2	2	-	3
CO 4	1	2	2	-	-	-	1	-	-	-	2	3	2	2	-	3
CO 5	2	2	2	3	2	2	2	-	-	-	2	2	3	3	-	3
Average	1.4	2	1.6	2.5	2	2.5	1.4	0	0	0	2	2.2	2.4	2.4	0	3

Subject Code	Subject Name	Category	L	T	P	C
FT19601	FOOD PROCESS ENGINEERING	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 mixing in food processing
□	To highlight the role of encapsulation in food processing
□	To understand the key aspects of extrusion cooking

UNIT-I	PROPERTIES OF FOOD	9

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

UNIT-II	PROCESS CALCULATIONS	12

Thermal Processing - Concept of thermo bacteriology, Thermal Process Evaluation- Basic considerations, General method, Mathematical method, Conversion of Heat penetration data, Process Determination Problems. Drying- 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, calculation of drying time. Freezing – Freezing time calculations, Glass transitions in frozen foods.

UNIT-III	MIXING- EMULSIONS	9

Mixing Equipment–Mixing Mechanisms, Laminar Mixing, Turbulent Mixing Liquid Mixers, Powder and Particle Mixers, Standard Geometry Stirred Tanks, Dough and Paste Mixers, Double Spiral Mixer, Blending Tank for Cream Mixing, Double-Arm Kneading Mixers.

Emulsions- Introduction to Emulsions, Methods to Form an Emulsion, Emulsion Characteristics- Micro- and Nano-Emulsions, Properties of Emulsions- Emulsion Stability, Disperse Phase Volume Fraction, Droplet Size, Interfacial Properties, Droplet Charge, Rheology, Particle Sizing Characterization of Emulsions.

UNIT-IV	ENCAPSULATION OF FOOD INGREDIENTS	9

Basic Principles of Encapsulation, Benefits of Encapsulation in Food Industry, Encapsulation process & design & Evaluation-Purpose of an encapsulation Process; Encapsulated Product's Yield; Microencapsulation Yield; Microencapsulating Efficiency; Percentage Retention, Encapsulating Agents, Encapsulation Methods- Spray Drying, Freeze Drying, Spray Cooling/Chilling, Fluidized-Bed Coating, Cocrystallization, Coacervation, Liposome entrapment.

UNIT-V	EXTRUSION	6

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 mixing and the effects of processing parameters on product quality.
□	Demonstrate the encapsulation 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" Wood head 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	TheodorosVarzakas and ConstantinaTzia. "Food Engineering Handbook: Food Process Engineering", CRC Press, 2015.
2	Berk, Zeki. "Food Process Engineering and Technology". Elsevier, 2009.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	3	3	3	3	2	0	1	1	2	3	2	2	2	3
CO 2	3	1	3	3	3	3	1	0	1	2	3	3	3	3	1	3
CO 3	3	2	3	3	3	2	1	0	1	1	2	2	3	3	1	3
CO 4	2	3	3	1	3	3	1	0	1	1	2	3	2	2	2	2
CO 5	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**
FT19602	**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

UNIT-I	**REFRIGERATION PRINCIPLES**	**9**
Refrigeration – principles - refrigeration effect – coefficient of performance – units of refrigeration - simple vapor compression cycle – T-S diagram – p-h chart - application of refrigeration		
UNIT-II	**VAPOR COMPRESSION REFRIGERATION AND COMPONENTS**	**9**
Vapour compression system - refrigeration components – compressor and condenser – types, construction and working - expansion device and evaporators – types, construction and working.		
UNIT-III	**REFRIGERANTS AND VAPOR ABSORPTION CYCLE**	**9**
Refrigerants – properties – classification – comparison and advantages – chloroflouro carbon (CFC) refrigerants - effect on environmental pollution - alternate refrigerants - vapour absorptioncycle – theoretical - deviation in practice - Electrolux refrigerator – construction and principles.		
UNIT-IV	**SHELF-LIFE OF FOOD PRODUCTS**	**9**
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.		
UNIT-V	**COLD CHAIN**	**9**
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.		
	Total Contact Hours :	**45**

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:

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

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. etal., “Handbook of Frozen Foods”. Marcel Dekker, 2004.

Subject Code	Subject Name	Category	L	T	P	C
FT19603	**BAKING AND CONFECTIONERY TECHNOLOGY**	**PC**	**3**	**0**	**0**	**3**

Objectives:	
	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 confectionery products

UNIT-I	**BAKINGINGREDIENTS**	**9**

Classification of bakery products. Bakery ingredients- Flour: Constituents; Types; Characteristics of good quality flour; Flour test; Functions of flour, Sweeteners: Types, Functions in baking, Eggs: Composition; Types; Quality test; Storage and Functions, Fats: Types and Functions, Yeast: Structure; Production; Types & Composition; Role of yeast in fermentation; Functions of yeast in bakery products, Salt: Functions, Leavening agents: Methods and Functions of leavening. Other ingredients- Moistening agents: Water; Milk; functions, Flour Improvers & Emulsifiers: Types and Functions.

UNIT-II	**PRINCIPLES OF BAKING & EQUIPMENTS**	**9**

Introduction to utensils and equipment's used in bakery industry with their purpose, Mixing- Bread Dough Mixers; Biscuit Dough Mixers; Cake Mixers; Pastry Mixers, Proving & Retarding, Shaping & Panning: Dividing; Rounding; Sheeting and Laminating, Fermentation en closures and brew equipment - Ovens and Slicers; Extrusion. Rheology of dough-Farinograph, Amylograph, Alveograph and Extensiograph.

UNIT-III	**BREAD MAKING PROCESS**	**9**

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.

UNIT-IV	**BAKERY PRODUCTS**	**9**

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.

UNIT-V	**CONFECTIONERY PRODUCTS**	**9**

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.

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

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 confectionery products and evaluate its quality characteristics.

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

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.

Subject Code	Subject Name	Category	L	T	P	C
FT19604	**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.

UNIT-I	**MILK PROPERTIES AND PRESERVATION**	**9**
Milk- Composition and Nutritional value- physico-chemical properties, Macro components –Micro components. Milk reception- Platform test - Cooling and storage of raw milk –principles and methods transfer of milk -transport and storage tanks - Standardization-cleaning and sanitization of Dairy equipment- CIP systems - Can washers - types - working principle and maintenance.		
UNIT-II	**PROCESSING AND QUALITY PARAMETERS OF MILK**	**9**
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.		
UNIT-III	**MILK PRODUCTS**	**9**
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.		
UNIT-IV	**MILK POWDER PROCESSING AND MILK SUBSTITUTES**	**9**
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.		
UNIT-V	**STORAGE SANITATION AND EFFLUENT TREATMENT**	**9**
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.		
	Total Contact Hours : 45	

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., "Diary 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. Teixeir "Engineering Aspects of Milk and Dairy Products". Jane Selia dos Reis Coimbra & Jose A. Teixeir, CRC Press, 2009.

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	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 (Laboratory Course)	Category	L	T	P	C
FT19611	**BAKING AND CONFECTIONERY TECHNOLOGY LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
□	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 confectionery products.
□	To study the rheological properties of dough.

List of Experiments	
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.	Experiment on Optimization and Production of biscuits- Short dough, crackers, Cookies
6.	Experiment on Optimization and production of Bread: Straight dough method, sponge dough method and No time dough method.
7.	Experiment on Optimization and production of Cake: Sugar batter method, Flour batter method, Blending method, Boiled method
8.	Experiment to Identify different stages of sugar boiled confectionery
9.	Experiment on optimization and production of sugar boiled confectionery – Hard and soft candy, Fondant & Fudges.

10.	Experiment on optimization and production of Chocolate			
11.	Determination of total Non-Fat Cocoa Solids in Chocolates			
12.	Visit to Baking/Confectionery industry			
		Total Contact Hours	**:**	**60**

Course Outcomes:

The students will be able to

	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 confectionery products.
	Evaluate the rheological properties of dough.

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.

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
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
CO 1	3	2	1	2	3	1	3	3	2	2	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	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 (Laboratory Course)	Category	L	T	P	C
FT19612	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.

List of Experiments				
1	Standardisation of Milk by Pearson Square Method			
2.	Determination of viscosity, density and specific gravity of milk			
3.	Platform test – MBRT and clot on boiling test.			
4.	Determination of SNF (Solid Not Fat) and Total solids of Milk			
5.	Detection of adulterants and preservatives in milk.			
6.	Determination of lactose in milk by Lane Eynon and polarimetric method.			
7.	Determination of water activity and sorption isotherms of milk products.			
8.	Determination of Overrun in Ice- Cream			
9.	Determination of Percentage Efficiency and working capacity of cream separation.			
10.	Determination of Pasteurization efficiency by Alkaline Phosphatase Test			
11.	Determination of % yield and Insolubility index of spray dried milk.			
12.	Determination of particle size of fat globules of homogenised milk			
13.	Determination of Reichert Meissl (rm) value and Polenske value (pv) in ghee			
14.	Visit to Dairy Processing Industry			
		Total Contact Hours	**:**	**60**

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.	GerritSmit, Dairy processing Improving quality, Published by Woodhead Publishing Limited, CCR 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.	Vat Pasteurizer	1
3.	Quevenne's Lactometer with jar	10
4.	Water bath	2
5.	Viscometer	1
6.	Density meter	2
7.	Spray dryer	1
8.	Richmond's scale	10
9.	Floating dairy thermometer	5
10.	Specific Gravity Bottle	10
11.	Desiccator	5
12.	Centrifugal Cream Separator	1
13.	Reichert-Meissl distillation apparatus	2
14.	Ice Cream Freezer	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO 1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO 2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO 3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO 4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO 5	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
CR19P62	MICROFLUIDICS LABORATORY	PE	0	0	2	1

Objectives:

	To introduce and strengthen the concept of microfluidic technology
	To gain clear understanding of fabrication techniques in microfluidics
	To familiarize the ways to analyse various applications of microfluidics
	To impart knowledge on the CAD design of micro-mixers
	To empower the students to design and fabricate novel microfluidic devices

1	Microfluidic Technology - Introduction, definitions and applications
2	Materials for microfluidic device fabrication
3	Fabrication Techniques for Microfluidics, Soft Lithography Technique in detail
4	Laboratory session 1- wafer cleaning process
5	Laboratory session 2- Prime mould fabrication
6	Laboratory session 3- Replicas by casting
7	Laboratory session 4- Sealing of microchannel with a cover glass
8	Laboratory session 5- Leak testing
9	Laboratory session 6- Characterization of microchannels
10	CAD design of microchannels, Simulation of micro-mixers
11	Applications of microfluidics – recent reports
	Total contact hours : 30

Course Outcomes:

On completion of the course, students will be able to

	Understand the fundamentals of microfluidic technology.
	Demonstrate the various fabrication techniques used in microfluidics.
	Analyze the working and design of various microfluidic devices.
	Design complex micro-mixers using CAD software.
	Fabricate any microfluidic devices in real time

References:

1	Albert Folch, “Introduction to BioMEMS”, CRC press, Taylor and Francis group, 2013.
2	Yujun Song, Daojian Cheng, Liang Zhao, “Microfluidics: Fundamentals, Devices, and Applications”, Wiley VCH publications, 2018.
3	Patrick Tabeling, Suelin Chen,” Introduction to Microfluidics”, Oxford University press,first edition 2005, reprint 2011.
4	Suman Chakraborty, Microfluidics and Microfabrication, Springer, 2014, ISBN-10:9781489984609

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	1	1	2	3	2	-	2	2	2	-	2	2	2	1	1	-
CO 2	1	1	2	3	2	-	2	2	2	-	2	2	2	1	1	-
CO 3	1	1	2	3	2	-	2	2	2	-	2	2	2	1	1	-
CO 4	1	1	2	3	2	-	2	2	2	-	2	2	2	1	1	-
CO 5	1	1	2	3	2	-	2	2	2	-	2	2	2	1	1	-
Average	1	1	2	3	2	0	2	2	2	0	1	2	3	1	1	0

Subject Code	Subject Name	Category	L	T	P	C
FT19701	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, Intelligent packaging system: Time-Temperature indicators, Radio Frequency Identification Tags (RFID), Sensors.

UNIT-IV	PACKAGING REQUIREMENTS OF DIFFERENT COMMODITIES	9

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.

UNIT-V	REGULATORY ASPECTS OF PACKAGING	9

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.			
	Total Contact Hours	**:**	**45**

Course Outcomes: 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.

Text Books:	
1	Robertson, G.L. "Food Packaging: Principles and Practice". 3rd 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

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

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO 2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO 3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO 4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO 5	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	0.4	2.4	2.2	2.6	2.4	0	3

Subject Code	Subject Name	Category	L	T	P	C
FT 19702	LIVESTOCK AND MARINE TECHNOLOGY	PC	3	0	0	3

Objectives:	
•	To study about basics of meat science and handling.
•	To gain knowledge in basic meat processing operations.
•	To gain insights into basics of marine food processing.
•	To understand the basics of poultry processing.
•	To gain knowledge in egg processing and its related aspects.

UNIT-I	MEAT HANDLING	9

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 in colour and flavours, microbiology and spoilage factors of meat and meat products.

UNIT-II	MEAT PROCESSING & PRESERVATION	9

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.

UNIT-III	MARINE PRODUCT PROCESSING	9

Fish -Types, composition, structure and spoilage factors of fish. Post-mortem changes in fish. Handling and transportation of fish, Processing and preservation techniques for fishes, Processing and preservation of Shell fish, Crustaceans and Molluscs.

Seaweed and marine by-products: Economic significance; fish meal and oil; protein concentrates; bioactive compounds, Seafood quality Assurance, sea food safety – illness associated with consumption –toxins, allergies and intolerances.

UNIT-IV	POULTRY PROCESSING	9

Introduction, Types and characteristics of poultry products, composition, nutritive value, calculation of nutritive value of poultry products. Unit operation involved in poultry processing: Slaughtering, Scalding &De-feathering, Eviscerating, Washing & Chilling and Packaging.

UNIT-V	EGG PROCESSING	9

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 product processing: Pasteurized liquid egg, egg powder processing, alternate technologies for egg processing: High pressure; gamma radiation; PEF, Functional properties of egg, FSSAI Guidance on safety and quality of Meat and Poultry, FSSAI guidance on safe handling, processing & consumption of poultry meat & eggs during bird flu outbreak.

	Total Contact Hours	:	45

Course Outcomes:	
On completion of course students will be able to	
	Understand different variety of meats and its handling.
	Familiarize with the concept of meat processing.
	Get insights into basics of marine food 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, 1985
4	Yimin Qin, “Bioactive Seaweeds for Food Applications: Natural Ingredients for Healthy Diets”, Academic Press, 2018

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	3	2	3	2	2	1	1	2	3	2	3	3	1	1
CO 2	3	2	3	3	3	2	2	2	1	2	3	3	3	3	2	1
CO 3	3	2	3	3	2	3	2	1	1	1	3	3	3	3	2	1
CO 4	2	2	3	3	3	3	2	1	1	1	3	3	3	3	2	2
CO 5	3	3	2	3	3	2	2	1	1	1	2	3	3	2	2	3
Average	2.6	2.2	2.8	2.8	2.8	2.4	2	1.2	1	1.4	2.8	2.8	3	2.8	1.8	1.6

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19703	**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 Fortification, Food Packaging & labelling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials,Traceability,Sustainability, Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection.		
UNIT-II	**FOOD QUALITY**	**9**
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, Organic Foods: Certification from NPOP and PGS, India		
UNIT-III	**HAZARDS AND QUALITY CONTROL**	**9**
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.		
UNIT-IV	**RECENT TRENDS IN FOOD SAFETY REGULATIONS& STANDARDS**	**9**
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.		
UNIT-V	**CODEX COMMISSION**	**9**
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.		
	Total Contact Hours : 45	

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.
3	Microbiological safety of Food by Hobbs BC, 1973.

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	0	2	0	3	0	1	3	2	2	1	2	1	0	2	0	1
CO 2	2	0	0	3	0	1	3	3	2	1	2	1	1	2	0	1
CO 3	1	2	0	0	0	0	1	3	1	1	1	1	1	2	1	1
CO 4	1	0	0	0	0	0	1	1	0	1	0	1	0	2	1	1
CO 5	1	0	0	0	0	0	1	1	0	1	0	1	0	2	1	1
Average	1.3	2.0	-	3.0	-	1.0	1.8	2.0	1.7	1.0	1.7	1.0	1.0	2.0	1.0	1.0

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19704	**PROFESSIONAL ETHICS**	**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.

UNIT-I	**HUMAN VALUES**	**10**
Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect forothers – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga andmeditation for professional excellence and stress management.		
UNIT-II	**ENGINEERING ETHICS**	**9**

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.		
UNIT-III	**ENGINEERING AS SOCIAL EXPERIMENTATION**	**9**
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.		
UNIT-IV	**SAFETY, RESPONSIBILITIES AND RIGHTS**	**9**
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.		
UNIT-V	**GLOBAL ISSUES**	**8**
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.		
	Total Contact Hours : 45	

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.

Text Books:	
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.

Reference Books	
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” McGraw Hill education, India Pvt. Ltd., New Delhi,2013.
Web links:	
1.	www.onlineethics.org
2.	www.nspe.org
3.	www.globalethics.org
4.	www.ethics.org

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	1	3	1	3	3	3	3	3	2	2	3	3
CO 2	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO 3	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO 4	1	1	1	1	1	3	1	3	3	3	3	3	2	2	3	3
CO 5	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
FT19705	**INNOVATION AND DESIGN THINKING FOR FOOD TECHNOLOGISTS**	**PC**	**0**	**1**	**2**	**2**

Objectives:	
□	To gain knowledge on market surveys methods to study consumer preferences.
□	To understand screening of new product concept
□	To be acquainted with prototype development
□	To familiarize with packaging and quality analysis of developed products
□	To understand cost analysis

THEORY	**OVERVIEW**	**5**
Organization and assignment of team, Definition of roles; Product Concepts; factors to consider; concept methodology; consumer testing; Product attributes; Concept testing approaches; Development of product specifications: Prototype development; role of ingredients and processing in defining attributes; scale up; Process flow sheet development; factors to consider in process development; process optimization; Factors to consider beyond formulation and processing - shelf life requirements; product performance testing; market positioning, Packaging and labelling, costing; Marketing: developing test market strategies		

List of Experiments				40
1	Market and literature survey to identify the concepts of new products based on special dietary requirements, functionality, convenience and improvisation of existing traditional Indian foods.			
2	Screening of product concept on the basis of techno-economic feasibility.			
3	Development of prototype product and Standardization of formulation process.			
4	Proximate Analysis of New Product			
5	Packaging, labelling and shelf-life studies			
6	Cost analysis and Final Project Report			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
The students will be able to	
□	Apply market surveys methods to study consumer preferences.
□	Carry out the screening of new product concept
□	Develop the prototype for formulation
□	Design a package and carry out the quality analysis of developed products
□	Perform cost analysis

Text Books:	
1.	Fuller, Gordon W. 2004. New Product Development- From Concept to Marketplace, CRC Press.
2.	Anil Kumar, S., Poornima, S.C., Abraham, M.K.&Jayashree, K.2004. Entrepreneurship Development. New Age International Publishers

Reference Books:	
1.	Moskowitz, Howard and Saguy,R. I. Sam 2009. An Integrated Approach to New Food Product , CRC Press

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

Subject Code	Subject Name	Category	L	T	P	C
FT19716	Problem solving using Artificial Intelligence and Machine Learning for Food Technologist	EEC	0	0	4	2

Objectives:	
	To identify the overall characteristics of Food Products
	To understand the present marketing trends in Food supply chain management
	To solve the problems related to Food Technology using modern software tools
	To develop software programmes related to Food Technology applications
	To describe the process of artificial intelligence and Machine learning in Food Processing

List of Problem oriented Projects	
	Identification of internal and external characteristics of grains, cereals, Fruits & Vegetable, Spices, live stocks & Poultry, Oilseeds etc using Software tools
	Design and fabrication of 3D Food products
	Development of Sensors – Biosensors, Nano sensors applications in Food Processing
	Distinguish the Fresh and Spoiled food products using Software – AI, ML, IOT etc
	Understand the Customer choice-based Food products in current market trends

Course Outcomes On the completion of course the students will be able to	
	Solve the problems associated with Food Process and Product development
	Analyse the consumer preference in food supply chain management
	Identify the problems and Create solutions in Food processing using modern software tools
	Design and develop programmes using software techniques
	Apply the knowledge of artificial intelligence and machine learning in Food Technology

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO 1	3	2	2	2	2	1	1	1	1	1	1	1	3	3	1	2
CO 2	2	2	1	1	1	1	1	1	1	1	1	1	3	2	1	2
CO 3	1	2	1	1	3	1	1	1	1	1	1	1	2	3	2	1
CO 4	2	1	1	2	2	1	1	1	1	1	2	1	2	2	2	2
CO 5	3	1	1	2	3	1	1	1	1	1	2	1	2	2	2	2
Average	2.2	1.6	1.2	1.6	2.2	1	1	1	1	1	1.4	1	2.4	2.4	1.6	1.8

Subject Code	Subject Name	Category	L	T	P	C
FT19711	FOOD PACKAGING TECHNOLOGY 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 rate 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 testingequipments.
	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
CO 1	3	2	2	2	3	1	1	1	1	-	1	1	3	2	-	3
CO 2	3	2	2	2	3	2	2	2	1	-	2	2	2	2	-	3
CO 3	3	2	3	2	3	2	2	3	1	-	3	2	2	2	-	3
CO 4	3	3	3	2	3	2	3	3	1	-	3	3	3	3	-	3
CO 5	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	Category	L	T	P	C
FT19712	**LIVESTOCK AND MARINETECHNOLOGY LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
	To describe testing methods for livestock and marine products
	To get familiar with quality analysis of meat, poultry and fish
	To gain experience with analysis of various components in livestock and marine products.
	To assess lipid oxidation in meat products.
	To learn the testing methods for eggs and processed egg products.

List of Experiments	
1	Proximate analysis of meat, poultry and fish - Direct and indirect method of Moisture Determination, fat Content, Mineral and Trace Element Analysis
2	Quality analysis of Meat, poultry and fish – Color, Texture, pH, Water/Protein Ratio
3	Determination of Extract Release Volume (ERV)
4	Determination of Meat Swelling Capacity (MSC)
5	Determination of Microbial load in Meat and Meat Products
6	Determination of Total Volatile Basic Nitrogen (TVBN)
7	Determination of Picric Acid Turbidity (PAT)
8.	Determination of Histamine in fishes
9.	Determination of dye reduction capacity

10.	Effect of chemical preservatives on meat – Sorbates, Nitrite and Nitrate in meat.
11	Assessment of Lipid Oxidation in meat- TBARS Assay
12	Determine % of different components & constituents such as yolk portion, white portion, ash, Total solids, moisture, specific gravity of egg.
13	Determine the efficiency of reduction in microbial load during egg Pasteurization
12	Determine the effect of drying temperature on production of egg white powder using spray dryer.
	Total Contact Hours : 60

Course Outcomes:	
The students will be able to	
	Demonstrate the testing methods for livestock and marine products
	Analyse the quality of meat, poultry and fish
	Determine various components in livestock and marine products.
	Assess lipid oxidation in meat products.
	Perform various tests to assess quality of eggs and to process egg products.

References:	
1.	FSSAI Lab manual, "Manual of methods of analysis- Meat & Meat products, Fish & Fish products", 2016

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Equipment Required		
S.No.	**Name of the equipment**	**Quantity**
1.	Hot Air Oven	1
2.	Vacuum Oven	1
3.	Soxhlet's apparatus	1
4.	Hunter colorimeter	1
5.	Texture analyser	1
6.	pH Meter	2
7.	Conway Microdiffusion apparatus	1
8.	UV-Visible Spectrophotometer	1
9.	Meat Mincer	1
10.	Water Bath	1
11.	Laminar Air Flow chamber	1
12.	Pasteurizer	1
13.	Spray dryer	1

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	3	2	3	2	2	1	1	2	3	2	3	3	1	1
CO 2	3	2	3	3	3	2	2	2	1	2	3	3	3	3	2	1
CO 3	3	2	3	3	2	3	2	1	1	1	3	3	3	3	2	1
CO 4	2	2	3	3	3	3	2	1	1	1	3	3	3	3	2	2
CO 5	3	3	2	3	3	2	2	1	1	1	2	3	3	2	2	3
Average	2.6	2.2	2.8	2.8	2.8	2.4	2	1.2	1	1.4	2.8	2.8	3	2.8	1.8	1.6

PROFESSIONAL ELECTIVE – I & II

Subject Code	Subject Name	Category	L	T	P	C
FT19P51	**BIOLOGY AND CHEMISTRY OF FOOD FLAVOURS**	PE	**3**	**0**	**0**	**3**

Objectives:	
•	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.

UNIT-I	**INTRODUCTION**	**9**
Different flavour in food – classification of food flavours; chemical compounds responsible for flavour		

UNIT-II	**FLAVOUR COMPOUNDS**	**9**
Chemical compound classes and their flavour responses; flavour development during biogenesis, flavour development during food processing; use of biotechnology to develop flavours.		

UNIT-III	**THE CHEMICAL SENSES**	**9**
Anatomy of the chemical senses; neural development of the chemical senses; receptor mechanisms, neural coding; the control of eating.		

UNIT-IV	**FLAVOUR ANALYSIS**	**9**
Subjective versus Objective methods of analysis; psychophysics and sensory evaluation and its types, E-NOSE, E-TONGUE; Instrumental analysis; sample handling and artefacts; data handling.		

UNIT-V	**TEACHING FLAVOUR CONCEPTS**	**9**
Problem based learning; tongue and nose; Onion-Beverage-Maillard reaction-Thio-stench		

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

Course Outcomes:	
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

Text Books:	
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.
Reference Books / Web links:	
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.

Course Outcomes:	
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

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

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**

FT19P52	MINIMAL PROCESSING OF FOODS	PE	3	0	0	3

Objectives:	
•	To acquire a knowledge about overview of minimal processing
•	To learn about the technologies involved in marketing of fresh cut plant produce.
•	To gain knowledge about Cook-Chill/freeze food.
•	To establish the knowledge about part baked food products
•	To understand the importance of minimally processed meat and fish products

UNIT-I	**MINIMAL PROCESSING OF FOODS- AN OVERVIEW**	**9**
Introduction, Purposes of Minimal Processing, Applications of Minimal Processing, Quality and Safety of Minimally Processed Foods, Impact of Minimal Processing on Quality of Food Product, Impact of Minimal Processing on Nutrition Contents.		
UNIT-II	**TECHNOLOGIES IN FRESH-CUT FRUIT AND VEGETABLES**	**9**
Fresh-Cut Produce: Biochemistry and Quality Parameters, Impact of Processing Operations Over Fresh-Cut and Vegetables- Ethylene production, Respiration Rate, Color Changes, Microbiological Quality. Emerging Technologies in Preservation of Fresh-Cut Quality Parameters- UV Irradiation, Controlled/Modified Atmospheres, High Pressure Processing, Edible Coatings, Active Packaging, Bioactive Compounds as Additives to Extend Shelf Life		
UNIT-III	**COOK-CHILL/FREEZE FOODS**	**9**
Cook-Chill and Cook-Freeze Systems, Microbiological Considerations, Applications of Cook-Chill Processing Systems, Advantages and Disadvantages of Cook-Chill and Cook- Freeze Products, Processing of Cook-Chill/Sous-Vide and Cook-Freeze Products- Processing Conditions; Production of Cook-Chill Products: Raw Materials and Ingredients, Heating Techniques, Rapid Chilling or Freezing Equipment, Packaging, Process Validation and Safety, Effect on Texture and Nutrition		
UNIT-IV	**PART-BAKED PRODUCTS**	**9**
Baking Process and Structure Formation, Staling of Baked Products, Reheat of Bakery Products, Part-Baking Process: Initial Baking (Part-Baking); Cooling or Freezing of Part-Baked Products; Storage of Part-Baked Products; Final Baking of Part Baked Stored Products, Advantages & Disadvantages of Part-Baking Process.		
UNIT-V	**MINIMALLY PROCESSED MEAT AND FISH PRODUCTS**	**9**
Minimal Processing with Thermal Methods and Non-thermal methods, Minimal Processing with Bio preservation and Natural Antimicrobials, Challenges in Minimal processing of animal products, Quality & safety in minimal processed animal and marine products.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Understand the importance of minimal processing
●	Demonstrate the technologies involved in marketing of fresh cut plant produce.

●	Grasp the knowledge about cook-chill/freeze foods.
●	Apply the knowledge in the production of part baked products
●	Infer the safety and nutritional aspects of minimally processed meat and fish products.

Text Books:	
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.

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

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19P53	**POST-HARVEST TECHNOLOGY**	PE	**3**	**0**	**0**	**3**

Objectives:	
•	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.

UNIT-I	**INTRODUCTION**	**9**
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.		
UNIT-II	**CLEANING, THRESHING AND GRADING**	**9**
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", DES tech 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

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

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19P54	**SPECIALITY FOODS**	PE	**3**	**0**	**0**	**3**

Objectives:	
•	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.

UNIT-I	**NEED AND SCOPE OF SPECIALTY FOODS**	**9**
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.		
UNIT-II	**SPECIALTY FOODS BASED ON SOURCES**	**9**
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.		
UNIT-III	**SPECIALTY FOOD BASED ON GENETICS**	**9**
Genetically modified foods, Transgenic foods, Biotechnological aspects of detoxification. Proprietary foods.		

Supplementary foods.		
UNIT-IV	**THERAPEUTIC FOODS**	**9**
Modification of diets in disorders, feeding purposes Disease oriented of different organs ex: digestive tract, liver, cardiovascular system, kidney, metabolic disorders, allergy, endocrine disorders.		
UNIT-V	**SPECIFIC CONSUMER ORIENTED FOODS**	**9**
Defense persons, Space / astronaut, High altitude mountain climbers, Disaster situation – crises, care, maintenance		
	Total Contact Hours : 45	

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.

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

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

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

Subject Code	Subject Name	Category	L	T	P	C
FT19P55	**BEVERAGES TECHNOLOGY**	PE	**3**	**0**	**0**	**3**

Objectives:	
•	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

UNIT-I	**INGREDIENTS IN BEVERAGES**	**10**
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.		
UNIT-II	**CARBONATED BEVERAGES**	**9**
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. Equipments used in the manufacture of carbonated beverages.		
UNIT-III	**NON-CARBONATED BEVERAGES AND BOTTLED WATER**	**9**
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	
●	Formulate the beverages using selected ingredients
●	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

Reference Books / Web links:	
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
CO 1	3	3	2	3	2	2	2	1	-	-	1	2	2	2	1	1
CO 2	3	3	2	2	2	2	2	1	-	-	1	2	2	2	1	1
CO 3	2	2	2	2	2	2	2	1	-	-	1	2	2	2	2	1
CO 4	2	2	2	2	3	3	1	1	-	-	1	3	3	2	2	1
CO 5	2	2	2	2	3	3	1	1	-	-	1	3	3	3	2	1
Average	2.4	2.4	2.0	2.2	2.4	2.4	1.8	1	-	-	1	2.4	2.4	2.2	1.8	1

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19P56	**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 in vivo and *in vitro* 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

UNIT-I	**INTRODUCTION AND SIGNIFICANCE**	**9**
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		
UNIT-II	**ANALYSIS OF PHYTOCHEMICALS**	**10**
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.		
UNIT-III	**ASSESSMENT OF ANTIOXIDANT ACTIVITY**	**10**
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.		
UNIT-IV	**ROLE IN HEALTH AND DISEASE**	**10**
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.		
UNIT-V	**SAFETY ISSUES**	**6**
Health Claims, regulations and safety issues- International and national.		
	Total Contact Hours : 45	

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
●	Analyse 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. Willams. "Functional Foods: Concept to Product". Wood head, 2000.
4	Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

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

Subject Code	Subject Name	Category	L	T	P	C
FT19P57	**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.

UNIT-I	**INTRODUCTION**	**9**
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.		
UNIT-II	**FOOD ALLERGY AND SENSITIVITY**	**9**
Chemistry of food allergens, celiac disease, food disorders associated with metabolism, lactose intolerance, and asthma.		
UNIT-III	**PRINCIPLES OF TOXICOLOGY**	**9**

Natural food toxicants - toxicity of mushroom alkaloids, seafood, vegetables, fruits, pulses, and antinutritional compounds. Biological factors that influence toxicity, toxin absorption in the GI. track, Industrial microflora, blood, brain barrier, storage and excretion of toxins.		
UNIT-IV	**DETERMINATION OF TOXICANTS IN FOOD SAMPLING**	**9**
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.		
UNIT-V	**TOXICANTS FORMED DURING FOOD PROCESSING**	**9**
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.		
	Total Contact Hours : 45	

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

Reference Books / Web links:	
1	Labbe, Ronald G. and Santos Garcia “Guide to Food Borne Pathogens” John Wiley &Sons, 2001.
2	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.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
CO 2	3	2	2	3	3	3	3	3	3	-	3	3	3	3	3	3
CO 3	3	2	2	3	3	2	3	2	3	-	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	3
Average	3	2. 6	2. 6	3	3	2. 8	3	2.4	3	-	3	3	3	3	3	3

PROFESSIONAL ELECTIVE – III

Subject Code	Subject Name	Category	L	T	P	C
FT19P61	**PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT**	PC	**3**	**1**	**0**	**4**

Objectives:	
•	To gain knowledge about production management
•	To understand engineering economics
•	To be acquainted with knowledge of profitability & investment
•	To familiarize with analysis of performance
•	To understand economic balance and quality control.

UNIT-I	**PRINCIPLES OF PRODUCTION MANAGEMENT AND ORGANISATION**	**9**
Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control		
UNIT-II	**ENGINEERING ECONOMICS FOR PROCESS ENGINEERS**	**9**
Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, invested capital and profitability.		
UNIT-III	**PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT**	**9**
Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.		
UNIT-IV	**ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE**	**9**
Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.		
UNIT-V	**ECONOMIC BALANCE AND QUALITY AND QUALITY CONTROL**	**9**
Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat transfer. Elements of quality control, role of control charts in production and quality control.		
	Total Contact Hours : 45	

Course Outcomes:
On completion of course students will be able to

●	Apply the production management principles.
●	Apply engineering economics principles in industry
●	Infer the profitability & investment
●	Analyse the performance based on annual reports
●	Comprehend economic balance approach

Text Books:	
1	Peters, M. S. and Timmerhaus, C. D., "Plant Design and Economics for Chemical Engineers", V Edn., McGraw Hill, 2002.
2	Holand, F.A., Watson, F.A. and Wilkinson, J.K., " Introduction to process Economics ", II Edn., John Wiley, 1983.
3	Narang, G.B.S. and Kumar, V., " Production and Costing ", Khanna Publishers, New Delhi, 1988.

Reference Books / Web links:	
1	Allen, L.A., "Management and Organization", McGraw Hill.
2	Perry, R. H. and Green, D., " Chemical Engineer's Handbook ", VII Edn., McGraw Hill.

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	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
CO 3	3	2	2	3	3	3	2	2	3	-	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
Average	3	2. 8	2. 8	3	3	3	3	2.8	3	-	3	3	3	3	3	3

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19P62	**NANOTECHNOLOGY IN FOOD APPLICATIONS**	**PE**	**3**	**0**	**0**	**3**

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

UNIT-I	**NANOPARTICLES- INTRODUCTION AND PREPARATION**	**9**

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.		
UNIT-II	**CHARACTERIZATION TECHNIQUES**	**9**
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.		
UNIT-III	**NANOTECHNOLOGY IN FOOD PROCESSING**	**9**
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.		
UNIT-IV	**NANOPACKAGING**	**9**
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.		
UNIT-V	**NANO SENSORS**	**9**
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		
	Total Contact Hours : 45	

Course Outcomes:	
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

Text Books:	
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.

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

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
FT19P63	**TECHNOLOGY OF PLANTATION CROPS AND SPICES**	PE	**3**	**0**	**0**	**3**

Objectives:	
•	To demonstrate the processing steps involved in the manufacture of tea and coffee
•	To learn the processing techniques of cashew and coconut to develop value added products
•	To analyse the chemistry and manufacturing techniques of Vanilla and cocoa products
•	To Compare the processing methods and extraction techniques of major spices
•	To evaluate the extraction of flavour components from minor spices

UNIT-I	**COFFEE AND TEA PROCESSING**	**9**
A. Coffee - 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. Tea** - 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		
UNIT-II	**CASHEW AND COCONUT PROCESSING**	**9**
Cashew-Importance - harvesting- products - uses of cashew & CSNL- cashew nut processing -methods of roasting - shelling - grading- packaging- infestation- Hygiene and safety. Coconut-harvesting - Processing		

technology of Virgin Coconut oil- Desiccated Coconut, Milk Cream, Nata-de-Coco, Packed Tender Coconut Water- Vinegar and Activated Carbon.		
UNIT-III	**VANILLA AND COCOA PROCESSING**	**9**
Vanilla- Occurrence -chemistry of vanilla -stage of harvesting - different curing techniques -quality control and grading of cured beans -vanillin extraction methods - super critical fluid extraction of vanillin- Cocoa - Occurrence - Chemistry of the cocoa bean - changes taking place during fermentation of cocoa bean - Processing of cocoa bean - cocoa powder - cocoa liquor manufacture- Chocolate - Types - Chemistry and technology of chocolate manufacture - Quality control of chocolates.		
UNIT-IV	**MAJOR SPICE PROCESSING**	**9**
Importance for spices - production and export status - stages and methods of harvest of important spices- equipment used for threshing, shelling, decortications of spices-Processing of cardamom-stage of harvest-processing of pepper-harvesting- packaging-processing of white pepper - wet and dry pulping and retting methods - drying; Processing of turmeric - Processing of chilli - harvesting and drying - packaging and grinding - low temperature grinding - advantages - refrigerant used - construction and working		
UNIT-V	**MINOR SPICE PROCESSING**	**9**
Minor Spices - processing of Cumin, Coriander, Cinnamon, fenugreek, Garlic and Clove- Oleoresins and essential oils- Method of manufacture - Chemistry of the volatiles- Enzymatic synthesis of flavour identicals - Quality control - Processing of ginger -harvesting, washing, drying, and packaging - quality aspects - processing of clove, nutmeg and other minor spices- Packaging and storage of spices - quality analysis- AGMARK and ASTA standards.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of course students will be able to	
●	Assess the unit operations and processing steps involved in the manufacture of tea and coffee
●	Apply the processing techniques of cashew and coconut to develop value added products
●	Analyse the chemistry and manufacturing techniques of Vanilla and cocoa products
●	Compare the processing methods and extraction techniques of major spices
●	Evaluate the extraction of flavour components from minor spices

Text Books:	
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, New Delhi.

Reference Books / Web links:	
1	ASTA, Official analytical methods of the American Spice Trade Association, IV Edition,1997
2	Purse glove, 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
CO 1	3	2	2	2	1	2	2	-	-	-	1	2	3	3	2	1
CO 2	3	2	2	2	1	2	2	-	-	-	1	2	3	3	2	1
CO 3	2	2	2	2	2	2	2	-	-	-	2	2	1	2	1	1
CO 4	2	2	2	3	2	3	2	-	-	-	2	3	1	2	1	2
CO 5	2	2	2	3	2	3	3	-	-	-	2	3	1	2	1	1
Average	2.4	2.0	2.0	2.4	1.6	2.4	2.2	-	-	-	1.6	2.4	1.8	2.4	1.4	1.2

PROFESSIONAL ELECTIVES – IV & V

Subject Code	Subject Name	Category	L	T	P	C
FT19P71	**FOOD PLANT DESIGN AND LAYOUT**	PE	**3**	**0**	**0**	**3**

Objectives:

- 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.

UNIT-I	**OVERALL DESIGN OF AN ENTERPRISE**	**9**

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.

UNIT-II	**PREPARATION OF A PLANT LAYOUT**	**9**

Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant Layout. Advantages of good layout. Organizing for Plant Layout, Data forms.

UNIT-III	**DEVELOPMENT AND PRESENTATION OF LAYOUT**	**9**

Development of the pilot layout, constructing the detailed layout: Functional design: Sitting of different sections in a plant, Layout installations.

UNIT-IV	**QUANTITATIVE ANALYSIS FOR PLANT LAYOUT**	**9**

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.

UNIT-V	**PRACTICAL LAYOUTS**	**9**

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, Waste (Food, water) / Effluent Treatment.

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

Course Outcomes:

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.

Text Books:

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.

Reference Books / Web links:

1	"Food plant engineering system" by Theunis C. Robberts, II Edition, CRC Press, Washington, 2013
2	John Holah, HuubLelieveld, "Hygienic Design of Food Factories", Wood head Publishing, 2011.
3	Slade, S. "Food Processing Plant" Vol. 1, Leonard Hill Books, 1990

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

Subject Code	Subject Name	Category	L	T	P	C
FT19P72	**FOOD PRODUCT DESIGN AND DEVELOPMENT**	PE	**3**	**0**	**0**	**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.

UNIT-I	**FOOD NEEDS & CONSUMER PREFERENCE**	**9**

Market survey and its importance; 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.		
UNIT-II	**DESIGNING NEW PRODUCTS**	**9**
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.		
UNIT-III	**STANDARDIZATION & LARGE SCALE PRODUCTION**	**9**
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.		
UNIT-IV	**QUALITY, SAFETY & REGULATORY ASPECTS**	**9**
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.		
UNIT-V	**ADVERTISEMENT, MARKETING & CASE STUDIES**	**9**
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.		
	Total Contact Hours :	**45**

Course Outcomes:

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.

Text Books:

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

Reference Books / Web links:

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

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

Subject Code	Subject Name	Category	L	T	P	C
FT19P73	**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.

UNIT-I	**CLASSIFICATION & CHARACTERIZATION OF FOOD INDUSTRY WASTE**	**9**
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.		
UNIT-II	**TREATMENT METHODS OF WASTE FROM FOOD INDUSTRY**	**9**
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.		
UNIT-III	**UTILIZATION OF WASTE PRODUCT FROM PLANT & ANIMAL BASED FOOD PRODUCTS**	**9**
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, brokens, rice bran, corn dry milling- tip cap, corn cob, germ, corn peel, corn wet milling-steep water; pulses milling - husk, germ, brokens, 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, FSSAI initiative- Repurpose Used Cooking Oil (RUCO)		
	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.

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

Subject Code	Subject Name	Category	L	T	P	C
FT19P74	**CEREAL, PULSES AND OIL SEED TECHNOLOGY**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	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 understand the chemical and biological structure of pulses.
●	To familiarize with different processing of legumes and its by product
●	To Identify chemical composition of oilseed and understand oil extraction process

UNIT-I	**WHEAT AND RICE**	**9**
Status, major growing areas and production of cereals, millets, pulses and oil seeds in India and the world, structure, Physical properties, Chemical composition, Distribution of nutrients, nutritional and anti-nutritional factors. Wheat: Wheat Morphology, Physicochemical properties, Wheat Quality, Wheat Milling, Quality aspects of flour, wheat proteins and their functions. Rice: Varieties of rice grown in India and other countries; Storage, Insect control; Processing: Rice - Milling, and sorting; Polishing; Parboiling; Aging of rice; Quick cooking rice, factors affecting quality of rice, Traditional Indian Products- Breakfast cereals, Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other instant products. Bran, germ and novel products from wheat / rice, Enrichment and fortification of rice		

UNIT-II	**MILLETS AND OTHER CEREALS**	**9**
Sorghum, Pearl Millet, Finger millet, Foxtail millet, Kodo Millet - storage, insect control; processing - Pearling, Milling, Malting, Malt based foods, value addition, by product utilization, flaked and fermented products; Traditional and Nutritional products based on finger millet. Other cereals Corn - Morphology, Physico-chemical properties, Corn milling - Wet and dry milling, Milling fractions of corn. Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking; Rye: Milling and processing, Rye based products.		

UNIT-III	**LEGUME PROCESSING**	**10**
Present status and future prospects of Pulses, 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 Processing of legumes: Red gram, Bengal gram, Green gram, Black gram, Dal milling – Principle, methods, equipments 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. Soya processing: 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.		
UNIT-IV	**OIL SEED PROCESSING**	**8**
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.		
UNIT-V	**OIL EXTRACTION PROCESS**	**9**
Oil seeds Processing - Sesame, Coconut, Groundnut, Mustard, Soybean, Sunflower, Safflower. Oil extraction - Traditional Methods, New Technologies in oil seed processing, Extraction principles, factors affecting the extraction process, Desolventization, Refining of Oils - Degumming, neutralization, bleaching, filtration, deodorization, their principles and process controls, utilization of oil seed meals of different food uses, Oil Modification Process – Hydrogenation, Interesterification, Fortification strategies for oil, High protein Product, like protein concentrate and isolates.		
	Total Contact Hours : 45	

Course Outcomes:	
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
●	Interpret the chemical and biological structure of pulses.
●	Comprehend different processing of legumes and its by product
●	Identify chemical composition of oilseed and demonstrate the oil extraction process

Text Books:	
1	Matz, Samuel A. " The Chemistry and Technology of Cereals as Food and Feed" 2nd Edition, CBS, 1996.
2	Khalil Khan and Peter.R.Shewry, " Wheat: Chemistry and Technology", 4th Edition, AACC International, Inc., 2009.
3	Kshirod. R. Bhattacharya, " Rice Quality: A guide to rice properties and analysis", Woodhead Publishing, 2011.
4	Brijesh Tiwari and Narpinder Singh, "Pulse Chemistry and Technology", RSC publishing, 20122.

Reference Books / Web links:

1	Delcour, Jan A. and R. Carl Hoseney. "Principles of Cereal Science and Technology". 3 rd Edition. American Association of Cereal Chemists, 2010.
2	Kulp, Karel "Handbook of Cereal Science and Technology". 2nd Edition, CRC Press, 2000
3	Skylar Barr and Mason Sulton, " Technology of Cereals, Pulses and Oilseeds", ED-Tech Press, 2020.
4	Hamm, Wolf and Richard J Hamilton "Edible Oil Processing" Blackwell Publishing, 2004

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	1	2	2	2	2	2	-	-	-	1	3	2	3	2	1
CO 2	2	3	2	3	2	3	2	-	-	-	1	2	1	3	1	2
CO 3	2	2	2	2	1	3	3	-	-	-	1	3	2	2	2	2
CO 4	3	2	1	3	2	2	2	-	-	-	1	3	2	3	1	1
CO 5	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	-	-	-	1.2	2.6	1.8	2.6	1.6	1.4

Subject Code	Subject Name	Category	L	T	P	C
FT 17E75	**STORAGE ENGINEERING**	PE	**3**	**0**	**0**	**3**

Objectives:	
•	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.

UNIT-I	**FOOD GRAIN STORAGE**	**9**

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.

UNIT-II	**DESIGN OF GRAIN STORAGE SYSTEM**	**9**

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.		
UNIT-III	**STORAGE OF FRUITS AND VEGETABLES**	**9**
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_2 and CO_2, 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.		
UNIT-IV	**COLD STORAGE SYSTEM**	**9**
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.		
UNIT-V	**DESIGN OF COLD STORAGE**	**9**
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.		
	Total Contact Hours : 45	

Course Outcomes:	
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.

Text Books:	
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.

Reference Books / Web links:	
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.

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	2	2	3	3	3	1	1	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
Average	3	3	3	2.8	2.8	2.8	3	3	3	1	1	3	3	3	3	3

Subject Code	Subject Name	Category	L	T	P	C
FT19P76	**FOOD SAFETY MANAGEMENT SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
•	To learn food safety Management system and quality auditing programme.
•	To prepare HACCP based SOP
•	To implement HACCP program to any food industry
•	To understand HACCP Pre-requisite Program
•	To conduct quality auditing in the food industries

UNIT-I	**STANDARD OPERATING PROCEDURES**	**9**
Preparing scope, quality policy and quality objectives of food processing company, Defining Standard operating procedure – purpose- Format - developing and implementing, effective writing. SOP for purchasing raw materials, receiving raw materials, storage, cleaning, holding, cooling, freezing, thawing, reheating, personal hygiene, facility and equipment. Systems in laboratory accreditation		
UNIT-II	**AUDIT CHECK LIST**	**9**
Preparation of HACCP based SOP checklist - personal hygiene, food preparation, hot holding, cold holding, refrigerator, freezer and milk cooler, food storage and dry storage, cleaning and sanitizing, utensils and equipment's, large equipment's, garbage storage and disposal and pest control.		
UNIT-III	**PRE-REQUISITE PROGRAM**	**9**
Good Manufacturing Practices - Personal hygiene – occupational health and safety specification, Food Plant Sanitation Management - Plant facilities construction and maintenance - exterior of the building- interior of		

the building- equipment's. Storage, transportation, traceability, recalling procedures, training.		
UNIT-IV	**HACCP PRINCIPLE**	**9**
Conduct a hazard analysis, CCP identification, establish critical limits for each CCP, establish CCP monitoring procedures, establish corrective actions procedures, establish procedures for HACCP verification and validation, documenting the HACCP Program.		
UNIT-V	**IMPLEMENTATION OF HACCP AND CONDUCTING AUDIT**	**9**
HACCP for jam, biscuit, bread, dairy, meat, fish and egg industries. Conducting of open meeting and close meeting in auditing, preparation of audit reports for different department- audit exercise		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
●	Implement food safety Management system and quality auditing programme.
●	Prepare HACCP based SOP
●	Implement HACCP program to any food industry
●	Assess HACCP Pre-requisite Program
●	Conduct quality auditing in the food industries

Text Books:	
1	Andres Vasconcellos J. 2005. Quality Assurance for the Food industry - A practical approach. CRC press.
2	Inteaz Alli. 2004. Food quality assurance - Principles & practices. CRC Press. New York.

Reference Books / Web links:	
1	Sara Mortimore and Carol Wallace. 2013. HACCP - A practical approach. Third edition. Chapman and Hall, London
2	Roday, S. 1998. Food Hygiene and Sanitation, Tata McGraw-Hill Education.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
CO 2	3	3	2	3	3	3	3	3	3	1	2	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
CO 4	3	2	2	3	3	3	2	3	3	1	1	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	1	1	3	3	3	3	3
Average	3	3	2.6	3	3	3	2.8	3	3	1	1.2	3	3	3	3	3

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
FT19P77	FOOD PLANT EQUIPMENT DESIGN	PE	3	0	0	3

Objectives:	
•	To understand the engineering properties of different materials for the development of food plant equipment
•	To understand the design and economic considerations
•	To learn methods for design of storage vessels and exchangers
•	To learn the methods for design of dryers, freezers, fermenters and extruders
•	To familiarize with the hazards in process industries and safety measures in equipment design

UNIT-I	MATERIALS AND PROPERTIES	9
Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes		
UNIT-II	**DESIGN CONSIDERATIONS**	**9**
Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations		
UNIT-III	**DESIGN OF STORAGE VESSEL AND EXCHANGERS**	**9**
Design of pressure and storage vessels Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort. Design of agitators and separators Design of agitators and baffles; Design of agitation system components and drive for agitation		
UNIT-IV	**DESIGN OF DRYER, FREEZER AND FERMENTERS**	**9**
Design of freezing equipment Design of ice-cream freezers and refrigerated display system Design of dryers Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer Design of fermenters Design of fermenter vessel, design problems		
UNIT-V	**EXTRUDERS AND EQUIPMENT SAFETY**	**9**
Extrusion cookers - cold extrusion, single and twin screw extrusion- Low pressure and high pressure extrusion - properties of Food materials and its significance in equipment design - processing and handling - Cold and hot extruder design, design of screw and barrel, design of twin screw extruder. Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices		
	Total Contact Hours : 45	

Course Outcomes:	
The students will be able to	
•	Analyse the engineering properties of different materials for the development of food plant equipment
•	Determine the design and economic considerations
•	Design the storage vessels and exchangers
•	Design the dryers, freezers, fermenters and extruders
•	Demonstrate the hazards in process industries and safety measures in equipment design

Text Books:	
1.	R. Paul Singh and Dennis R. Heldman. Introduction to Food Engineering, 5th Edition. Elsevier, Amsterdam, The Netherlands.2014.
2.	Albert Ibarz and Gustavo V. Barbosa-Cánovas. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.2003.
3.	George D. Saravacos and Athanasios E. Kostaropoulos. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.2002.
4.	R. K. Sinnott. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Edition. Butterworth-Heinemann, Oxford, UK.1999.
5.	Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA. 1997.

References:	
1.	Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 2013, Principles of Fermentation Technology, 2nd Edition. Elsevier Science Ltd., Burlington, MA, USA. 2. 3. 4. 5. 6.
2.	J.F. Richarson and D.G. Peacock. Coulson &Richardsons's ChemicalEngineering, Vol. 3, Chemical &Biochemical Reactors & Process Control, 3rd Edition. Elsevier ButterworthHeinemann, Amsterdam, The Netherlands. 1994.
3.	James R. Couper, W. Roy Penney, James R. Fair and Stanley M. Walas Chemical Process Equipment Selection and Design. Elsevier Inc. 2012.
4.	Mahajani, V. V. and Umarji, S. B., Process equipment design, 4th edition, 2009, Macmillan publishers.
5.	Bhattacharyya, B. C., Introduction to Chemical Equipment design, 2008, CBS Publishers and Distributors.
6.	Geankoplis C. J. Transport processes and unit operations,1983, Prentice-Hall

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

Subject Code	Subject Name	Category	L	T	P	C
FT19P78	**SENSORY EVALUATION OF FOODS**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To learn the principles and significance of the sensory perception mechanism
●	To get familiar with flavour and odour perception mechanism.
●	To gain knowledge on factors that influence the sensory measurement
●	To gain knowledge on various sensory evaluation techniques
●	To learn the importance of market analysis

UNIT-I	PRINCIPLES AND SIGNIFICANCE	9
Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation, test protocol considerations Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value, factors affecting senses, visual, auditory, tactile and other responses.		
UNIT-II	**FLAVOURS AND ODOUR**	**9**
Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste;		
UNIT-III	**SENSORY MEASUREMENT**	**9**
Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests		
UNIT-IV	**SENSORY QUALITY EVALUATION**	**9**
Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, , statistical interpretation of results, dilution procedures, descriptive sensory analysis, contour method, other procedures, Statistical techniques for SE data analysis		
UNIT-V	**MARKET ANALYSIS**	**9**
Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey, Statistical techniques for Consumer study data analysis		
	Total Contact Hours : 45	

Course Outcomes: **The students will be able to**	
●	Apply the principles and significance of the sensory perception mechanism
●	Demonstrate the flavour and odour perception mechanism.
●	Analyse the factors that influence the sensory measurement
●	Perform the sensory evaluation of foods
●	Apply the market analysis and understand the consumer needs

Text Books:	
1.	Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2.	Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3.	Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.
4.	Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker.
5.	Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press.

Reference Books:	
1.	Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
2.	Piggot, J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science Publ.
3.	Potter, N.N. and Hotchleiss, J.H. 1997. Food Science, 5th Ed. CBS Publishers, Delhi.
4.	Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
5.	Stone, H. and Sidel, J.L. 1985. Sensory Evaluation Practices. Academic Press, London.
6.	Harry, T. Lawless, Hildegarde Heymann. 2010. Sensory Evaluation of Food: Principles and Practices, 2nd Ed., Springer, New York or Dordrecht Heidelberg, London.

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

Subject Code	Subject Name	Category	L	T	P	C
FT 19P79	**COMPREHENSION IN FOOD TECHNOLOGY**	**PE**	3	0	0	3

Objectives:	
●	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 CO2 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.		
UNIT-IV	**TECHNOLOGY OF MILK AND MILK PRODUCTS**	**9**
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.		
UNIT-V	**BAKING AND CONFECTIONERY TECHNOLOGY**	**9**
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.			
	Total Contact Hours	**:**	**45**

Course Outcomes:	
●	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

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

PO/PSO / CO	PO1	PO 2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO 4
CO 1	3	3	3	3	3	3	2	2	1	2	1	3	3	2	3	3
CO 2	3	3	3	3	3	2	1	2	1	2	2	3	3	3	3	3
CO 3	2	3	3	2	2	3	2	2	2	2	1	3	3	3	3	2
CO 4	2	3	3	2	2	3	2	2	2	2	2	3	3	3	3	2
CO 5	2	3	3	2	2	3	2	2	2	2	2	3	3	3	3	2
Average	2.4	3	3	2.4	2.4	2.8	1.8	2	1.6	2	1.6	3	3	2.8	3	2.4