Guru Nanak Institute of Technology

(NAAC 'A+' Accredited An Autonomous Institute) (Affiliated to Maulana Abul Kalam Azad University of Technology)

R25 [B.Tech., Food Technology]

Curriculum and Syllabus for B.Tech. under Autonomy (NEP-2020 implemented)

Dept. of Food Technology

(Effective from 2025-26 admission batch)

Department: Food Technology (FT)

Curriculum Structure & Syllabus (Effective from 2025-26 admission batch)

1st Year 1st Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/ Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT101	Chemistry of Food	3	0	0	3	3
2	SCI	Multidisciplinary	PH101	Engineering Physics	3	0	0	3	3
3	SCI	Multidisciplinary	M101	Engineering Mathematics- I	3	0	0	3	3
4	HUM	Value Added Course	HU101	Environmental Science	2	0	0	2	2
5	HUM	Value Added Courses	HU102	Indian Knowledge System	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	FT191	Chemistry of Food Lab I	0	0	3	3	1.5
2	SCI	Skill Enhancement Course	PH191	Engineering Physics Lab	0	0	3	3	1.5
3	ENGG	Skill Enhancement Course	ME194	Engineering Graphics & Computer Aided Design Lab	0	0	3	3	1.5
4	HUM	Ability Enhancement Course	HU191	Communication & Presentation Skill	0	0	3	3	1.5
C. MANDATORY ACTIVITIES / COURSES									
1	MC	Mandatory Course	MC181	Induction Program	0	0	0	0	0
Total of Theory, Practical								**24**	**18**

**HUM: Humanities; ENGG: Engineering; SCI: Science; PRJ: Project*

1st Year 2nd Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT201	Food Microbiology	3	0	0	3	3
2	ENGG	Major	FT202	Biochemistry and Nutrition	3	0	0	3	3
3	ENGG	Minor	CS202	Introduction to Artificial Intelligence	2	0	0	2	2
4	SCI	Multidisciplinary	CH201	Engineering Chemistry	2	0	0	2	2
5	SCI	Multidisciplinary	M201	Engineering Mathematics –II	3	0	0	3	3
6	HUM	Value Added Course	HU205	Constitution of India & Professional Ethics	1	0	0	1	1
7	HUM	Ability Enhancement Course	HU203	Design Thinking & Innovation	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	FT291	Food Microbiology lab	0	0	3	3	1.5
2	ENGG	Major	FT292	Biochemistry and Nutrition Lab	0	0	3	3	1.5
3	SCI	Skill Enhancement Course	CH291	Engineering Chemistry Lab	0	0	2	2	1
4	ENGG	Skill Enhancement Course	ME293	IDEA LAB Workshop	0	0	3	3	1.5
5	ENGG	Minor	CS292	Introduction to Artificial Intelligence Lab	0	0	3	3	1.5
C. MANDATORY ACTIVITIES / COURSES									
1	MC	Mandatory Course	MC281	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0	0
Total of Theory, Practical								**29**	**22**
Total Credit in 1st year									**40**

2nd Year 3rd Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT301	Food Process Technology–I (Fish, Meat, Poultry)	3	0	0	3	3
2	ENGG	Major	FT302	Food Process Technology–II (Cereals, Fruits, Vegetables and Spices)	3	0	0	3	3
3	ENGG	Minor	CH(FT)301	Industrial stoichiometry	3	0	0	3	3
4	ENGG	Minor	CS(FT) 301A/B/C	A. Data Structure and Algorithms B. Data Base Management System C. Software Engineering	3	0	0	3	3
5	SCI	Minor	M(FT)301	Applied Statistics and Numerical Methods	2	0	0	2	2
B. PRACTICAL									
1	ENGG	Major	FT391	Chemistry of Food Lab II	0	0	4	4	2
2	ENGG	Minor	CS(FT) 391A/B/C	A. Data Structure and Algorithms Lab B. Data Base Management System Lab C. Software Engineering Lab	0	0	3	3	1.5
3	ENGG	Minor	M(FT)391	Applied Statistics and Numerical Methods Lab	0	0	3	3	1.5
4	HUM	Ability Enhancement Course	HU(FT)391	Technical Seminar Presentation & Group Discussion	0	0	3	3	1.5
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC381	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives		0	0	0	0
Total of Theory, Practical								27	20.5

2nd Year 4th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT401	Principles of Food Preservation	3	0	0	3	3
2	ENGG	Major	FT402A/B/C	A. Food Biotechnology B. Environmental Biotechnology C. Industrial Biotechnology	3	0	0	3	3
3	ENGG	Major	FT403A/B/C	A. Fluid Mechanics and Heat Transfer B. Mass Transfer I C. Mechanical Operation and Separation Process I	3	1	0	4	4
4	ENGG	Major	FT404	Bakery, Confectionery and Extruded Foods	3	0	0	3	3
5	ENGG	Major	FT405	Food Packaging Technology	3	0	0	3	3
6	ENGG	Minor	CH(FT)401	Chemical Engineering Thermodynamics and Kinetics	3	0	0	3	3
B. PRACTICAL									
1	ENGG	Major	FT491A/B/C	A. Food Biotechnology Lab B. Environmental Biotechnology Lab C. Industrial Biotechnology Lab	0	0	3	3	1.5
2	ENGG	Major	FT492A/B/C	A. Fluid Mechanics and Heat Transfer Lab B. Mass Transfer I Lab C. Mechanical Operation and Separation Process I Lab	0	0	3	3	1.5
3	PRJ	Project	FT481	Project-I	0	0	2	2	1
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC481	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives	0	0	0	0	0
Total of Theory, Practical								**27**	**23**
Total credit in 2nd year									**43.5**

3rd Year 5th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT501	Food Process Technology–III (Milk and Milk Products)	3	0	0	3	3
2	ENGG	Major	FT502A/B/C	A. Mass Transfer II B. Mechanical Operation and Separation Process II C. Transport Phenomena	3	1	0	4	4
3	ENGG	Major	FT503	Applied Microbial Technology for Industry	4	0	0	4	4
4	ENGG	Major	FT504	Food Process Technology–IV (Edible Fats and Oils)	3	0	0	3	3
5	HUM	Value Added Course	HU501	Research Methodology and IPR	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	FT591	Food Processing Lab I	0	0	3	3	1.5
2	ENGG	Major	FT592A/B/C	A. Mass Transfer II lab B. Mechanical Operation and Separation Process II Lab C. Transport Phenomena Lab	0	0	3	3	1.5
3	ENGG	Major	FT593	Applied Microbial Technology for Industry Lab	0	0	3	3	1.5
4	ENGG	Major	FT594	Food Analysis and Quality Control Lab-1	0	0	4	4	2
5	PRJ	Project	FT581	Project-II	0	0	4	4	2
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC581	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives	0	0	0	0	0
Total of Theory, Practical								32	23.5

3rd Year 6th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT601	Principles of Biochemical Engineering	3	1	0	4	4
2	ENGG	Major	FT602	Food Process Engineering	3	0	0	3	3
3	ENGG	Major	FT603A/B/C	A. National and Global Food Regulation B. Supply Chain Management and Food Marketing C. Food Security and Sustainability	3	0	0	3	3
4	ENGG	Major	FT604A/B/C	A. Functional Foods and Nutraceuticals B. Protein Technology C. Enzyme Technology	3	0	0	3	3
5	ENGG	Minor	ECS(FT)601A EE(FT)601B EC(FT)601C	Process Instrumentation and Control Renewable Energy Technology Introduction to Nanotechnology	3	0	0	3	3
6	ENGG	Minor	CS(FT)602A/ B/C	A. Digital Image Processing B. Introduction to Machine Learning C. Introduction to Internet of Things	3	0	0	3	3
B. PRACTICAL									
1	ENGG	Major	FT691	Food Processing Lab II	0	0	3	3	1.5
2	ENGG	Major	FT692	Food Analysis and Quality Control Lab-II	0	0	4	4	2
3	PRJ	Project	FT681	Project-III	0	0	6	6	3
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC681	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives	0	0	0	0	0
Total of Theory, Practical								32	25.5
Total Credit in 3rd Year									**49**

4th Year 7th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT701	Waste Management of Food Industries	3	1	0	4	4
2	ENGG	Minor	HU(FT)701 A	Entrepreneurship Development and Start-Up Management	3	0	0	3	3
			HU(FT)701 B	Quality Management System					
			CS(FT)701 C	Smart Technologies					
3	ENGG	Minor	HU(FT)702 A	Consumer Behavior Research	3	0	0	3	3
			HU(FT)702 B	Product Design and Development					
			HU(FT)702 C	Business Research Method					
4	HUM	Skill Enhancement Course	HU(FT)703	Project Management and Finance	2	0	0	2	2
B. PRACTICAL									
1	ENGG	Skill Enhancement Course	PR(FT)791	Rapid Prototyping Lab	0	0	3	3	1.5
2	PRJ	Project	FT781	Project-IV	0	0	12	12	6
Total of Theory, Practical								27	19.5

4th Year 8th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
B. PRACTICAL									
1	PRJ	Project	FT881	Grand Viva	0	0	0	0	4
2	PRJ	Project	FT882	Internship/ Entrepreneurship	0	0	0	0	4
Total of Theory, Practical									8
Total Credit in 4th Year									27.5

Total credit: 160

Credit Distribution

Sem	Major	Minor	Multidisciplinary	Ability enhancement course	Skill enhancement course	Value added course	Project	Internship	Total
1	4.5		6	1.5	3	3			**18**
2	9	3.5	5	1	2.5	1			**22**
3	7.5	11		1.5					**20**
4	19	3					1		**23**
5	20.5					1	2		**23.5**
6	16.5	6					3		**25.5**
7	4	6			4		6		**20**
8							4	4	**8**
	81.5	**29.5**	**11**	**4**	**9**	**5**	**16**	**4**	**160**

Major Courses					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Chemistry of Food	FT101	1	3:0:0	3
2	Chemistry of Food Lab I	FT191	1	0:0:3	1.5
3	Food Microbiology	FT201	2	3:0:0	3
4	Biochemistry and Nutrition	FT202	2	3:0:0	3
5	Food Microbiology lab	FT291	2	0:0:3	1.5
6	Biochemistry and Nutrition Lab	FT292	2	0:0:3	1.5
7	Food Process Technology– I (Fish, Meat, Poultry)	FT301	3	3:0:0	3
8	Food Process Technology–II (Cereals, Fruits, Vegetables and Spices)	FT302	3	3:0:0	3
9	Chemistry of Food Lab II	FT391	4	0:0:4	2
10	Principles of Food Preservation	FT401	4	3:0:0	3
11	Food Biotechnology	FT402A	4	3:0:0	3
	Environmental Biotechnology	FT402B			
	Industrial Biotechnology	FT402C			
12	Fluid Mechanics and Heat Transfer	FT403A	4	3:1:0	4
	Mass Transfer I	FT403B			
	Mechanical Operation and Separation Process I	FT403C			
13	Bakery, Confectionery and Extruded Foods	FT404	4	3:0:0	3
14	Food Packaging Technology	FT405	4	3:0:0	3
15	Food Biotechnology Lab	FT491A	4	0:0:3	1.5
	Environmental Biotechnology Lab	FT491B			
	Industrial Biotechnology Lab	FT491C			
16	Fluid Mechanics and Heat Transfer Lab	FT492A	4	0:0:3	1.5
	Mass Transfer I Lab	FT492B			

	Mechanical Operation and Separation Process I Lab	FT492C			
17	Food Process Technology–III (Milk and Milk Products)	FT501	5	3:0:0	3
18	Mass Transfer II	FT502A	5	3:1:0	4
	Mechanical Operation and Separation Process II	FT502B			
	Transport Phenomena	FT502C			
19	Applied Microbial Technology for Industry	FT503	5	4:0:0	4
20	Food Process Technology–IV (Edible Fats and Oils)	FT504	5	3:0:0	3
21	Food Processing Lab I	FT591	5	0:0:3	1.5
22	Mass Transfer Lab II lab	FT592A	5	0:0:3	1.5
	Mechanical Operation and Separation Process II Lab	FT592B			
	Transport Phenomena Lab	FT592C			
23	Applied Microbial Technology for Industry Lab	FT593	5	0:0:3	1.5
24	Food Analysis and Quality Control Lab-1	FT594	5	0:0:4	2
25	Principles of Biochemical Engineering	FT601	6	3:1:0	4
26	Food Process Engineering	FT602	6	3:0:0	3
27	National and Global Food Regulation	FT603A	6	3:0:0	3
	Supply Chain Management and Food Marketing	FT603B			
	Food Security and Sustainability	FT603C			
28	Functional Foods and Nutraceuticals	FT604A	6	3:0:0	3
	Protein Technology	FT604B			
	Enzyme Technology	FT604C			
29	Food Processing Lab II	FT691	6	0:0:3	1.5
30	Food Analysis and Quality Control Lab-II	FT692	6	0:0:4	2
31	Waste Management of Food Industries	FT701	7	3:1:0	4
Total Credit Major courses up to 4th year					81.5

Minor Courses					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Introduction to Artificial Intelligence	CS202	2	2:0:0	2
2	Introduction to Artificial Intelligence Lab	CS292	2	0:0:3	1.5
3	Industrial Stoichiometry	CH(FT)301	3	3:0:0	3
4	Data Structure and Algorithms	CS(FT) 301A	3	3:0:0	3
	Data Base Management System	CS(FT) 301B			
	Software Engineering	CS(FT) 301C			
5	Applied Statistics and Numerical Methods	M(FT)301	3	2:0:0	2
6	Data Structure and Algorithms Lab	CS(FT) 391A	3	0:0:3	1.5
	Data Base Management System Lab	CS(FT) 391B			
	Software Engineering Lab	CS(FT) 391C			
7	Applied Statistics and Numerical Methods Lab	M(FT)391	3	0:0:3	1.5
8	Chemical Engineering Thermodynamics and Kinetics	CH(FT)401	4	3:0:0	3
9	Process Instrumentation and Control	ECS(FT)601A	6	3:0:0	3
	Renewable Energy Technology	EE(FT)601B			
	Introduction to Nanotechnology	EC(FT)601C			

10	Digital Image Processing	CS(FT)602A	6	3:0:0	3
	Introduction to Machine Learning	CS(FT)602B			
	Introduction to Internet of Things	CS(FT)602C			
11	Entrepreneurship Development and Start-Up Management	HU(FT)701A	7	3:0:0	3
	Quality Management System	HU(FT)701B			
	Smart Technologies	CS(FT)701C			
12	Consumer Behavior Research	HU(FT)702A	7	3:0:0	3
	Product Design and Development	HU(FT)702B			
	Business Research Method	HU(FT)702C			
Total Credit Minor courses up to 4th year					29.5

Multidisciplinary					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Engineering Physics	PH101	1	3:0:0	3
2	Engineering Mathematics- I	M101	1	3:0:0	3
3	Engineering Chemistry	CH201	2	2:0:0	2
4	Engineering Mathematics –II	M201	2	3:0:0	3
Total Credit for Multidisciplinary courses up to 4th year					11

Skill Enhancement Course					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Engineering Physics Lab	PH191	1	0:0:3	1.5
2	Engineering Graphics & Computer Aided Design Lab	ME194	1	0:0:3	1.5
3	Engineering Chemistry Lab	CH291	2	0:0:2	1
4	IDEA LAB Workshop	ME293	2	0:0:3	1.5
5	Project Management and Finance	HU(FT) 703	7	2:0:0	2
6	Rapid Prototyping Lab	PR(FT)791	7	0:0:3	1.5
Total Credit for Skill Enhancement Course up to 4th year					9

Value Added Courses					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Environmental Science	HU101	1	2:0:0	2
2	Indian Knowledge System	HU102	1	1:0:0	1
3	Constitution of India & Professional Ethics	HU205	2	1:0:0	1
4	Research Methodology and IPR	HU501	5	1:0:0	1
Total Credit for Value Added Courses up to 4th year					5

Ability Enhancement Courses					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Communication & Presentation Skill	HU191	1	0:0:3	1.5
2	Design Thinking & Innovation	HU203	2	1:0:0	1
3	Technical Seminar Presentation & Group Discussion	HU(FT)391	3	0:0:3	1.5
Total Credit for Value Added Courses up to 4th year					4

Project					
Sl. No.	**Course Name**	**Course Code**	**Semester**	**L:T:P**	**Credit**
1	Project-I	FT481	4	0:0:2	1
2	Project-II	FT581	5	0:0:4	2
3	Project-III	FT681	6	0:0:6	3
4	Project-IV	FT781	7	0:0:12	6
5	Grand Viva	FT881	8	0:0:0	4
6	Internship/ Entrepreneurship	FT882	8	0:0:0	4
Total Credit for Value Added Courses up to 4th year					20

Curriculum Structure & Detailed Syllabus (Effectivefrom2025-24 admission batch)

1st Year 1st Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/ Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT101	Chemistry of Food	3	0	0	3	3
2	SCI	Multidisciplinary	PH101	Engineering Physics	3	0	0	3	3
3	SCI	Multidisciplinary	M101	Engineering Mathematics- I	3	0	0	3	3
4	HUM	Value Added Course	HU101	Environmental Science	2	0	0	2	2
5	HUM	Value Added Courses	HU102	Indian Knowledge System	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	FT191	Chemistry of Food Lab I	0	0	3	3	1.5
2	SCI	Skill Enhancement Course	PH191	Engineering Physics Lab	0	0	3	3	1.5
4	ENGG	Skill Enhancement Course	ME194	Engineering Graphics & Computer Aided Design Lab	0	0	3	3	1.5
5	HUM	Ability Enhancement Course	HU191	Communication & Presentation Skill	0	0	3	3	1.5
C. MANDATORY ACTIVITIES / COURSES									
1	MC	Mandatory Course	MC181	Induction Program	0	0	0	0	0
Total of Theory, Practical								**24**	**18**

Course Name: Chemistry of Food

Course Code: FT101

Contact (L: T: P): 3 : 0 : 0

Total Contact Hours: 36

Credit: 3

Pre requisites: Engineering Chemistry

Course Objectives

The objective of the course is to make the students able to –

O1: Differentiate the types of chemical interactions and reactions among major food components such as carbohydrates, proteins, and lipids.

O2: Analyze the impact of these chemical reactions on the sensory, nutritional, and functional properties of foods.

O3: Evaluate how various food processing techniques influence the chemical properties and quality attributes of food components.

Course Outcome(s):

After completion of the course students will be able to:

CO1	**Apply** the principles of food chemistry to classify food groups and evaluate moisture content and water activity in various food matrices.
CO2	**Analyze** the structure-function relationships of carbohydrates and proteins in relation to their physico-chemical behavior in food systems.
CO3	**Evaluate** the quality and stability of fats and oils using physico-chemical parameters and recommend appropriate use of antioxidants.
CO4	**Assess** the impact of processing and storage on the nutritional quality of foods by interpreting changes in vitamins, minerals, and pigments.

CO-PO-PSO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	2	1	-	-	-	-	3	2	2
CO2	3	3	3	2	1	2	1	1	2	1	2	3	3	2
CO3	3	3	3	3	2	2	2	1	2	2	1	3	3	3
CO4	3	3	2	2	2	2	2	2	2	2	1	3	3	3

Course Contents:

Module 1 (8L)

Importance of food chemistry; Food Groups; Water in foods and its properties: different types of moisture in food; Water activity, Determination of moisture content, water absorption isotherm.

Carbohydrate: Sources of food carbohydrates; Classifications; Structure, Physico-chemical and functional properties: Monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides, homosachharides and heterosachharides; Starch: Structure, sources, properties (hydrolysis, gelatinization, retrodradation, dextrinisation, crystallization); Glycogen: definition, properties, Cellulose, pectin, gums: Occurrences, properties, uses.

Module 2 (8L)

Proteins: Sources, Basic structure and physico-chemical and functional properties: Amphoterism, hydration, binding of ions, precipitation with antibiotics, gel formation, Different types of food proteins. Purification of proteins (basic concepts): Electrophoresis, Gel filtration Spectrophotometric analysis, Chromatographic analysis. Amino acids: Essential and non-essential amino acids, their structures, deficiency diseases; Acidic and basic amino acids.

Module 3 (8L)

Fats: Sources; Classifications; Fatty acids: Classifications with examples and structure (SAFA, MUFA, PUFA); Omega 3 and Omega 6 fatty acids. Physico-chemical and functional properties; Rancidity: Definition, types of rancidity of fats and oils; Reversion of fats; Antioxidants: Definition, examples, roles; Saponification number, iodine value, Reichert-Meissl number, Polenske value; Lipids of biological importance like cholesterol and phospholipids.

Module 4 (8L)

Minerals and Vitamins: Sources and structures of minerals & vitamins; Effect of processing and storage of vitamins; Provitamins A&D; Vitamins as antioxidants. Food Pigments & Flavouring Agent: Importance, types and sources of pigments (Chlorophyll, Carotenoids, anthocyanin, and flavonoids)− their changes during processing and storages.

Revision: (4L)

Textbooks:

1. Food Chemistry by H. K. Chopra & P. S. Panesar, 2nd reprint 2015
2. Essentials of Food & Nutrition by Swaminathan, Vol. 1 &2, 2nd edition
3. Food Chemistry by L. H. Meyer, reprint 2004

Reference books:

1. Food Science by Norman N. Potter & Joseph H. Hotchkiss, 5th edition
2. Hand Book of Analysis of fruits & vegetables by S. Ranganna Chemical changes in food during processing by Richardson

Course Name: Engineering Physics

Course Code: PH101

Contact (L: T: P): 3 : 0 : 0

Total Contact Hours: 36

Credit: 3

Prerequisites: Knowledge of Physics up to 12th standard.

Course Objectives:

The objective of the course is to make the students able to –

O1: **Provide foundational understanding** of core physical principles such as optics, quantum mechanics, solid-state physics, and statistical mechanics relevant to engineering disciplines.

O2: **Develop the ability** to apply theoretical knowledge of physical sciences in interpreting engineering phenomena and solving problems using scientific reasoning and quantitative analysis.

O3: **Expose students to the working principles** of modern devices and technologies like lasers, fiber optics, semiconductors, and nanomaterials used in engineering and industrial applications.O4: **Encourage scientific curiosity and innovation** by connecting physical theories with practical tools and techniques in emerging fields like nanotechnology and quantum systems.

O5: **Understand the role of physics** in interdisciplinary domains for the advancement of science, technology, and sustainable development through real-life engineering contexts.

Course Outcomes (COs):

After Successful completion of the course, students will be able to

CO1	*Explain* the principles of lasers, fibre optics, and holography and *apply* them in modern optical and communication systems.
CO2	*Identify* different crystal structures and *compute* structural parameters such as Miller indices and packing factors; *distinguish* between metals, semiconductors, and insulators using band theory.
CO3	*Utilize* the principles of quantum theory, wave-particle duality, and Schrödinger equation—to *interpret* fundamental quantum phenomena.
CO4	*Illustrate* the basic concepts of statistical mechanics and e*xamine* their implications on microscopic particle behaviour.
CO5	*Describe* the properties of nanomaterials and display/storage devices and *analyze* their applications in modern technology.

CO-PO Mapping:

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CO1	3	-	-	-	-	-	-	-	2	-	2
CO2	3	3	-	-	-	-	-	-	2	-	2
CO3	3	3	-	-	-	-	-	-	2	-	2
CO4	3	3	-	-	-	-	-	-	2	-	2
CO5	3	3	-	-	-	-	-	-	2	-	2

Course Content:

Module 1: Modern Optics (11L)

1.01- Laser: Concepts of various emission and absorption processes, Einstein A and B coefficients and

equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. 6L

1.02-Fibre Optics-Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L

1.03—Holography: Theory of holography (qualitative analysis), viewing of holography, applications.

2L

Module 2: Solid State Physics (5L)

2.01 Crystal Structure: Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices –Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 3L

2.02 Semiconductor: Physics of semiconductors, electrons and holes, metal, insulator and semiconductor, intrinsic and extrinsic semiconductor, p-n junction. 2L

Module 3: Quantum and Statistical Mechanics (14L)

3.01 Quantum Theory: Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: Black body radiation, Photoelectric and Compton Effect: no derivation required), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment, related numerical problems.

5L

3.02 Quantum Mechanics 1: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions-Qualitative discussion; uncertainty principle, relevant numerical problems, Introduction of Schrödinger wave equation (only statement). 4L

3.03 Statistical Mechanics

Concept of energy levels and energy states, phase space, microstates, macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)-physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero & non-zero temperature, Concept of Fermi level-Qualitative discussion. 5L

Module 4: Physics of Nanomaterials (4L)

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, graphene, electronic, environment, medical).

Module 5: Storage and display devices (2L)

Different storage and display devices-Magnetic storage materials, Operation and application of CRT, CRO, LED and OLED.

Text book:

1. Concepts of Modern Engineering Physics- A. S. Vasudeva. (S. Chand Publishers)
2. Engineering Physics - Rakesh Dogra
3. Introduction to Nanoscience and Nanotechnology, An Indian Adaptation-Charles P. Poole, Jr., Frank J.
Owens.
4. Quantum Mechanics – S. N. Ghosal
5. Nanotechnology – K. K. Chattopadhyay

Reference Books:

1. Optics - Ajay Ghatak (TMH)
2. Solid state Physics - S. O. Pillai

3. Quantum mechanics -A.K. Ghatak and S Lokenathan

4. Fundamental of Statistical Mechanics: B. B. Laud

6. Perspective & Concept of Modern Physics—Arthur Beiser

Course Name: Engineering Mathematics - I

Course Code: M101

Contact (L: T: P): 3 : 0 : 0

Total Contact Hours: 36

Credit: 3

Prerequisites:

The students to whom this course will be offered must have the understanding of (10+2) standard algebraic operations, coordinate geometry, and elementary calculus concepts including limits, continuity, differentiation, and integration.

Course Objective(s):

The objective of the course is to make the students able to –

O1: Develop a strong foundation in both fundamental and advanced concepts of linear algebra and calculus essential for engineering applications.

O2: Build competency in applying integration techniques in multiple dimensions, including line, surface, and volume integrals, to solve problems relevant to engineering and applied sciences.

O3: Gain proficiency in analyzing multivariable functions using differentiation techniques such as partial and total derivatives, Jacobians, and methods for finding extrema.

Course Outcomes (COs):

After Successful completion of the course, students will be able to

CO1	Apply linear algebra methods to perform matrix operations, classify matrix structures, solve systems of linear equations, and compute eigenvalues and eigenvectors in engineering contexts.
CO2	Apply differential and integral calculus to evaluate and approximate the behavior of single-variable and multivariable real-valued functions relevant to engineering scenarios.
CO3	Analyze the properties of eigenvalues and eigenvectors to assess matrix diagonalizability and interpret linear transformations using the Cayley-Hamilton theorem in engineering systems.
CO4	Analyze single-variable and multivariable real-valued functions using differential and integral calculus to model and interpret complex behavior in engineering applications.

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	1	1	-	-	-	-	-	-	2
CO4	3	3	1	1	-	-	-	-	-	-	2
M101	**3**	**2.5**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.5**

Course Content:

Module I: Liner Algebra (11L)

Echelon form and normal (canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors; Diagonalization of matrix, Cayley-Hamilton theorem.

Module II: Single Variable Calculus (5L)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Taylor's series.

Module III: Multivariable Calculus (Differentiation) (13L)

Function of several variables; Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function; Jacobian; Maxima and minima of functions of two variables.

Module IV: Multivariable Calculus (Integration) (7L)

Double Integral, Triple Integral; Change of order in multiple integrals; Line Integral, Surface Integral, Volume Integral. Change of variables in multiple integrals.

Text Books:

1. Higher Engineering Mathematics, Grewal, B.S., Khanna Publishers, 36th Edition, 2010.
2. Advanced Engineering Mathematics, 9th Edition, Kreyszig, E., John Wiley & Sons, 2006.

Reference Books:

1. A text book of Engineering Mathematics-I, Guruprasad, S., New age International Publishers.
2. Higher Engineering Mathematics, Ramana, B.V., Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Engineering Mathematics for first year, Veerarajan, T., Tata McGraw-Hill, New Delhi, 2008.
4. A text book of Engineering Mathematics, Bali, N.P. and Goyal, M., Laxmi Publications, Reprint, 2008.
5. Calculus and Analytic geometry, 9th Edition, Thomas, G.B. and Finney, R.L., Pearson, Reprint, 2002.
6. Calculus, Volumes 1 and 2 (2nd Edition), Apostol, M., Wiley Eastern, 1980.
7. Linear Algebra - A Geometric approach, Kumaresan, S., Prentice Hall of India, 2000.
8. Linear Algebra: A Modern Introduction, 2nd Edition, Poole, D., Brooks/Cole, 2005.
9. Schaum's Outline of Matrix Operations, Bronson, R., 1988.
10. Differential and Integral Calculus, Vol. I & Vol. II, Piskunov, N., Mir Publishers, 1969.

Course Name: Environmental Science

Course Code: HU101

Contact (L: T: P): 2: 0 : 0

Total Contact Hours: 24

Credit: 2

Prerequisites: 10+2

Course Objective (s):

This course will enable the students to,

O1: Realize the importance of environment and its resources.

O2: Apply the fundamental knowledge of science and engineering to assess environmental and health risk.

O3: Know about environmental laws and regulations to develop guidelines and procedures for health and safety issues.

O4: Solve scientific problem-solving related to air, water, land and noise pollution.

Course Outcome (s):

CO1	Able to understand the natural environment and its relationships with human activities
CO2	The ability to apply the fundamental knowledge of science and engineering to assess environmental and health risk
CO3	Ability to understand environmental laws and regulations to develop guidelines and procedures for health and safety issues
CO4	Acquire skills for scientific problem-solving related to air, water, noise & land pollution

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3	-	-	2	3	1	-	-	1
CO2	3	3	3	1	1	2	3	1	-	-	1
CO3	3	3	3	2	1	2	3	1	-	-	1
CO4	1	3	3	-	-	2	1	1	-	-	1
CO5	1	3	3	-	-	2	1	1	-	-	1

Course Content:

Module I - Resources and Ecosystem (6L)

1. Resources (4L)

Types of resources, Human resource, Population Growth models: Exponential Growth, Logistic growth curve with explanation. Maximum Sustainable Yield [Derivation]Alternative sources of Energy [Solar energy, tidal energy, geothermal energy, biomass energy]

2. Ecosystem (2L)

Components of ecosystem, types of ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Pond eco system, Food chain, Food web.

Module II – Environmental Degradation (10L)

1. Air Pollution and its impact on Environment (3L)

Air Pollutants, primary & secondary pollutants, Criteria pollutants, Smog, Photochemical smog and London smog, Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion.

2. Water Pollution and its impact on Environment (4L)

Water Pollutants, Oxygen demanding wastes, heavy metals, BOD [Rate equation], COD, Eutrophication, Hardness, Alkalinity, TDS and Chloride, Heavy metal (As, Hg, Pb) poisoning and toxicity. Numerical on BOD, Hardness.

3. Land Pollution and its impact on Environment (1L)

Solid wastes, types of Solid Waste, Municipal Solid wastes, hazardous wastes, bio-medical wastes, E-wastes,

4. Noise Pollution and its impact on Environment (2L)

Types of noise, Noise frequency, Noise pressure, Measurement of noise level and decibel (dB) Noise intensity, Noise Threshold limit, Effect of noise pollution on human health. Numerical on Measurement of noise level and decibel (dB) and Noise Threshold limit.

Module III – Environmental Management (6L)

1. Environmental Impact Assessment (1L)

Environmental Auditing, Environmental laws and Protection Acts of India, carbon footprint, Green building practices. *(GRIHA norms)*

2. Pollution Control and Treatment (2L)

Air Pollution controlling devices, Catalytic Converter, Electrostatic Precipitator. WasteWater Treatment (Surface water treatment &Activated sludge process), Removal of hardness of water (Temporary &Permanent -Permutit process).

3. Waste Management (3L)

Solid waste management, Open dumping, Land filling, incineration, composting & Vermicomposting, E-waste management, and Biomedical Waste management.

Module IV – Disaster Management (2L)

1. Study of some important disasters (1L)

Natural and Man-made disasters, earthquakes, floods drought, landslide, cyclones, volcanic eruptions, tsunami, oil spills, forest fires.

2. Disaster Management Techniques (1L)

Basic principles of disaster management, Disaster Management cycle, Disaster management policy, Awareness generation program

Text Books:

1. Basic Environmental Engineering and Elementary Biology (For MAKAUT),

Gourkrishna Dasmohapatra, Vikas Publishing.

2. Basic Environmental Engineering and Elementary Biology, Dr. Monindra Nath Patra & Rahul Kumar Singha, Aryan Publishing House.

3. Textbook of Environmental Studies for Undergraduate Courses, Erach Barucha for UGC, Universities Press

Reference Books:

1. A Text Book of Environmental Studies, Dr. D.K. Asthana & Dr. Meera Asthana, S.Chand Publications.

2. Environmental Science (As per NEP 2020), Subrat Roy, Khanna Publisher

Course Name: Indian Knowledge System

Course Code: HU102

Contact (L: T: P): 1: 0 : 0

Total Contact Hours: 12

Credit: 1

Course Objectives:

The objective of this course is to make the students able to—

O1: understand the extent and aspects of ancient Indian cultural, philosophical and scientific heritage.

O2: explore the philosophical roots of Indian knowledge, the scientific temper and quest for advanced understanding of the universe and deeper knowledge of the self.

O3: identify and describe the Indian scientific and technological tools, techniques and discoveries and assess their significance and continuing relevance.

O4: develop a liberality and open-mindedness of outlook to foster lifelong learning.

O5: acquire the skills to apply traditional knowledge in their everyday lives.

Course outcome: After successful completion of the course, students will be able to

CO1	define, identify, describe and classify the philosophical, literary and socio-religious heritage of ancient India and the core concepts of the Vedic corpus and way of life.
CO 2	discover, enumerate, compare, contrast and categorize the importance of pioneering developments in science and mathematics and evaluate their continuing relevance.
CO 3	analyze, appraise, correlate and describe the ancient Indian heritage in science and technology and examine technological correlations with present-day technological applications.
CO4	discover, assess and describe traditional knowledge in health care, architecture, agriculture and other sectors and to explore the history of traditional Indian art forms.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	1	2	-	3	-	3
CO2	2	-	1	-	-	2	-	-	3	-	3
CO3	3	1	1	1	2	3	-	-	3	-	3
CO4	2	-	1	-	2	3	-	-	3	-	3

Course Content:

Module-1 An overview of Indian Knowledge System (IKS): (3L)

Importance of Ancient Knowledge - Definition of IKS - Classification framework of IKS - Unique aspects of IKS.

The Vedic corpus: Vedas and Vedangas - Distinctive features of Vedic life.

Indian philosophical systems: Different schools of philosophy (Orthodox and Unorthodox).

Module-2 Salient features of the Indian numeral system: (3L)

Developments in Indian Mathematics in ancient India - Importance of decimal representation - The discovery of zero and its importance - Unique approaches to represent numbers- Contribution of ancient Indian mathematicians

Highlights of Indian Astronomy: Historical development of astronomy in India- key contributions of ancient Indian astronomers.

Module-3 Indian science and technology heritage: (3L)

Metals and metalworking - Mining and ore extraction –Structural engineering and architecture in ancient India: planning, materials, construction and approaches- Dyes and painting; Shipbuilding.

Module-4 Traditional Knowledge in Different Sectors: (3L)

Traditional knowledge and engineering. Traditional Agricultural practices (resources, methods, technical aids); Traditional Medicine and Surgery; History of traditional Art forms and Culture.

Text Books:

1. Amit Jha . *Traditional Knowledge System in India*. New Delhi: Atlantic Publishers, 2024.

2. B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana . *Introduction to Indian Knowledge System: Concepts and Applications*. New Delhi: PHI, 2022.

3. Angad Godbole. *Science and Technology in Ancient India*. New Delhi: Biblia Implex, 2023.

4. Pritilakshmi Swain. *Indian Knowledge System*. New Delhi: Redshine Publication, 2024.

5. Vishnudut Purohit. *Fundamentals of Indian Knowledge System*. New Delhi: ABD Publishers, 2024.

Reference Books:

1. A. L. Basham. *The Wonder that was India*. Vol. I. New Delhi: Picador, 2019.

2. Arun Kumar Jha and Seema Sahay ed. *Aspects of Science and Technology in Ancient India.* Oxford and New Delhi: Taylor and Francis, 2023.

3.Kapil Kapoor and Awadhesh Kumar Singh. *Indian Knowledge Systems*. Vols. 1 and 2. New Delhi: D. K. Printworld, 2005.

4. S. N. Sen and K. S. Shukla, *History of Astronomy in India*. New Delhi: Indian National Science Academy, 2nd edition, 2000.

5. Arpit Srivastava. *Indian Knowledge System*. Rewa: AKS University, 2024.

Course Name: Chemistry of Food Lab I

Course Code: FT191

Contact (L: T: P): 0 : 0 : 3

Credit: 1.5

Pre requisites: Engineering Chemistry

Course Objective:

The objective of the course is to make the students able to –

O1: Define food chemistry as the study of the composition, structure, and properties of food materials.

O2: Identify suitable methods and instruments used in the study of food chemistry for quality assessment.

O3: Prioritize and apply different quality-controlling parameters to improve shelf-life and prevent food adulteration.

Course Outcomes:

CO1	**Apply** standard analytical techniques to determine proximate composition (moisture, protein, ash, fat) in various food samples.
CO2	**Employ** instrumental and classical methods to assess quality parameters in milk and other beverages, including fat content, pH, and acidity.
CO3	**Analyze** food samples for nutritional components such as sugars and Vitamin C using appropriate chemical analysis techniques.
CO4	**Create** an innovative experiment related to food analysis, integrating scientific reasoning and practical skills.

CO-PO-PSO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	–	–	2	2	2	1	3	2	3	2	2
CO2	3	2	2	1	–	3	2	1	2	3	2	3	3	2
CO3	3	2	2	2	2	2	2	2	2	3	1	3	3	2
CO4	3	3	2	2	1	–	–	–	–	2	2	3	3	3

List of Experiment:

1. Determination of Moisture in food sample
2. Determination of Protein in food sample
3. Determination of Ash in food sample
4. Determination of Crude Fat in food sample by Soxhlet apparatus.
5. Determination of fat present in liquid milk by Gerber centrifuge.
6. Determination of Acidity and pH in food sample/beverages
7. Determination of total, non-reducing and reducing sugars in food sample
8. Determination of Vitamin C in food sample
9. Innovative experiment

Text books:

1. Essentials of Food & Nutrition by Swaminathan, Vol. 1 &2, 2nd edition
2. Food Chemistry by L. H. Meyer, reprint 2004, 2nd reprint 2015

Reference books:

1. Food Science by Norman N. Potter & Joseph H. Hotchkiss, 5th edition
2. Food Chemistry by H. K. Chopra & P. S. Panesar,
3. Hand Book of Analysis of fruits & vegetables by S. Ranganna
4. Chemical changes in food during processing by Richardson

Course Name: Engineering Physics Lab

Course Code: PH191

Contact (L: T: P): 0 : 0 : 3

Credit: 1.5

Prerequisites: Knowledge of Physics up to 12th standard.

Course Objective(s):

The objective of the course is to make the students able to –

O1: **Become familiar with scientific instruments and measurement techniques** used to determine various physical parameters of materials and systems.

O2: **Reinforce theoretical concepts learned in classroom physics** by performing related practical experiments and observing real-time outcomes.

O3: **Develop a systematic and analytical approach** to collecting, organizing, and interpreting experimental data for error analysis and validation of physical laws.

O4: **Engage in the experimental validation of physical laws** through laboratory activities involving classical mechanics, optics, electronics, and quantum phenomena.

O5: **Encourage innovation and problem-solving abilities** through hands-on investigation of advanced and application-oriented physics experiments, including specially designed extension activities.

Course Outcomes (COs):

After Successful completion of the course, students will be able to

CO1	*Determine* mechanical properties such as Young's modulus and rigidity modulus through hands-on experiments and *analyze* material behaviour under applied forces.
CO2	*Perform* optical experiments including Newton's Rings, laser diffraction, and optical fiber characterization, and *interpret* the results based on wave optics principles.
CO3	*Investigate* quantum effects such as the photoelectric effect and atomic transitions, and *relate* experimental outcomes to basic quantum principles.
CO4	*Study* the performance of semiconductor and electronic devices like solar cells, LEDs, and LCR circuits, and *investigate* their operational characteristics.
CO5	*Conduct* experiments such as Hall Effect, e/m determination, prism dispersion, or optical rotation to *demonstrate* the application of advanced physical principles in practical scenarios.

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO10	PO11
CO 1	3	3	-	-	-	-	-	3	2	-	2
CO 2	3	3	-	-	3	-	-	3	2	-	2
CO 3	3		-	-	3	-	-	3	2	-	2
CO 4	3	3	-	-	3	-	-	3	2	-	2
CO 5	3	3	-	-	3	-	-	3	2	-	2

Course Content:

Module 1: General idea about Measurements and Errors (One Mandatory)

a) Error estimation using Slide callipers/ Screw-gauge/travelling microscope for one experiment.

Module 2: Experiments on Classical Physics (Any 4 to be performed from the following experiments)

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of Young's moduli of different materials.
3. Determination of Rigidity moduli of different materials.
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Laser diffraction method.
6. Optical Fibre-numerical aperture, power loss.

Module 3: Experiments on Quantum Physics (Any 2 to be performed from the following experiments)

7. Determination of Planck's constant using photoelectric cell.
8. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
9. Determination of Stefan's Constant.
10.

a) Study of characteristics of solar cell (illumination, areal, spectral)

b) Study of characteristics of solar cell (I-V characteristics, Power-load characteristics, Power-wavelength characteristics)

Module 4: Perform at least one of the following experiments

11. Determination of Q factor using LCR Circuit.
12. Study of I-V characteristics of a LED/LDR.
13. Determination of band gap of a semiconductor.

**In addition, it is recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

Module 5: Probable experiments beyond the syllabus

1. Determination of the specific charge of the electron (e/m) from the path of an electron beam by Thomson method.
2. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor3. Study of dispersive power of material of a prism.
3. Determination of thermal conductivity of a bad/good conductor using Lees-Charlton / Searle apparatus.
4. Determination of the angle of optical rotation of a polar solution using polarimeter.
5. Any other experiment related to the theory.

Text book:

1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing) 3. Practical Physics by R. K. Kar (Book & Allied Publisher)

Course Name: Engineering Graphics & Computer Aided Design Lab

Course Code: ME194

Contact (L: T: P): 0 : 0 : 3

Credit: 1.5

Prerequisites: Basic knowledge of geometry

Course objectives:

The objective of the course is to teach detailed engineering drawing and modeling of a component or system for a given dimension or constraints through ample understanding of engineering views, projections and sections. It will help students to acquire the manual drawing techniques as well as computer aided graphics skills, using modern engineering tools to communicate their design effectively in industries.

Course Outcomes: Upon successful completion of this course, the student will be able to:

CO1	Use common drafting tools with the knowledge of drafting standards
CO2	Understand the concepts of engineering scales, projections, sections.
CO3	Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints
CO4	Produce part models; carry out assembly operation and represent a design project work.

CO-PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	-	-	3	-	2	1	-	2	-	1	-
CO2	-	-	3	-	2	1	-	2	-	1	-
CO3	-	-	3	-	3	1	-	2	-	2	-
CO4	-	-	3	-	3	1	-	2	-	2	-

Course Contents:

Basic Engineering Graphics: **3P**

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Module 1: Introduction to Engineering Drawing **6P**

Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2: Orthographic & Isometric Projections **6P**

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice- versa.

Module 3: Sections and Sectional Views of Right Angular Solids **6P**

Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

Computer Graphics: **3P**

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module 4: Overview of Computer Graphics **3P**

Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module 5: CAD Drawing, Customization, Annotations, layering 6P

Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerance; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

Module 6: Demonstration of a simple team design project 3P

Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

Reference Books:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

Course Name: Communication & Presentation Skill

Course Code: HU191

Contact (L: T: P): 0 : 0 : 3

Credit: 1.5

Pre requisites: Basic knowledge of LSRW skills.

Course Objectives: The objectives of the course are to make the students able to-

O1: acquire interpersonal communication skills of listening comprehension and speaking in academic and professional situations.

O2: understand English pronunciation basics and remedy errors.

O3:operate with ease in reading and writing interface in global professional contexts.

O4:deliver professional presentations before a global audience.

O5:develop confidence as a competent communicator.

Course Outcome:

After successful completion of the course, the students will be able to:

CO1	Recognize, identify and express advanced skills of Technical Communication in English and Soft Skills through Language Laboratory.
CO2	Understand, categorize, differentiate and infer listening, speaking, reading and writing skills in societal and professional life.
CO3	Analyze, compare and adapt the skills necessary to be a competent interpersonal communicator in academic and global business environments.
CO4	Deconstruct, appraise and critique professional writing documents, models and templates.
CO5	Adapt, negotiate, facilitate and collaborate with communicative competence in presentations and work-specific conclaves and interactions in the professional context.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	-	1	2	3	-
CO2	-	2	-	-	-	2	-	-	-	3	-
CO3	-	-	-	-	-	2	-	-	3	3	-
CO4	-	2	-	-	-	-	-	3	-	3	-
CO5	-	-	-	-	-	3	-	-	3	3	-

Course Contents:

Module 1: Introduction Theories of Communication and Soft Skills

a. Communication and the Cyclic Process of Communication (Theory, benefits and application)

b. Introduction to Workplace Communication (Principles and Practice)

c. Non-Verbal communication and its application

c. Soft Skills Introduction: Soft-Skills Introduction

What is Soft Skills? Significance of Soft-Skills

Soft-Skills Vs. Hard Skills

Components of Soft Skills

Identifying and Exhibiting Soft-Skills (Through classroom activity)

Module 2: Active Listening

a. What is Active Listening?

b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking

c. Differences between Listening and Hearing, Critical Listening, Barriers to Active Listening, Improving Listening.

d. Listening in Business Telephony and Practice

Practical (Role plays, case studies)

Module 3: Speaking Skills

a. Effective Public Speaking: Public Speaking, Selecting the topic for public speaking, (Understanding the audience, Organizing the main ideas, Language and Style choice in the speech, delivering the speech, Voice Clarity). Practical (Extempore)

Self Learning Topics: Preparation, Attire, Posture and Delivery techniques

b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation

c. Fluency-focused activities—JAM, Conversational Role Plays, Speaking using Picture/Audio

Visual inputs

d. Group Discussion: Principles, Do’s and Don’ts and Practice;

Module 4: Writing and Reading Comprehension

a. Reading and Writing a Book Review (classroom activity)

b. Writing a Film Review after watching a short film (classroom activity)

c. Reading Strategies: active reading, note-taking, summarizing, and using visual aids like diagrams and graphs

d. Solving Company-Specific Verbal Aptitude papers.(Synonyms, Antonyms, Error Correction and RC Passages)

Module 5: Presentation Skills

Kinds of Presentation. Presentation techniques, planning the presentation,

Structure of presentation: Preparation, Evidence and Research, Delivering the presentation, handling questions, Time management, Visual aids.

- Self Introduction, Creation of Video Resume`
- Need for expertise in oral presentation.
- Assignment on Oral presentation.
- Rules of making micro presentation (power point). Assignment on micro presentation

Text Books:

1. Pushp Lata and Sanjay Kumar. *A Handbook of Group Discussions and Job Interviews*. New Delhi: PHI, 2009.

2. Jo Billingham. *Giving Presentations*. New Delhi: Oxford University Press, 2003.

3. B. Jean Naterop and Rod Revell. *Telephoning in English*. 3rd ed. Cambridge: Cambridge University Press, 2004.

4. Jeyaraj John Sekar. *English Pronunciation Skills: Theory and Praxis*. New Delhi: Authorspress, 2025.

5. Career Launcher. *IELTS Reading: A Step-by-Step Guide*. G. K. Publications. 2028

Reference Books:

1. Ann Baker. *Ship or Sheep? An Intermediate Pronunciation Course*. Cambridge: Cambridge University Press, 2006.

2. Barry Cusack and Sam McCarter. *Improve Your IELTS: Listening and Speaking Skills.* London: Macmillan, 2007.

3. Eric H. Glendinning and Beverly Holmström. *Study Reading.* Cambridge: Cambridge University Press, 2004.

4.Malcolm Goodale. *Professional Presentations*. New Delhi: Cambridge University Press, 2005.

5. Mark Hancock. *English Pronunciation in Use*. Cambridge: Cambridge University Press, 2003.

6. Tony Lynch, *Study Listening*. Cambridge: Cambridge University Press, 2004.

7. J. D. O'Connor. *Better English Pronunciation*. Cambridge: Cambridge University Press, 2005.

8. Peter Roach. *English Phonetics and Phonology: A Practical Course*. Cambridge: Cambridge University Press, 2000.

1st Year 2nd Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT201	Food Microbiology	3	0	0	3	3
2	ENGG	Major	FT202	Biochemistry and Nutrition	3	0	0	3	3
3	ENGG	Minor	CS202	Introduction to Artificial Intelligence	2	0	0	2	2
4	SCI	Multidisciplinary	CH201	Engineering Chemistry	2	0	0	2	2
5	SCI	Multidisciplinary	M201	Engineering Mathematics –II	3	0	0	3	3
6	HUM	Value Added Course	HU205	Constitution of India & Professional Ethics	1	0	0	1	1
7	HUM	Ability Enhancement Course	HU203	Design Thinking & Innovation	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	FT291	Food Microbiology lab	0	0	3	3	1.5
2.	ENGG	Major	FT292	Biochemistry and Nutrition Lab	0	0	3	3	1.5
3	SCI	Skill Enhancement Course	CH291	Engineering Chemistry Lab	0	0	2	2	1
4	ENGG	Skill Enhancement Course	ME293	IDEA LAB Workshop	0	0	3	3	1.5
5	ENGG	Minor	CS292	Introduction to Artificial Intelligence Lab	0	0	3	3	1.5
C. MANDATORY ACTIVITIES / COURSES									
1	MC	Mandatory Course	MC281	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0	0
Total of Theory, Practical								**29**	**22**
Total Credit in 1st year									**40**

Course Name: Food Microbiology

Course Code: FT201

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre-requisites: Biology, Life Science

Course Objective:

The objective of the course is to make the students able -

O1: To familiarize students with procedures and techniques used to detect and enumerate microorganisms in foods.

O2: To develop an understanding of spoilage microorganisms and their effects on food.

O3: To integrate their basic knowledge of microbiology, chemistry, biochemistry, food processing.

Course outcome(s):

After the completion of the course, students will be able to:

CO1	Understand different types of microorganisms that are present in the environment with special reference to food.
CO2	Describe the internal and external factors and predict the growth of microorganisms, which can cause food spoilage.
CO3	Interpret the microbiology of various food materials and causes of foodborne diseases and their etiology.
CO4	Evaluate the measures required to control undesired microorganisms in food based on the knowledge about disinfection and disinfectants.

CO-PO-PSO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	-	-	2	-	-	1	3	3	3	3
CO2	3	2	2	2	2	1	-	2	-	-	3	3	3	2
CO3	3	2	3	3	2	2	2	1	-	1	3	3	2	1
CO4	2	2	3	3	-	1	-	-	2	1	3	3	2	3

Course Contents:

Module 1 (8L)

Introduction – definition, significance of food microbiology; Microscope; Classification & morphology of microbes, including pathogens and non-pathogens; Techniques of pure culture; Bacterial growth kinetics; Bacteriology of water, Microbial toxins, Biofilm formation.

Module 2 (8L)

Antimicrobial agents –physical & chemical–mechanism & action, Disinfection & disinfectants; Thermal inactivation of microbes; Concept, determination & importance of TDT, F, Z & D values; Factors affecting heat resistance; Control of biofilm; Pasteurization and sterilization.

Module 3 (8L)

Microbiology of milk & milk products like cheese, butter, Yoghurt; Prebiotics and probiotics, Probiotics in immunity and gut health, Concept of fermentation, bioconversion using microbes.

Module 4 (8L)

Basic microbiology and spoilage of meat, fish, poultry; Microbiology of fruits & vegetables and products like jam, jelly, juice; Microbiology of cereal and cereal products like bread, biscuits, confectionery.

Revision (4L)

Text Book:

1. Essentials of Microbiology; K. S. Bilgrami; CBS Publishers, Delhi, First Edition, 2019
2. Food Microbiology; WC Frazier; Tata McGraw Hill, Delhi, 5th Edition, 2017

Reference books:

1. Modern Food Microbiology; James M Jay; CBS Publishers, Delhi, 7th ed. 2004. Corr. 2nd printing2006
2. Microbiology; Pelczar, Chan and Krieg; Tata McGraw Hill, Delhi, 5th Edition, 2002
3. Food Microbiology; M. R.Adams , 2nd Edition, 2002
4. Hand Book of Microbiology; Bisen, 3rd Edition, 2003

Course Name: Biochemistry and Nutrition

Course Code: FT202

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre-requisites: Biology, Chemistry

Course Objective:

The objective of the course is to make the students able-

O1: To introduce the students to the biological basis of nutrition and biomolecules

O2: To understand the mechanisms by which diet can influence health

O3: To develop laboratory skills required for modern biochemical and molecular studies of nutrition.

Course outcome(s):

After the completion of the course, students will be able to:

CO1	Understand the principles of biochemical processes and methods and be able to use them with appropriate application.
CO2	Describe the major metabolic pathways involved in the metabolism of nutrients in the human body.
CO3	Interpret the basis of reactivity of biologically relevant molecules and their interactions.
CO4	Evaluate the data for different biochemical and nutritional experimental procedures.

CO-PO-PSO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	2	-	-	-	3	3	3	3
CO2	3	3	2	2	2	1	-	2	-	-	3	3	3	2
CO3	3	3	3	3	2	2	2	1	-	1	3	3	3	1
CO4	2	3	3	3	-	-	-	-	2	1	3	3	2	3

Course Contents:

Module 1 (8L)

Introduction to Biochemistry: Amino acids, Protein synthesis and protein structures; Trans amination; Metabolism of proteins (digestion and absorption); Nitrogen balance and nitrogen pool; Evaluation of quality of proteins: BV, PER, NPU, Chemical Score.

Module 2 (8L)

Enzymes; Definition, function, classification, nomenclature & structure; Co- enzymes and its function; Mechanism of enzyme action: Single, bi and multi substrate reactions; Lock and Key model, Induced fit model; Enzyme kinetics: MME, Significance of MM Constant, MME and Allosteric enzyme kintics; Enzyme inhibition: Reversible and Irreversible; LB Plot, Feedback inhibition, Substrate acts as inhibitor, Turn over number.

Module 3 (10L)

Carbohydrates; Photosynthetic pathway to produce glucose, Metabolic pathways for breakdown of carbohydrates: glycolytic pathway and its importance, energy yield; pentose phosphate pathway and its importance, energy yield; citric acid cycle and its importance, energy yield; Gluconeogenesis; Pathway, importance, energy yield, Cori cycle; Electron transport chain: Pathway, importance, Energy yield, Oxidative phosphorylation, ATP balance. Essential fatty acids, Metabolism of ketone bodies, alpha, beta and omega oxidation of fatty acids; Digestion & absorption of lipids.

Module 4 (6L)

Vitamins & minerals: Physiological function of vitamins and minerals. Introduction to human nutrition; Nutritive values of foods; Basal metabolic rate; Techniques for assessment of human nutrition, gastrointestinal absorption of nutrition, Dietary requirements and deficiency diseases of different nutrients, micronutrients, importance of nutraceuticals with some case studies.

Revision (4L)

Textbooks:

1. Lehninger, Nelson & Cox, Principle of Biochemistry, CBS Publication
2. Modern Experimental Biochemistry, Boyer, Pearson Education
3. Lubert stryer, Biochemistry, Freeman & Co, N.Y.

Reference books:

1. Voet & Voet, Fundamentals of Biochemistry, Jonh Willey &Sons
2. Instant Notes in Biochemistry by D. Hames & N. Hooper
3. Biochemistry by Debojyoti Das
4. Textbook of Biochemistry by E. S. West & W. R. Tod

Course Name: Introduction to Artificial Intelligence

Course Code: CS202

Contact: 2:0:0

Total Contact Hours: 24

Credit: 2

Course Objectives:

The objectives of this course are to enable students to

O1: Comprehend the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context.

O2: Formulate a problem as State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.

O3: Use the strategies of AI-Heuristics to find acceptable solutions avoiding brute-force techniques.

O4: Design AI-Frameworks for Inferencing based on knowledge base.

O5: Analyze the effectiveness of AI-Inferencing Model in offering solutions to the respective problem.

Course Outcomes (COs):

After successful completion of this course, students will be able to:

CO1	Understand and explain the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	Identify and formulate an engineering problem primarily to fit a State-Space Exploration Framework or an Inferencing Model/Agent Design Framework within the scope of Artificial Intelligence paradigm.
CO3	Explore relevant literature and apply the concept of Heuristic Techniques of Artificial Intelligence to solve problems.
CO4	Develop Inferencing Models for proposing solutions to the problems of Artificial Intelligence.
CO5	Implement Inferencing Models of Artificial Intelligence through developing feasible algorithms and investigate their effectiveness by analyzing their performances in solving the relevant problems.

CO-PO Mapping:

COs	Program Outcomes (PO)										
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	2
CO5	2	2	3	3	2	-	-	-	-	-	2

Course Contents:

Module 1: Introduction to Artificial Intelligence (3 Lectures)

Why AI • Definition of AI • Goals of AI • History and evolution of AI • Types of AI: Narrow, General, Super • Human vs Artificial Intelligence • Applications of AI in various domains • AI for social good

Module 2: Intelligent Agents and Logic-Based Thinking (8 Lectures)

Intelligent systems • Agents and environments • Decision making using rules and logic • Symbolic AI concepts • Propositional Logic: Knowledge Representation and Inference using Propositional Logic • Predicate Logic: Knowledge Representation, Inference and Answer Extraction using First Order Predicate Logic

Module 3: Overview of AI Branches and Perception (8 Lectures)

Machine learning • Deep learning • Natural language processing • Computer vision • Expert systems • Fuzzy logic • Evolutionary algorithms • Reinforcement learning • Planning and scheduling • Human-AI collaboration

Module 4: Basics of Machine Learning (6 Lectures)

What is machine learning • AI vs ML • Types of learning: supervised, unsupervised • Concept of dataset, features, and labels • ML model and prediction flow • Common ML applications

• Introduction to decision trees (concept only) • ML pipeline overview.

Module 5: Applications and Ethics of AI (5 Lectures)

AI in robotics and automation • AI-enabled smart applications • Industry 4.0 and intelligent systems • AI in different sectors: healthcare, agriculture, transport, education, etc. • Human-AI teamwork • Basics of AI ethics: bias, fairness, privacy • Career opportunities and future scopes in AI.

Textbook:

1. Saptarsi Goswami , Amit Kumar Das , Amlan Chakrabarti - AI for Everyone: A Beginner's Handbook for Artificial Intelligence (AI), Pearson.
2. Rich, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.
3. Russell , S. and Norvig , P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice
Hall.

Reference Books:

1. Reema Thareja, Artificial Intelligence: Beyond Classical AI, Pearson.
2. Patterson , Introduction to Artificial Intelligence and Expert Systems, Pearson.

Course Name: Engineering Chemistry

Course Code: CH201

Contact: 2:0:0

Total Contact Hours: 24

Credit: 2

Course Objective

O1: Understand the basic principles of atomic structures and periodic properties of elements, different engineering materials, advanced polymers.

O2: Apply the knowledge of free energy, energy storage device and semiconductors to design environment friendly and sustainable devices.

O3: Apply the concept of corrosion and fuel to improve its efficacy and application for industrial purpose.

O4: Analyze the organic reaction with the structure of organic molecules by applying the knowledge of different spectroscopic techniques.

O5: Evaluate the electrical, optical, and structural properties of semiconductors to analyze their potential applications in modern electronic and energy devices

Course Outcome

After successful completion of this course, students will be

CO1	Able to understand the basic principles of atomic structures and periodic properties of elements, different engineering materials, advanced polymers.
CO2	Able to apply the knowledge of free energy, energy storage device and semiconductors to design environment friendly and sustainable devices.
CO3	Able to apply the concept of corrosion and fuel to improve its efficacy and application for industrial purpose.
CO4	Able to analyze the organic reaction with the structure of organic molecules by applying the knowledge of different spectroscopic techniques.
CO5	Able to evaluate the electrical, optical, and structural properties of semiconductors to analyze their potential applications in modern electronic and energy devices.

CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	2	-	2
CO3	3	-	-	-	-	-	-	-	2	-	2
CO4	3	3	-	-	-	-	-	-	2	-	2
CO5	3	3	3	-	-	-	-	-	2	-	2

Course Content

Module 1

Quantum Properties of Atoms (4 L)

Schrodinger Wave Equation (time independent – basic principles only), de Broglie Equation, Heisenberg Uncertainty Principle, Quantum Numbers, Effective nuclear charge, Slater's rule, penetration of orbitals, variations of orbital energies in the periodic table, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, oxidation properties.

Chemistry of materials (2L)

Semiconductor-Based Memory Materials (Si & Ge) [Introduction, Properties and role of Si & Ge), Intensive & Extensive semiconductor,

Module II

Chemical Thermodynamics (5L)

1st & 2nd Law of Thermodynamics, Tendency for maximum randomness, Carnot Heat Engine [Derivation], Entropy characteristics, Mathematical explanation & physical significance of Entropy, Entropy change of ideal gas for isothermal reversible process, Gibbs free Energy Function, Standard free Energy, Criterion of spontaneity.

Electricity production through chemical reactions (2L)

Electrochemical Cell, writing of cell notation, free energy and EMF, Criterion of spontaneity in terms of Cell. Nernst equation (only expression, no derivation) and applications, calculation of EMF of a cell, calculation of single electrode potential, calculation of Kc, calculation of Kc from G0.

Working principle and applications of Lithium-ion batteries

Module III

Polymers for Engineering Applications (3L)

Polymers and their classifications (based on origin, chemical structure, polymeric structure, tacticity and molecular forces)

Commercially important polymers: Synthesis and applications of Bakelite, nylon 6,6, HDPE & LDPE

Conducting polymers –Types examples and applications.

Biodegradable polymers –definition, example and uses

Industrial Chemistry (3L)

Types of corrosion, Electrochemical theory of corrosion, rusting of iron, comparison of chemical & electrochemical corrosion. [Mechanism excluded]

Factors affecting the rate of corrosion; nature of metal (physical state, purity, position in Galvanic series) & environment.

Corrosion control: Cathodic protection, anodic protection, Inorganic coatings.

Classification of Fuel (LPG, CNG, BIOGAS), Calorific value, Octane number, Cetane number, HCV, LCV. [Definition only]

Module IV

Organic Reactions & synthesis of drugs (3L)

Acidity and basicity comparison of organic compounds(acids, alcohols & amines), Nucleophilic Substitution reaction and Electrophilic Addition reactions, Markonikov's rule, peroxide effect, Synthesis of Paracetamol & Aspirin and uses.(Name reactions are not in syllabus)

Spectroscopy (2L)

Electromagnetic spectrum, Lambert-Beer Law, Finding of λ max value & concentration of the unknown solution, Applications of UV-VIS spectroscopy, Chromophores & Auxochromes. Applications of IR spectroscopy, Fingerprint region

Text Books:

1. Chemistry –I, Gourkrishna Das Mohapatro
2. A text book of Engineering Chemistry, Dr. Rajshree Khare
3. Engineering Chemistry, U. N. Dhar
4. Physical Chemistry, P.C. Rakshit

Reference Books

1. Engineering Chemistry, Jain & Jain
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishna
3. Text book of Engineering Chemistry, Jaya Shree Ani reddy

Course Name: Engineering Mathematics –II

Course Code: M201

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites:

The students to whom this course will be offered must have the understanding of (10+2) standard algebraic operations, coordinate geometry, and elementary calculus concepts including limits, continuity, differentiation, and integration.

Course Objective(s):

The objective of the course is to make the students able to –

O1: Develop a thorough understanding of ordinary differential equations and their role in modeling real-world systems.

O2: Build competency in applying the Laplace transform as a tool for solving initial value problems and linear differential equations in engineering contexts.

O3: Gain proficiency in numerical techniques for solving mathematical problems where analytical methods are difficult or impossible.

Course Outcomes (COs):

After Successful completion of the course, students will be able to

CO1	Apply analytical methods to solve ordinary differential equations in engineering contexts.
CO2	Apply the properties and inverse of Laplace Transforms to compute improper integrals and determine solutions of linear ordinary differential equations with constant coefficients in engineering scenarios.
CO3	Apply numerical methods to interpolate data, perform numerical integration, and solve ordinary differential equations in engineering applications.
CO4	Analyze the behavior of solutions using analytical and numerical approaches, including Laplace transforms, to assess stability, convergence, and accuracy in engineering contexts.

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	1
CO3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	1	1	-	-	-	-	-	-	2
M201	**3**	**2.25**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.25**

Course Content:

Module I: First Order Ordinary Differential Equations (ODE) (9L)

Solution of first order and first degree ODE: Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation.

Solution of first order and higher degree ODE: solvable for$p$, solvable for y and solvable for $x$and Clairaut's equation.

Module II: Second Order Ordinary Differential Equations (ODE) (8L)

Solution of second order ODE with constant coefficients: Complementary Function and Particular Integral, Method of variation of parameters, Cauchy-Euler equations.

Module III: Laplace Transform (LT) (12L)

Concept of improper integrals; Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $tf(t)$, LT of $\frac{f(t)}{t}$, LT of derivatives of $f(t)$, LT of integral of $f(t)$, Evaluation of improperintegrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties,Convolution theorem (statement only) and its application to the evaluation of inverse LT, Solution oflinear ODE with constant coefficients (initial value problem) using LT.

Module IV: Numerical Methods (7L)

Introduction to error analysis, Calculus of finite difference. **Interpolation:** Newton forward and backward interpolation, Lagrange's interpolation. **Numerical integration:** Trapezoidal rule, Simpson's 1/3 Rule. **Numerical solution of ordinary differential equation:** Euler method, Fourth order Runge-Kutta method.

Text Books:

1. Higher Engineering Mathematics, Grewal, B.S., Khanna Publishers, 36th Edition, 2010.
2. Advanced Engineering Mathematics, 9th Edition, Kreyszig, E., John Wiley & Sons, 2006.

Reference Books:

1. A text book of Engineering Mathematics-I, Guruprasad, S. New age International Publishers.
2. Higher Engineering Mathematics, Ramana, B.V., Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Engineering Mathematics for first year, Veerarajan, T., Tata McGraw-Hill, New Delhi, 2008.
4. A text book of Engineering Mathematics, Bali, N.P. and Goyal, M., Laxmi Publications, Reprint, 2008.
5. Calculus and Analytic geometry, 9th Edition, Thomas, G.B. and Finney, R.L., Pearson, Reprint, 2002.
6. Calculus, Volumes 1 and 2 (2nd Edition), Apostol, M., Wiley Eastern, 1980.
7. Linear Algebra - A Geometric approach, Kumaresan, S., Prentice Hall of India, 2000.
8. Linear Algebra: A Modern Introduction, 2nd Edition, Poole, D., Brooks/Cole, 2005.
9. Schaum's Outline of Matrix Operations, Bronson, R., 1988.
10. Differential and Integral Calculus, Vol. I & Vol. II, Piskunov, N., Mir Publishers, 1969.

Course Name: Constitution of India & Professional Ethics

Course Code: HU205

Contact: 1:0:0

Total Contact Hours: 12

Credit: 1

Prerequisites:

A basic knowledge (10+2 level) of the Indian Constitution and moral science.

Course Objectives: The objectives of this course are to make the student able to-

O1: Understand the salient features of the Indian constitution and form of government.

O2: Develop ethical awareness and responsible professional conduct.

understand ethical frameworks, guidelines and recognize ethical dilemmas.

O4: Understand professional responsibilities and applications of ethical principles in real-life scenarios.

O5: Develop an awareness of the social impact of the profession and act responsibly in the broader community.

Course outcome: After successful completion of this course, students will be able to

CO1	Identify, define and understand the significance of the Constitution of India, its spirit and values and the fundamental rights and duties as a responsible citizen.
CO2	define and discover core ethical concepts, the basic perception of profession, and professional ethics that shape the ethical behavior of an engineer.
CO3	identify, examine and apply codes of engineering ethics, engineers' social responsibilities and industrial standards and ethical dilemmas.
CO4	consider, correlate and appraise ethical leadership and principles in addressing gender issues, concerns of IPR and industrial responsibilities.

CO-PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1	-	-	-	-	-	-	-	2	-	-	2
CO 2	-	-	-	-	-	**3**	3	2	-	-	2
CO 3	-	-	-	-	-	2	3	2	-	-	2
CO 4	-	-	-	-	-	2	3	3	-	-	2

Course Contents:

Module 1: Introduction to the Constitution of India and Indian Government: (2L)

Preamble : Salient Features, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliament -Powers and Functions –Executive- President -Governor - Council of Ministers.

Module 2: Professional Ethics and Human Values: (3L)

Introduction to Ethical Thinking; what is Ethics, Work ethics; Scope of Professional Ethics, Values and Characteristics, Types of values: Negative and positive values, Ethical values for Professional success.

Module 3: Codes of Professional Ethics, Violation and Safeguards: (4L)

Engineering Ethics, Ethical theories: a brief overview; utilitarianism, deontology, virtue ethics. Professional Codes, Codes of professional ethics-Moral dilemmas, and moral autonomy-Internal ethics of business: whistle blowing, conflicts of interest, Job discrimination, and Exploitation of Employees; Social and ethical responsibilities of technologists: Responsibilities towards Customers, shareholders, employees – Social Audit.

Case Studies: Bhopal Gas Tragedy, Chernobyl (linking ethics to real-world failures).

Module 4: Business Ethics and Workplace Issues: (3L)

Business ethics, ethical decision-making frameworks - Impact of ethics on business policies and strategies- Characteristics of ethical leaders; fostering integrity in teams; Addressing occupational crime, discrimination, and gender-based issues in workplaces-Intellectual property rights (IPR), Plagiarism and Academic Misconduct.

Text Books:

1.Durga Das Basu. *Introduction to the Constitution of India*. 27th ed. New Delhi: Lexis Nexis, 2024.

2. R.S Naagarazan. *A Textbook on Professional Ethics and Human Values*. New Age International (P) Limited, 2022.

3. N. Subramanian. *Professional Ethics.* New Delhi: Oxford University Press, 2017.

4. A N Tripathi, *Human Values*. New Delhi: New Age Publishers, 2019.

5. S. K. Chakraborty. *Values and Ethics for Organizations: Theory and Practices*. New Delhi: Oxford University Press, 1997.

Reference Books:

1.O. C. Ferrell, John Friaedrich and Linda Ferrell. *Business Ethics: Ethical Decision Making and Cases.* New Delhi: Cengage India, 2024.

2.Charles Fledderman. *Engineering Ethics*. 3rd ed. New Delhi: Pearson Education, 2007.

3.Dinesh G. Harkut and Gajendra R. Bamnote. *Professional Ethics for Engineers*. Chennai: Notion Press, 2023.

4.U.C.Mathur, *Corporate Governance and Business Ethics*: *Text and Cases*. Chennai: Macmillan, 2012.

5. Fernando. A. C., K. P. Muralidheeran and E. K. Satheesh. *Business Ethics – An Indian Perspective*. New Delhi: Pearson Education, 2019.

Course Name: Design Thinking & Innovation

Course Code: HU203

Contact: 1:0:0

Total Contact Hours: 15

Credit: 1

Prerequisites:

For a course on the Basics of Design Thinking, students should ideally possess basic computer skills, communication abilities, problem-solving aptitude, critical thinking, introductory knowledge of Sustainable Development Goals, curiosity, and openness to new ideas, as well as basic understanding of mathematics, technology, and manufacturing processes.

However, even if these prerequisites are not satisfied, the faculty will cover them in the first few classes.

An awareness of 21st-century skills, including creativity and collaboration, is also beneficial.

These prerequisites aim to provide a foundation, and any gaps in knowledge will be addressed by the instructor early in the course.

Course Objective:

The objective of this Course is to provide new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products and services which are useful for a student in preparing for an engineering career.

Course Outcomes (COs): Upon completion of the course, students shall be able to

CO1	Analyze emotional experience and expressions to better understand stakeholders while designing innovative products through group brainstorming sessions.
CO2	Generate and develop design ideas through different technique
CO3	Develop new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing any innovative products using facility in AICTE IDEA LAB

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	-	2	2	-	2	3	1	-	-
CO2	1	2	3	3	3	-	2	3	-	3	2
CO3	1	3	3	3	3	2	2	3	-	2	2

Course Content:

Module 1 (2L)

Basics of Design Thinking:
Definition of Design Thinking, Need for Design Thinking, history of Design Thinking, Concepts & Brainstorming, 2X2 matrix, 6-3-5 method, NABC method;

Module 2: (4L)

PROCESS OF DESIGN: Understanding Design thinking

Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

Stages of Design Thinking Process (explain with examples) –

Empathize (Methods of Empathize Phase: Ask 5 Why / 5W+H questions, Stakeholder map, Empathy Map, Peer observation, Trend analysis).

Define (Methods of Define Phase: Storytelling, Critical items diagram, Define success).

Ideate (Brainstorming, 2X2 matrix, 6-3-5 method, NABC method).

Prototype (Types of prototypes - Methods of prototyping - Focused experiments, Exploration map, Minimum Viable Product).

Test (Methods of Testing: Feedback capture grid, A/B testing).

Module 3: (2L)

Tools for Design Thinking
Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space– Empathy for design – Collaboration in distributed Design

Module 4: (2L)

Design Thinking in IT

Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenariobased Prototyping

Module 5: (2L)

Design Thinking For strategic innovations
Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model

Module 6: (3L)

Problem Solving & Critical thinking

Introduction to TRIZ, SCAMPER, UI and UX,

Sustainable development goals (SDG)

Integrating and mapping 17 Sustainable development goals (SDG) during designing a product; goods or service. Introduction to 21st Century Skill Set

Case Study & Project Report Submission

Text Books :

1. Karmin Design Thinking by Dr. Bala Ramadurai, Mudranik Technology Private Ltd. ISBN 978-93-5419-0I0-0.
2. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
3. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009.
4. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
5. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

Reference Books:

1. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011.
2. Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins e-books, 2009.
4. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Toolbox, John Wiley & Sons, 2020.
5. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook, John Wiley & Sons, 2018.
6. Kristin Fontichiaro, Design Thinking, Cherry Lake Publishing, USA, 2015.
7. Walter Brenner, Falk Uebernickel, Design Thinking for Innovation - Research and Practice, Springer Series, 2016.
8. Gavin Ambrose, Paul Harris, Design Thinking, AVA Publishing, 2010.
9. Muhammad MashhoodAlam, Transforming an Idea into Business with Design Thinking, First Edition, Taylor and Francis Group, 2019.

10. S. Balaram, Thinking Design, Sage Publications, 2011.

WEB REFERENCES:

1. https://designthinking.ideo.com/
2. https://thinkibility.com/2018/12/01/engineering-vs-design-thinking/
3. https://www.coursera.org/learn/design-thinking-innovation
4. https://swayam.gov.in/nd1_noc20_mg38/preview
5.www.tutor2u.net/business/presentations/. /productlifecycle/default.html
6. https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf
7. www.bizfilings.com › Home › Marketing › Product Developmen
8. https://www.mindtools.com/brainstm.html
9. https://www.quicksprout.com/. /how-to-reverse-engineer-your-competit
10.www.vertabelo.com/blog/documentation/reverse-engineering
https://support.microsoft.com/en-us/kb/273814
11. https://support.google.com/docs/answer/179740?hl=en

Course Name: Food Microbiology Lab

Course Code: FT291

Contact: 0:0:3

Credit: 1.5

Pre-requisites: Biology

Course Objective:

The objective of the course is to make the students able –

O1: To help the students understand various methods of isolation, characterization and screening of bacteria, fungi, and other related microorganisms

O2: To apply different preservation techniques relative to food safety and spoilage.

Course outcome(s):

After the completion of the course, students will be able to:

CO1	Understand various methods of isolation, characterization and screening of bacteria, fungi and other related organisms.
CO2	Describe the process to skills to monitor various microbial food processing operations in food industries.
CO3	Interpret different preservation techniques relative to food safety and spoilage.
CO4	Evaluate the growth requirements of common foodborne pathogens and spoilage microorganisms.

CO-PO-PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	2	-	-	-	3	3	3	3
CO2	3	3	2	3	2	1	-	1	-	-	3	3	3	2
CO3	3	3	3	3	2	2	2	1	2	1	3	3	3	1
CO4	2	3	3	3	-	-	-	-	2	1	3	3	2	3

List of Experiments:

1. Gram Staining and the study of cellular morphology of bacteria.
2. Study of autoclave, preparation and sterilization of nutrient broth.
3. Sub-culturing of a bacterial strain in liquid and solid medium.
4. Study of the bacterial growth curve by spectrophotometer.
5. Study of microbial quality of milk by MBRT test.
6. Study the growth of yeast and molds.
7. Serial dilution and Plating by spread–plate and pour–plate techniques.
8. Isolation of a pure culture.
9. Preparation and characterization of fermented food products
10. Innovative Experiments

Text Books:

1. Food Microbiology; M. R.Adams , 2nd Edition, 2002

Reference Books:

1. Hand Book of Microbiology; Bisen, 3rd Edition, 2003

Course Name: Biochemistry and Nutrition Lab

Course Code: FT292

Contact: 0:0:3

Credit: 1.5

Pre-requisites: Biochemistry Theory

Course Objective:

The objective of the course is to make the students able-

O1: To assist the students, in developing skills to monitor various enzymatic reactions and

O2: To learn about the association of food protein structure

O3: To help the students point out the threat of possible danger to health from contamination in water from effluent.

Course outcome(s):

After the completion of the course, students will be able to:

CO1	Understand the separation of immiscible liquids and solids from liquids, including various methods of sugar and amino acid separation.
CO2	Describe the process to develop skills to monitor various enzymatic reactions.
CO3	Interpret the association of food protein structure with solubility, viscosity, gelation, texturization, emulsification and foaming.
CO4	Evaluate the threat of possible danger to health, or the very existence of certain species, for the determination of the quality of a water source before water is drawn off for consumption.

CO-PO-PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	2	-	-	-	3	3	3	3
CO2	3	3	2	2	2	1	-	2	-	-	3	3	3	2
CO3	3	3	3	3	2	2	2	1	-	1	3	3	3	1
CO4	2	3	3	3	-	-	-	-	2	1	3	3	2	3

List of Experiments:

1. Separation of amino acids/sugars by Ascending Paper Chromatography.
2. Separation of sugars/amino acids by Thin Layer Chromatography.
3. Separation of sugars /amino acids by Radial Chromatography.
4. Separation of triglycerides and sterols of the oil sample by Thin Layer Chromatography.
5. Separation and isolation of proteins/amino acids by Electrophoresis.
6. Preparation of cell-free extract: Bacterial cells by sonication, and Chicken liver by homogenization.
7. Assay of enzyme activity (a) Phosphatase assay [Chicken liver] (b) Protease assay
8. Study on the presence of alkaline phosphatase enzyme in raw and pasteurized milk.
9. Determination of BOD5 of a sample of wastewater.
10. Innovative Experiments

Text Books:

1. Modern Experimental Biochemistry, Boyer, Pearson Education

Reference Books:

1. An Introduction to Practical Biochemistry, David T Plummer

Course Name: Engineering Chemistry Lab

Course Code: CH291

Contact: 0:0:2

Credit: 1

Prerequisites: 10+2

Course Objective

The objective of the course is to make the students able to –

O1: Study the basic principles of pH meter and conductivity meter for different applications

O2: Analysis of water for its various parameters in relation to public health, industries & environment

O3: Learn to synthesis Polymeric materials and drugs

O4: Study the various reactions in homogeneous and heterogeneous medium

O5: Designing of innovative experiments

Course Outcome

After Successful completion of the course, students will be able to

CO1	Able to operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
CO2	Able to analyse and determine the composition and physical property of liquid and solid samples when working as an individual and also as a team member
CO3	Able to analyse different parameters of water considering environmental issues
CO4	Able to synthesize drug and sustainable polymer materials.
CO5	Capable to design innovative experiments applying the fundamentals of modern chemistry

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3	1	3	1	-	2	3	-	-	-	-
2	2	2	1	1	-	1	-	-	-	1	-
3	-	-	-	-	-	-	-	-	3	3	2
4	2	1	2	2	-	-	1	-	-	-	-
5	3	3	3	3	1	1	1	1	-	-	2

Course Content

Any 10 experiments to be conducted preferably a combination of estimation, water quality analysis, instrumental analysis and synthesis

1. To determine strength of given sodium hydroxide solution by titrating against standard oxalic acid solution.
2. Estimation of amount of Fe^{2+} in Mohr's salt using permanganometry.
3. To determine the surface tension of a given liquid at room temperature using stalagmometer by drop number method.
4. To determine the viscosity of a given unknown liquid with respect to water at room temperature, by Ostwald's Viscometer.
5. Water quality analysis :
   i. Determination of total, permanent and temporary hardness of sample water by complexometric titration.
   ii. Determination of Cl^- ion of the sample water by Argentometric method
   iii. Determination of alkalinity of the sample water.
   iv. Determination of dissolved oxygen present in a given water sample.
6. Determination of the concentration of the electrolyte through pH measurement.
7. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
8. Determination of cell constant and conductance of solutions.
9. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
10. Determination of Partition Coefficient of acetic acid between two immiscible liquids.
11. Drug design and synthesis
12. Synthesis of polymers (Bakelite) for electrical devices and PCBs.
13. Synthesis of Silver Nanoparticles doped organic thin film for organic transistors.
14. Determination of R_F of any amino acid by thin layer chromatography.
15. Saponification /acid value of any oil.
16. Isolation of graphene from dead dry batteries

Course Name: IDEA LAB Workshop

Course Code: ME293

Contact: 0:0:3

Credit: 1.5

Course Objectives:
The objective of the course is to make the students able to –

O1: Learn all the skills associated with the tools and inventory associated with the IDEA Lab.
O2: Learn useful mechanical and electronic fabrication processes.

O3: Learn necessary skills to build useful and standalone system/ project with enclosures.

O4: Learn necessary skills to create print and electronic documentation for the system/project

Course Contents*:*

Module	Topics	
1	Electronic component familiarisation, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,

2	Familiarisation and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.
3	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototypingtechnology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverseengineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4	Discussion and implementation of a mini project.	
5	Documentation of the mini project (Report and video).	

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testiof the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling w

3.	3D scanning of computer mouse geometry surface. 3D printing of scann geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mthickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardwa software and machined or 3D printed enclosure.

Reference Books:

S. No.	Title
1.	AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing, New Delhi.
2.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3.	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.

Course Name: Introduction to Artificial Intelligence Lab

Course Code: CS292

Contact: 0:0:3

Credit: 1.5

Course Objectives:

The objectives of this course are to enable students to

O1: Gain foundational knowledge of PROLOG to implement an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing

O2: Formulate a problem by analyzing its characteristics to fit a State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.

O3: Apply the concepts of Artificial Intelligence to solve a problem by implementing well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.

04: Build expert systems offering solutions to the challenging problems of Artificial Intelligence.

05: Implement Artificial Intelligence based ideas as executable PROLOG programs through developing intelligent heuristic strategies

Course Outcomes (COs):

After successful completion of this course, students will be able to:

CO1	Acquire foundational knowledge of PROLOG to implement an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing and understand the working principle of the agent and assess its utilitarian importance in current technological context leading towards lifelong learning**.**
CO2	Identify and formulate an engineering problem by analyzing its characteristics to fit a State-Space Exploration Framework or an Inferencing Agent Formulation Framework of Artificial Intelligence.
CO3	Explore relevant literature and apply the concepts of Artificial Intelligence to solve a problem by implementing well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.
CO4	Develop ideas and propose an expert system offering solutions to the challenging problems of Artificial Intelligence.

CO5	Plan and Implement Artificial Intelligence based ideas as executable PROLOG programs through developing intelligent heuristic strategies or expert systems with adequate documentation in a collaborative environment for successfully carrying out projects on Artificial Intelligence Problems and investigate their effectiveness by analyzing the performances using proper techniques and tools.

CO–PO Mapping:

COs	**Program Outcomes (PO)**										
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	2
CO5	2	2	3	3	2	2	2	2	2	2	2

Course Contents:

Module 1: Introduction to PROLOG Programming along with the IDE and its Basic Components

Assignments for understanding the Basic Components of Knowledge Representation and Inferencing in Artificial Intelligence using PROLOG Programming and its working strategy. Understanding facts, rules, queries, and syntax.

Module 2: Recursive definitions in Prolog

Fibonacci Series, Calculator, Factorial, summation, list length, etc. Using recursive rules.

Module 3: Defining facts and simple queries

Writing a knowledge base for family relationships, basic objects.

Module 4: Rules and inference in Prolog

Creating logical rules and testing inferences.

Module 5: List operations in Prolog

Checking membership, concatenation, reverse, max/min of list.

Module 6: Pattern matching and symbolic reasoning

Simple examples involving pattern recognition (e.g., shape or name matching, Family Tree design)

Module 7: Expert system simulation (Mini project)

Building a mini knowledge-based system (e.g., Animal Classification, Medical diagnosis, etc).

Textbook:

Ivan Bratko, Prolog Programming for Artificial Intelligence, 4th Edition, Addison-Wesley.

2nd Year 3rd Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	FT301	Food Process Technology–I (Fish, Meat, Poultry)	3	0	0	3	3
2	ENGG	Major	FT302	Food Process Technology–II (Cereals, Fruits, Vegetables and Spices)	3	0	0	3	3
3	ENGG	Minor	CH(FT)301	Industrial stoichiometry	3	0	0	3	3
4	ENGG	Minor	CS(FT) 301A/B/C	A. Data Structure and Algorithms B. Data Base Management System C. Software Engineering	3	0	0	3	3
5	SCI	Minor	M(FT)301	Applied Statistics and Numerical Methods	2	0	0	2	2
B. PRACTICAL									
1	ENGG	Major	FT391	Chemistry of Food Lab II	0	0	4	4	2
2	ENGG	Minor	CS(FT) 391A/B/C	A. Data Structure and Algorithms Lab B. Data Base Management System Lab C. Software Engineering Lab	0	0	3	3	1.5
3	ENGG	Minor	M(FT)391	Applied Statistics and Numerical Methods Lab	0	0	3	3	1.5
4	HUM	Ability Enhancement Course	HU(FT)391	Technical Seminar Presentation & Group Discussion	0	0	3	3	1.5
MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC381	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives		0	0	0	0
Total of Theory, Practical								27	20.5

Course name: Food Process Technology – I (Fish, Meat, Poultry)

Course Code: FT301

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Food Chemistry, Food Preservation, Food Microbiology

Course Objective:

O1: To provide an opportunity for students to classify different processing techniques required for preservation of fish, meat, poultry and classify the different by products related to these industries.

Course outcome(s):

After completion of the course, the students will be able to

CO1	Identify the significance different processing techniques required for the preservation of fish.
CO2	Analyse the different by products related to fish processing industries and describe their use.
CO3	Compare the various components of the meat muscle with special focus on slaughtering and post mortem changes in meat, preservation and to recognize the different processing techniques related to meat processing industry and use of meat byproducts
CO4	Develop a general understanding on the structure, composition, nutritional values and effective preservation methods of eggs.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PS03
CO1	2	3	3	3	-	3	3	3	3	3	3	2	3	3
CO2	2	3	3	3	2	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	2	3	3	3	3	3	3	2	2	3
CO4	2	3	3	3	2	3	3	3	3	3	3	2	3	3

Course Contents:

Module I: (12L)

Classification of fresh water fish and marine fish; Commercial handling, storage and transport of fish; proximate composition and nutritive value of fish; Indices of freshness and its quality assessment, contaminants and toxicants in fish- both endogenous and exogenous,; Spoilage of fish; Methods of Preservation of fish and fish products: Canning, Freezing, Drying, Curing, Smoking, Fermentation (fish sauce) and pickling, effect of processing and storage on nutritive value

Module II: (**6L)**

Fish byproducts - production of fish meal, fish protein concentrate, and fish protein hydrolysate fish liver oil and fish silage; Production of chitin, chitosan; Processing of fish wastes.

Module III: (12L)

Classification, composition and nutritive value of poultry meat; Slaughtering of animals; Meat cuts and portions of meat, muscle, Color of meat; Post mortem changes of meat; Meat processing - curing and smoking; Fermented meat products (sausages and sauces); Frozen meat & meat storage; By-products from meat industries and their utilization.

Module IV: (6L)

Structure, composition and nutritional values of eggs; Egg processing, Byproduct Utilization – commercial processing of lecithin, Utilization of egg-derived products as food ingredients.

Text Books:

1. Fish & Fisheries of India; Jhingram VG; 1983, Hindustan Pub Corp

2. Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.

3. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988 Elliswood Ltd.

4. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.

5. Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRC Press.

Reference Books:

1. Meat Science and Applications - Y H. Hu., Wai-Kit Nip, Robert W. Rogers& Owen A. Young, Marcel Dekker,2001.
2. Advanced Technologies for Meat Processing - Leo M. L. Nollet& Fidel Toldrá, CRC Press, 2006.
3. Meat; Cole DJA &Lawrie RA; 1975, AVIPub.
4. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA &Pasch S; 1988, Elliswood Ltd.
5. Developments in Meat Science – I & II, Lawrie R; Applied Science Pub.Ltd.
6. Fish as Food, Vol. I-IV; George Borgstrom, Academic Press
7. Fish Processing Technology ,Rogestein & Rogestein
8. Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRCPress.
9. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVIPub.

Course Name: Food Process Technology – II (Cereals, Fruits, Vegetables and Spices)

Course Code: FT302

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Food Chemistry, Food Preservation, Food Microbiology

Course Objective:

O1: To provide the students an opportunity to gain knowledge about the storage procedure of different cereals, fruits and vegetables

O2: To help students to understand the different procedure of production of various cereal based, fruit based and vegetable based products.

Course outcome(s):

After completion of the course, the students will be able to

CO1	**Apply** the principles of sustainable processing depending on cereal composition, drying, milling, and storage to extend the shelf life of different cereal grains.
CO2	**Analyze** the processes for extracting value-added products from cereals and vegetables such as starch, proteins, and feed components.
CO3	**Evaluate** pre-processing, preservation, and minimal processing methods for fruits and vegetables and assess the utilization of fruit and vegetable by-products.
CO4	**Outline** integrated processing strategies for non-alcoholic beverages, tea, coffee, chocolate, and food additives while ensuring safety, quality, and efficiency.

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	2	3	2	1	1	1	2	3	3	2
CO 2	3	3	3	3	3	2	2	2	2	2	2	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I: (8L)

Basic composition and utilization of cereals; Drying of grains; Milling of rice and processes for rice- based products; Parboiling; Milling of wheat and processes of wheat-based products; Milling and utilization of corn, barley, oat and millets; Common infestation in grains; Principle and practice of storage of cereals; Storage structures.

Module II: (6L)

Feed for livestock from wheat bran and germ; Production of starch, modified starch; Extraction of proteins from cereals; Potato processing (potato chips, flakes, powder).

Module III: (10L)

Handling and quality assessment of fruits & vegetables; Storage of fruits & vegetables; Production of fruits and vegetable juices/puree/nectar, Intermediate moisture foods from fruits (jam, jelly, marmalade, leathers, candy); Sauce and ketchup from tomato., Dehydrated fruits & vegetables; Equipment, cleaning methods, sorting, grading, peeling and blanching of fruits and vegetables before processing, methods of precooling.

Module IV: (8L)

Non-alcoholic beverages; Processing of tea, coffee and cocoa, Instant coffee; Production of chocolate and cocoa butter; Extraction of caffeine from tea leaves; Processing of spices and herbs. Food additives -coloring agents, humectants, anti-caking agents, natural and artificial

low calorie sweeteners, pH control agents, thickeners.

Revision: (4L)

Text Books:

1. Food Science, 5th edition, by N.N. Potter & J. H. Hotchkiss
2. Food Science by Sumati Rajagopal Mudambi, Shalini M. Rao, M. V. Rajagopal
3. Food Science, 3rd edition, by B. Srilakhsmi

Reference Books:

1. Postharvest Technology of Fruits & Vegetables (vol 1 & 2): Handling, Processing, Fermentation and Waste Management – L. R. Verma& V. K. Joshi, Indus Pub, New Delhi, 2000.
2. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices –A. Chakraverty, Arun S. Mujumdar, G. S. V. Raghavan& H. S. Ramaswamy - Marcel Dekker, 2003
3. Postharvest Technology and Food Process Engineering – A Chakraverty & R. Paul Singh, CRC Press, 2014
4. Fruit and Vegetable Preservation by Srivastava and Sanjeev Kumar
5. Principles of Food Science, Vol-I by Fennma Karrel
6. Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon

Course Name: Industrial Stoichiometry

Course Code: CH(FT)301

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Engineering mathematics, physics, chemistry

Course Objective:

O1: To enable students to understand and apply various unit conversion techniques relevant to engineering systems.

O2: To develop students' ability to formulate and solve material balance problems across different chemical and food engineering processes.

O3: To help students analyze and perform energy balance calculations using appropriate mathematical interpretations and engineering principles.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	**Demonstrate** the use of dimensional analysis techniques, including Buckingha Pi-theorem, and **interpret** graphical methods for engineering problem-solving.
CO2	**Apply** material balance principles to chemical process systems with and witho reactions.
CO3	**Analyze** energy balance scenarios in steady and unsteady-state processes and **calculate** enthalpy changes in different engineering processes.
CO4	**Evaluate** the combined material and energy balances for selected industrial processes to assess efficiency and performance.

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO 2	PSO3
CO1	3	2	–	2	3	–	–	–	–	–	2	2	3	1
CO2	3	3	–	2	3	–	–	–	–	–	2	3	3	2
CO3	3	3	–	2	3	–	–	–	–	–	2	3	3	2
CO4	3	3	2	2	3	–	–	–	–	–	2	3	3	3

Course Contents:

Module I (6L)

Small units and dimensions, Dimensional analysis by Buckingham Pi-theorem, Dimensionless groups, Conversion of equations, Solution of simultaneous equations, use of log- log and semi-log graph paper, triangular diagram, Graphical differentiation and graphical integration

Module II (10L)

Material balance: Introductory Concepts, Simplification of the general mass balance equation for steady processes, Procedure for material balance calculations, Material balance without chemical reactions, Material balance with chemical reactions, Material Balance with recycle, bypass, and purge streams.

Module III (10L)

Energy Balance: General energy balance equation for steady-state and unsteady-state processes; Energy balance without chemical reaction; Energy balance with chemical reaction: Heat of reaction, heat of formation, heat of combustion, Hess's Law, Kirchhoff's Law, Enthalpy calculation procedures.

Module IV (6L)

Combined Material and Energy Balances: Simultaneous material and energy balances, selected industrial process

Revision: (4L)

Text Book:

1. K. V. Narayanan and B. Lakshmikutty, Stoichiometry and Process Calculations, PHI

2. Ghosal, Sanyal and Dutta, Introduction to Chemical Engineering, TMH

Reference Books:

1. Hougen and Watson, Chemical Process Principles (Part one): 2nd Ed, John Wiley.

2. Basic Principles and Calculations in Chemical Engineering: Himmelblau, 6th Ed. PrenticeHall

3. Bhatt and Bhora, Stoichiometry, 4th Ed., TM

Course Code: Data Structures and Algorithm

Course Code: CS(FT)301A

Contact: 3:0:0

Total Contact Hours: 36

Credits: 3

Course Objective:

O1: The objective of this course is to equip students with the fundamental concepts, principles, and techniques of data structures and algorithms for efficient problem-solving and software development. Students will learn to analyze the performance of algorithms, select appropriate data structures for given applications, and implement them using a high-level programming language.

Pre requisites:

1. Familiarity with the fundamentals of C or other programming language
2. A solid background in mathematics, including probability, set theory.

Course Outcomes:

After the completion of the course students will be able to:

CO1	Differentiate how the choices of data structure & algorithm methods impact the performance of program.
CO2	Solve problems based upon different data structure & also write programs.
CO3	Identify appropriate data structure & algorithmic methods in solving problem.
CO4	Discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing
CO5	Compare the benefits of dynamic and static data structures implementations.

CO-PO-PSO Mapping

CO(s)	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	-	-	-	3	-	2	2	2
CO2	-	-	-	-	-	2	3	2	2	-	-	2	2	1
CO3	-	-	1	-	-	-	-	-	2	3	-	2	3	1
CO4	-	1	-	-	-	-	-	-	-	-	-	2	3	1
CO5	3	-	-	-	-	3	-	-	-	-	-	2	3	1

Course Contents:

Module I (10L)
Linear Data Structure

Introduction (2L):

Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code (1L)

Algorithm efficiency and analysis, time and space analysis of algorithms – order notations (1L) Array (2L):

Different representations – row major, column major (1L)

Sparse matrix - its implementation and usage, Array representation of polynomials (1L)

Linked List (6L): Singly linked list – operations, Doubly linked list – operations (4L)

Circular linked list – operations, Linked list representation of polynomial and applications (2L)

Module II (6L)
Linear Data Structure

Stack and Queue (4L):

Stack and its implementations (using array and linked list) (1L) Applications (infix to Postfix, Postfix Evaluation) (1L)

Queue, circular queue, de-queue (1L)

Implementation of queue- linear and circular (using array and linked list) (1L)

Recursion (2L): Principles of recursion - use of stack, tail recursion. (1L)

Applications - The Tower of Hanoi(1L)

Module III (12L)

Nonlinear Data structures

Trees (8L):

Basic terminologies, forest, tree representation (using array and linked list) (1L) Binary trees - binary tree traversal (pre-, in-, post- order) (1L)

Threaded binary tree (1L)

Binary search tree- operations (creation, insertion, deletion, searching) (1L) Concept of Max-Heap and Min-Heap (creation, deletion) (1L)

Height balanced binary tree – AVL tree (insertion with examples only) (1L) Height balanced binary tree – AVL tree (deletion with examples only) (1L)

m –Way Search Tree, B Tree – operations (insertion, deletion with examples only) (1L)

Graphs (4L): Graph theory review (1L)

Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) - concepts of edges used in DFS and BFS (tree-edge, back-edge, cross-edge, and forward-edge) (2L)

Minimal spanning tree – Prim's algorithm, Kruskal's algorithm (basic idea of greedy methods) (1L)

Module IV (8L)

Searching, Sorting

Sorting Algorithms (4L):

Bubble sort, Insertion sort, Selection sort – with notion of complexity (1L) Quick sort, Merge sort – with complexity (2L)

Radix sort – with complexity (1L) Searching (2L):

Sequential search – with complexity (1L)

Binary search, Interpolation Search– with complexity (1L) Hashing (2L):

Introduction to Hashing and Hashing functions (1L) Collision resolution techniques (1L)

Text Books:

1. Data Structures Through 'C' Language by Samiran Chattopadhyay, Debabrata Ghosh Dastidar, Matangini Chattopadhyay, Edition: 2001, BPB Publications

2. Fundamentals of Data Structures of C by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed 2nd Edition, Universities Press

Reference Books:

1. Data Structures, Algorithms, and Software Principles in C by Thomas A. Standish, 1 Edition, Pearson
2. Data Structures by S. Lipschutz, Special Indian Edition, Tata McGraw Hill Education (India) Private Limited
3. Data Structures and Program Design In C by Robert L. Kruse, Bruce P. Leung 2nd Edition, Pearson

Course Name: Database Management System

Course Code: CS(FT)301B

Contacts: 3:0:0

Total Contact Hours: 36

Credits: 3

Prerequisite:

1. Logic of programming language
2. Basic concepts of data structure and algorithms

Course Objectives:

O1: To learn the data models, conceptualize and depict a database system

O2: To design system using E-R diagram.

O3: To learn SQL & relational database design.

O4: To understand the internal storage structures using different file and indexing techniques.

O5: To know the concepts of transaction processing, concurrency control techniques and recovery procedure.

Course Outcome(s):

CO1	Apply the knowledge of Entity Relationship (E-R) diagram for an application.
CO2	Create a normalized relational database model
CO3	Analyze real world queries to generate reports from it.
CO4	Determine whether the transaction satisfies the ACID properties.
CO5	Create the database of an organization.

CO-PO-PSO Mapping

CO(s)	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	2	1	1	2	2	3	2	2	2
CO2	2	3	3	3	3	1	1	1	2	2	3	2	2	1
CO3	3	3	2	3	3	2	2	2	3	3	3	2	3	1
CO4	3	3	2	2	2	1	1	1	1	1	2	2	1	1
CO5	3	3	3	3	3	2	2	2	3	3	3	2	2	1

Course Contents:

Module I (3L)

Introduction

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Module II (9L)

Entity-Relationship and Relational Database Model

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features, case study on E-R Model. Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.

Module III (6L)

SQL and Integrity Constraints

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Module IV (6L)

Relational Database Design

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF , Case Study

Module V (6L)

Internals of RDBMS

Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols; two-phase locking, Dead Lock handling

Module VI (6L)

File Organization & Index Structures

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single- Level Index (primary, secondary, clustering), Multilevel Indexes

Text Books:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc. Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System, McGraw-Hill
4. Gray Jim and Reuter Address, “Transaction Processing: Concepts and Techniques”, Moragan Kauffman Publishers.
5. Ullman JD., “Principles of Database Systems”, Galgottia Publication.

Reference Books:

1. Jain: Advanced Database Management System CyberTech
2. Date C. J., “Introduction to Database Management”, Vol. I, II, III, Addison Wesley.
3. “Fundamentals of Database Systems”, Ramez Elmasri, Shamkant B. Navathe, Addison Wesley Publishing Edition
4. “Database Management Systems”, Arun K. Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

Course Name: Software Engineering

Course Code: CS(FT)301C

Contacts: 3:0:0

Total Contact Hours: 36

Credits: 3

Prerequisites:

1. An understanding of basic computer software
2. Object Oriented programming skills.

Course Objectives:

O1: To develop basic Knowledge in Software Engineering including software Engineering layered architecture, software process models for software development.

O2: To design software requirements and specifications of documents.

O3: To understand project planning, scheduling, cost estimation, risk management.

O5: To describe data models, object models, context models, behavioral models and coding style and testing issues.

O6: To know about the quality checking mechanism for software process and product.

Course Outcomes:

On completion of the course students will be able to:

CO1	Analyze software engineering problems, including the specification, design, implementation, and testing of software systems that meet specification, performance, maintenance and quality requirements
CO2	Specify software requirements through a productive working relationship with various stakeholders of the project
CO3	Design applicable solutions in one or more application domains using software engineering approaches that integrates ethical, social, legal and economic concerns.
CO4	Develop the code from the design and effectively apply relevant standards and perform testing, and quality management and practice.
CO5	Identify modern engineering tools necessary for software project management, time management and software reuse, and an ability to engage in life-long learning.

CO-PO-PSO Mapping

CO(s)	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	2	2	-	-	-	-	-	2	2	2	2
CO2	2	2	1	-	-	-	-	-	-	1	-	2	2	2
CO3	-	-	3	-	-	2	-	2	-	2	-	1	1	2
CO4	-	-	-	-	2	-	-	1	3	-	1	2	2	2
CO5	-	-	-	-	-	-	-		2	1	2	1	2	1

Course Contents:

Module I (10L)

Software Engineering–Characteristics, Components, Application, Definitions, Software Process models- Waterfall Model, Prototype model, Spiral., Software Project Planning-Feasibility Analysis, Technical Feasibility, Cost-Benefit Analysis, Basics of estimation: COCOMO (Basic, intermediate, Complete) model

Module II (8L)

System Analysis: Principle of Structure Analysis, Requirement Analysis, DFD, Entity Relationship Diagram, Data Dictionary, Data Modeling, Software Requirements Specification

Software Design Aspects: Objectives, Principles, Concepts, HLD and LLD, Top-Down and Bottom- Updesign; Decision tree, decision table and structured English, Structure chart, Transform analysis Functional Vs. Object-Oriented approach.

Module III (10L)

Coding & Documentation–Structured Programming, Modular Programming, Module Relationship- Coupling, Cohesion, Object Oriented Programming, Information Hiding, Reuse, System Documentation. Testing–Levels of Testing, Integration Testing, System Testing.

Test Cases-White Box and Black Box testing Software Quality, Quality Assurance, Software Maintenance, Software Configuration Management.

Module IV (8L)

Software Project Management – Project Scheduling, Staffing, Quality Assurance, Risk Management: Reactive vs. Proactive Risk strategies, Software risks, Risk identification, Risk projection, Risk refinement Project Monitoring.

Text Books:

1. Software Engineering: A practitioner's approach–Pressman(TMH)

Reference Books:

1. Software Engineering-Pankaj Jalote (Wiley-India)
2. Software Engineering-Rajib Mall(PHI)
3. Software Engineering–Agarwal and Agarwal(PHI)

Course Name: Applied Statistics and Numerical Methods

Course Code: M(FT)301

Contact (L: T: P): 2: 0: 0

Total Contact Hours: 24

Credit: 2

Pre requisites: The students to whom this course will be offered must have the concept of (10+2) standard number system, algebra and calculus.

Course Objectives:

The objective of the course is to make the students able to –

O1: The purpose of this course is to provide basic understanding of the derivation and the use of the numerical methods and applied statistics.

Course Outcome(s):

After completion of the course students will be able to:

CO1	Recall fundamental concepts of applied statistics and numerical methods
CO2	Explain the underlying principles and assumptions of statistical techniques and numerical algorithms
CO3	Apply appropriate statistical tools and numerical techniques to solve practical mathematical and engineering problems
CO4	Analyze results obtained from the numerical methods and statistical procedures, and interpret their implications in applied contexts

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	-	-	-	-	3	1	2
CO2	3	2	1	-	-	-	-	-	-	-	-	3	2	2
CO3	3	2	2	-	-	-	-	-	-	-	-	3	3	3
CO4	3	3	2	3	-	-	-	-	-	-	-	2	2	2

Course Contents:

MODULE I:(8 L)

Numerical solution of system of linear equations

Gauss Elimination method, LU Factorization method, Gauss-Seidel iterative method.

Numerical solution of algebraic and transcendental equations

Bisection method, Regula-Falsi, Newton-Raphson method, Secant Method

MODULE II: (16 L)

Descriptive Statistics:

Measures of central Tendency, Measures of Dispersion, Skewness and Kurtosis.

Correlation and Regression:

Types of Correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation and Spearmen's Rank Correlations, Method of Least Squares, Regression lines.

Curve Fitting

Curve fitting by the method of least squares- fitting of straight lines, second degree parabola.

Test of significance

Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Testing of fitness

Test for single mean, difference of means and correlation coefficients, Chi-square test for goodness of fit and independence of attributes

Statistical Quality Control: Importance of SQC in food industry, Construction of control charts for variables (mean, range and standard deviation)

Text Books:

1. Shishir Gupta &S.Dey, Numerical Methods, Mc. Grawhill Education Pvt. Ltd.

2. C.Xavier: C Language and Numerical Methods, New age International Publisher.

3. Dutta& Jana: Introductory Numerical Analysis. PHI Learning

4. N. G. Das: Statistical Methods, TMH.

5. Sancheti , D. S. &Kapoor ,V.K. : Statistics Theory , Method & Application, Sultan Chand & sons , New Delhi

6. N.K.Dutta (2004). Fundamentals of Biostatistics, Kanishka Publishers.

Reference Books

1. J.B.Scarborough: Numerical Mathematical Analysis.Oxford and IBH Publishing

2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K.Numerical Methods (Problems and Solution). New age International Publisher.

3. Prasun Nayek: Numerical Analysis, Asian Books

4. Gurumani N. (2005). An Introduction to Biostatistics, MJP Publishers

Course Name: Chemistry of Food Lab II

Course Code: FT391

Contact: 0:0:4

Credit: 2

Pre requisites: Food Chemistry

Course Objective:

O1: To develop students' conceptual understanding of the principles and significance of analyzing minerals, pigments, crude fiber, antioxidants, and related food components.

O2: To familiarize students with various spectrophotometric and chemical methods used for the estimation of bioactive and nutritional compounds in food.

O3: To enhance students' practical skills in performing accurate and reliable quantitative analyses of food constituents using standard laboratory techniques.

Course outcome:

After the completion of the Chemistry of Food Lab II the students will be able to:

CO1	**Apply** suitable analytical techniques to estimate mineral, crude fiber and other components in various food samples.
CO2	**Demonstrate** the application of spectrophotometric analysis for the determination of pigments and antioxidants/polyphenols in food materials.
CO3	**Analyze** changes in food pigments under different conditions to understand their stability and implications for food quality.
CO4	**Evaluate** data generated by experimental methods for chemical characterization of food materials.

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	3	2	2	1	2	2	3	3	3	2
CO2	2	2	1	-	3	2	2	2	2	2	3	3	3	2
CO3	3	2	2	2	2	-	-	-	2	2	3	3	2	3
CO4	3	2	2	1	1	-	-	-	2	2	3	3	2	3

List of Experiments:

1. Determination of pigments in food sample.
2. Estimation of calcium in food sample.
3. Estimation of iron in food products.
4. Estimation of zinc in food sample.
5. Estimation of crude fiber in food sample.
6. Estimation of antioxidant(s) / polyphenol(s) in food sample.
7. Analysis of lysine content in animal /vegetable sources.
8. Estimation of alcoholic acidity present in wheat flour.
9. Innovative Experiments

Text books:

1. Essentials of Food & Nutrition by Swaminathan, Vol. 1 &2
2. Food Chemistry by L. H. Meyer

Reference books:

1. Hand Book of Analysis of fruits & vegetables by S. Ranganna
2. Chemical changes in food during processing by Richardson
3. Food Science by Norman N. Potter & Joseph H. Hotchkiss
4. Food Chemistry by H. K. Chopra & P. S. Panesar

Course Code: Data Structures and Algorithm Lab

Course Code: CS(FT)391A

Contact: 0:0:3

Credits: 1.5

Pre requisites: Computer Fundamentals and principal of computer programming Lab

Course Outcomes:
After the completion of the course students will be able to:

CO1	Select appropriate data structure as applied to specified problem definition.
CO2	Handle operations like searching, insertion, deletion, traversing mechanism on various data structures.
CO3	Use practical knowledge on the applications of data structures.
CO4	Able to store, manipulate and arrange data in an efficient manner.
CO5	Implement queue and stack using arrays and linked list. Implementation of queue, binary tree and binary search tree.

CO-PO-PSO Mapping

CO(s)	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	3	-	3	2	2
CO2	-	2	2	-	2	-	-	-	-	2	-	3	2	3
CO3	2	1	1	-	-	-	-	-	-	-	-	3	3	3
CO4	3	2	-	2	-	-	-	-	-	-	3	3	3	3
CO5	-	-	2	1	2	-	-	-	-	-	2	3	3	3

List of Experiment:

1. Write a C program to implement Single Link List
2. Write a C program to implement Double Link List
3. Write a C program to implement Single Circular Link List
4. Write a C program to implement Double Circular Link List
5. Write a C program to implement Polynomial addition and Polynomial multiplication using Linked List.
6. Write a C program to convert a given infix expression into its postfix Equivalent.
7. Write C programs to implement a queue ADT using i) array and ii) doubly linked list respectively.
8. Write a C program to implement Binary Search Tree (BST).
9. Write C programs for implementing the following sorting methods to arrange a list of integers in ascending order:
   a. Insertion sort
   b. Merge sort
10. Write C programs for implementing the following sorting methods to arrange a list of integers in ascending order:
    a. Quick sort
    b. Selection sort
11. Write C programs for implementing the following searching methods:
    a. Linear Search
    b. Binary Search

Write a C program to implement all the functions of a dictionary (ADT) using hashing.

12. Write C programs for implementing the following graph traversal algorithms:
    a. Depth first search
    b. Breadth first search
13. Innovative experiments

Text Books:

1. Data Structures using C, R. Thareja, 2nd Edition, Oxford University Press.
2. Data Structures Using C E. Balagurusamy, Mcgraw Hill

Reference Books:

1. Data Structures in C by Aaron M. Tenenbaum, 1st Edition, Pearson
2. Data Structures Through 'C' Language by Samiran Chattopadhyay, Debabrata Ghosh Dastidar, Matangini Chattopadhyay, Edition: 2001, BPB Publications
3. Data structures using C, A.K.Sharma, 2nd Edition, Pearson
4. Fundamentals of Data Structures of C by Ellis Horowitz, SartajSahni, Susan Anderson-freed 2nd Edition, Universities Press

Course Name: Database Management System Lab

Course Code: CS(FT)391B

Contacts: 0:0:3

Credits: 1.5

Prerequisite:

1. Logic of programming language

2. Basic concepts of data structure and algorithms

Course Objectives:

O1: To learn the data models, conceptualize and depicts data base system

O2: To learn the fundamental concepts of SQL queries.

O3: To understand the concept of designing a data base with the necessary attributes.

O4: To know the methodology of Accessing, Modifying and Updating data& information from the relational databases

O5: To learn database design as well as to design user interface and how to connect with database.

Course Outcome(s):

On completion of the course students will be able to

CO1	Understand the basic concepts regarding database, know about query processing and techniques involved in query optimization
CO2	Understand the introductory concepts of some advanced topics in data management like distributed databases, data warehousing, deductive databases and be aware of some advanced databases like partial multimedia and mobile databases.
CO3	Differentiate between DBMS and advanced DBMS and use of advanced database concepts and become proficient in creating database queries.
CO4	Analyze database system concepts and apply normalization to the database.
CO5	Apply different transaction processing and concurrency control applications.

CO-PO-PSO Mapping

CO(s)	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	2	1	1	2	2	3	3	2	2
CO2	2	3	3	3	3	1	1	1	2	2	3	3	2	3
CO3	3	3	2	3	3	2	2	2	3	3	3	3	3	3
CO4	3	3	2	2	2	1	1	1	1	1	2	3	3	3
CO5	3	3	3	3	3	2	2	2	3	3	3	3	3	3

Course Contents:

1. Study of Backend Tool – Oracle. Introduction to Structured Query Language.

2. Data Definition Language (DDL) commands in RDBMS.

3. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.

4. High-level language extension with Cursors.

5. High level language extension with Triggers

6. Procedures and Functions.

7. Embedded SQL.

8. Database design using E-R model and Normalization.

9. Mini project (Application Development using Oracle and Visual Basic)

i. Inventory Control System.

ii. Material Requirement Processing

iii. Hospital Management System

iv. Railway Reservation System

v. Personal Information System

vi. Web Based User Identification System

vii. Time-table Management System

Text Books:

1) ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition

2) Reference books:

3) ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw Hill.

4) SQL & PL/SQL for Oracle 10g, Black Book, Dr.P.S. Deshpande.

Course Name: Software Engineering Lab

Course Code: CS(FT)391C

Contact Hours: 0:0:3

Credits: 1.5

Prerequisites:

For Software Engineering Lab, design a project proposal which will be used throughout the lab for performing different experiments using CASE Tools.

Course Objectives:

O1: To learn software development skill through various stages of software life cycle.

O2: To ensure the quality of software through software development with various protocol based environment.

Course Outcomes:

On completion of the course students will be able to:

CO1	Handle software development models through rational method.
CO2	Prepare SRS document, design document, test cases and software configuration management and risk management related document.
CO3	Develop function oriented and object oriented software design using tools like rational rose.
CO4	Perform unit testing and integration testing
CO5	Apply various white box and black box testing techniques

CO-PO-PSO Mapping

CO(s)	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	-	-	-	-	-	3	2	2
CO2	3	2	3	-		-	-	-	-	-	-	3	2	3
CO3	3	2	3	2	3	-	-	-	-	-	-	1	3	3
CO4	2	2	-	-	2	-	-	-	-	-	-	3	2	3
CO5	3	2	-	-	-	-	-	-	-	-	-	3	3	3

Course Contents

Assignments to be given from the following

1. Preparation of requirement document for standard application problems in standard format. (e.g. Library Management System, Railway Reservation system, Hospital management System, University Admission system). DFD of standard application problems.

2. Project Schedule preparation. Software Requirement Analysis: Describe the individual Phases/ modules of the project, Identify deliverables.

3. Use Case diagram, Class Diagram, Sequence Diagram, Activity Diagram and prepare Software Design Document using tools like Rational Rose. (For standard application problems)

4. Software Development and Debugging. Estimation of project size using Function Point(FP) for calculation.

5. Design Test Script/Test Plan (both Black box and White Box approach)

6. Compute Process and Product Metrics (e.g Defect Density, Defect Age, Productivity, Cost etc.) Cost Estimation models. COCOMO

Text Book:

1. Software Engineering: A practitioner's approach–Pressman(TMH)

Reference Book:

1. Software Engineering-Pankaj Jalote (Wiley-India)

Course Name: Applied Statistics and Numerical Methods Lab

Course Code: MFT(391)

Contact Hours: 0:0:3

Credits: 1.5

Prerequisites:

The students to whom this course will be offered must have the concept of any introductory course on programming language (C / Matlab).

Course Objectives:

O1: The purpose of this course is to provide basic programming skills for solving the problems in numerical methods and applied statistics.

Course Outcomes:

On completion of the course students will be able to:

CO1	Apply programming skills to implement and solve problems using appropriate statistical and numerical methods.
CO2	Analyze, interpret, and visualize results obtained from applied statistical and numerical computations.
CO3	Evaluate the accuracy and efficiency of various numerical and statistical techniques in practical scenarios.
CO4	Design and develop optimized algorithms and programs to address engineering problems using applied statistics and numerical methods.

CO-PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	3	1	2
CO2	3	3	2	-	-	-	-	-	-	-	-	3	2	2
CO3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	3	3	3

List of Experiments:

1. Assignments on Newton forward /backward, Lagrange‘s interpolation.
2. Assignments on numerical solution of a system of linear equations using Gauss elimination method, LU Factorization method, Gauss-Seidel iterative method.
3. Assignments on numerical solution of Algebraic Equation by Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method.
4. Assignments on Measures of Central Tendency- Mean, Median, Mode,
5. Assignments on Measures of Dispersion - Variance, Standard Deviation, Mean Deviation.
6. Assignments on Skewness and Kurtosis.
7. Assignments on Correlation Coefficient and Regression lines.
8. Assignments on curve fitting

Text Books:

1. Scarborough, J. B., Numerical Mathematical Analysis, Oxford University Press.
2. Kanetkar, Y., Let us C, BPB Publication,15th Edition
3. Das, N. G., Statistical Methods, TMH.
4. Gupta, S. and Dey, S., Numerical Methods, Mc. Grawhill Education Pvt. Ltd.
5. Balagurusamy, E., Numerical Methods, Scitech. TMH.

Reference Books:

1. Xavier, C., C Language and Numerical Methods, New age International Publisher.

2. Venugopal, K. R. and Prasad, S.R., Mastering-C, TMH, 2nd Edition.

3. Sancheti, D. S. and Kapoor, V. K., Statistics Theory , Method & Application, Sultan chand & sons , New Delhi.

4. Guha, S. and Srivastava, R. Numerical Methods, Oxford Universities Press.

2nd Year 4th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT401	Principles of Food Preservation	3	0	0	3	3
2	ENGG	Major	FT402A/B/C	A. Food Biotechnology B. Environmental Biotechnology C. Industrial Biotechnology	3	0	0	3	3
3	ENGG	Major	FT403A/B/C	A. Fluid Mechanics and Heat Transfer B. Mass Transfer I C. Mechanical Operation and Separation Process I	3	1	0	4	4
4	ENGG	Major	FT404	Bakery, Confectionery and Extruded Foods	3	0	0	3	3
5	ENGG	Major	FT405	Food Packaging Technology	3	0	0	3	3
6	ENGG	Minor	CH(FT)401	Chemical Engineering Thermodynamics and Kinetics	3	0	0	3	3
B. PRACTICAL									
1	ENGG	Major	FT412A/B/C	A. Food Biotechnology Lab B. Environmental Biotechnology Lab C. Industrial Biotechnology Lab	0	0	3	3	1.5
2	ENGG	Major	FT492A/B/C	A. Fluid Mechanics and Heat Transfer Lab B.Mass Transfer I Lab C.Mechanical Operation and Separation Process I Lab	0	0	3	3	1.5
3	PRJ	Project	FT481	Project-I	0	0	2	2	1
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC481	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives	0	0	0	0	0
Total of Theory, Practical								**27**	**23**
Total credit in 2nd year									**43.5**

Paper Name: Principles of Food Preservation

Paper Code: FT401

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Food Microbiology, Food Chemistry

Course Objective:

O1: To describe students, different principles involved in food preservation and processing

O2: To make them aware about different concepts involved in food spoilage and its prevention by using different food preservation principles and technologies.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	**Apply** the principles and techniques of thermal food preservation such as canning, and **calculate** thermal process time while identifying common spoilage patterns in canned foods.
CO2	**Demonstrate** the effectiveness of low-temperature and dehydration methods of food preservation in enhancing shelf-life and maintaining food quality.
CO3	**Analyze** the mechanisms and efficacy of preservation methods such as fermentation, chemical preservatives, curing, pickling, and the use of bio-preservatives and antibiotics.
CO4	**Evaluate** the role of modern and non-conventional preservation methods and **design** suitable combinations for minimal processing and extended shelf life

CO-PO-PSO Mapping

COs	Program Outcome (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	2	3	–	–	–	–	–	2	3	2	2
CO2	3	2	2	2	3	2	–	–	–	–	2	3	2	2
CO3	3	3	2	2	3	2	–	–	–	–	2	3	2	2
CO4	3	3	3	2	3	2	–	–	–	–	2	3	3	3

Course Contents:

Module I (8L)

Introduction to food preservation – Objectives and techniques of food preservation. Preservation by application of heat. Canning: Preservation principle of canning of food items, thermal process time calculations for canned foods, spoilage in canned foods.

Module II (8L)

Preservation by drying; Low temperature preservation: cold chain, cold storage preservation, freezing (including cryogenic freezing)

Module III (6L)

Preservation by fermentation and chemical preservatives, curing, pickling, Bio-preservatives, Antibiotics.

Module IV (10L)

Ionization Radiation including UV Radiation. Other non-conventional preservation methods, Hurdle technology; Non- thermal preservation processes (High pressure processing, Osmo dehydration, Use of ultrasonic sound, Pulse electric field), minimal processing. Applications of food enzymes in food preservation.

Revision: (4L)

Text Books:

1. Technology of Food Preservation by Desrosier
2. Food Science by Potter
3. Fruits and vegetable processing by Cruess
4. Preservation of Fruits & Vegetables by IRRI

Reference Books:

1. Principles of Food Preservation- Fennema
2. Handbook of Food Presrevation-M. Shafiur Rahman

Paper Name: Food Biotechnology

Paper Code: FT402A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Chemistry of Food, Food Preservation, Food Microbiology

Course Objective:

O1: To provide an opportunity for students to know about the pathogenic & nonpathogenic beneficial organisms

O2: To understand the use of beneficial organisms in food industry along with genetic engineering.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	Use of the idea of biotechnology and microbiological quality of water and food.
CO2	Understand the production method of organic acids, alcoholic beverages and glycerol.
CO3	Apply fermentation method to produce different foods and medicines.
CO4	Understand the basic knowledge on genetic engineering and genetically modified crop.

CO-PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	2	2	-	-	2	-	3	2	1
CO2	3	3	-	-	2	2	2	-	2	2	-	3	2	2
CO3	3	3	-	-	-	1	-	-	2	-	-	2	3	3
CO4	3	3	1	-	3	2	3	2	-	-	2	3	3	1

Course Contents:

Module I (8L)

Methods for the microbiological examination of water and foods, Coliform bacteria, Coliform test; Foodborne illnesses and diseases.

Module II (8L)

Production of organic acids (vinegar, lactic acid), alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka).

Module III (8L)

Propagation of baker's yeasts; Microbial production of vitamins (B2 and B12), antibiotics (penicillin, streptomycin, tetracycline); SCP and mushrooms

Module IV (8L)

Basics of microbial genetics – Gene, DNA, RNA; Replication, transcription, transformation, transduction, conjugation, translation; Regulation of gene expression; Application in GM foods with case studies.

Revision: (4L)

Text Book:

1. Industrial Microbiology Prescott & Dunn, CBS Publishers
2. Food Microbiology; Frazier WC; 4th ed, Tata-McGrawhill Pub.
3. Modern Food Microbiology by Jay JM, CBS Publishers

4. Microbiology by Pelczar, Chan, and Krieg, TMH

Reference books:

1. Comprehensive Biotechnology by Murray & Mooyoung, Academic press

2. Industrial Microbiology by Casida L.R., New Age International Pvt. Ltd.

3. Fermentation Biotechnology, Principles, Processed Products by Ward OP, Open University Press.

Course Name: Environmental Biotechnology

Course Code: FT402B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of Food, Food Microbiology, Environmental Engineering

Course Objective:

O1: To help the students understand various toxic and hazardous substances in environment

O2: To understand food safety and safe environment.

Course outcome(s):

After completion of the course students will able to:

CO1	Describe biotechnology and microbiological quality of water and air.
CO2	Identify management methods of wastes.
CO3	Demonstrate about marine pollution.
CO4	Analyze genetic engineering and genetically modified crop.

CO-PO-PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	2	2	-	-	2	-	3	2	1
CO2	3	3	-	-	2	2	2	-	2	2	-	3	2	2
CO3	3	3	-	-	-	1	-	-	2	-	-	2	3	3
CO4	3	3	1	-	3	2	3	2	-	-	2	3	3	1

Course Contents:

Module I (8L)

Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

Module II (8L)

Sources, generation, classification & composition of solid wastes. Solid waste management methods. Coliform test of water.

Module III (8L)

Marine pollution, sources of marine pollution and its control. Effects of pollutants on human beings, plants, animals and climate.

Module IV (8L)

Gene, RNA, DNA, Basic techniques in genetic engineering, GM crop.

Revision: (4L)

Text Books:

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry – Manhan

Reference Books:

1. Environmental hazards & human health R.B. Philip
2. Toxicology - principles & applications – Niesink & Jon devries
3. Solid Waste Management CPCB. New Delhi.
4. Principles of Biochemistry - Lehninger

Course Name: Industrial Biotechnology

Course Code: FT402C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of Food, Food Microbiology, Environmental Engineering

Course objectives:

O1: To understand the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.

O2: To understand the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures.

Course Outcomes:

At the end of the course, the students will be able

CO1	To explain the steps involved in the production of bio products and methods to improve modern biotechnology.
CO2	To apply basic biotechnological principles, methods and models to solve biotechnological tasks.
CO3	To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.
CO4	To design and deliver useful modern biotechnology products to the Society.

COs-POs-PSOs Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	3	2	-	-	-	3	2	1
CO2	3	-	-	-	1	1	1	-	-	2	-	3	2	2
CO3	3	2	2	-	-	2	3	-	2	2	1	2	3	3
CO4	3	-	-	2	2	2	3	-	-	-	1	3	3	1

Course Contents:

Module I (8L)

Introduction to Industrial Bioprocess:

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

Module II (8L)

Production of Primary and secondary Metabolites:

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols. Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

Module III (8L)

Production of Enzymes and Other Bioproducts:

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.

Module IV (8L)

Production Modern Biotechnology Products:

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines.

Bioprocess strategies in Plant Cell and Animal Cell culture.

Revision: (4L)

Text Books:

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.

2. Kumar, H.D. "A Textbook on Biotechnology" 2nd Edition. Affiliated East West Press Pvt. Ltd., 1998.

3. Balasubramanian, D. et al., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004.

4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2nd Edition Cambridge University Press, 2001.

5. Dubey, R.C. "A Textbook of Biotechnology" S. Chand & Co. Ltd., 2006.

References Books:

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.

2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.

3. Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2000.

4. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprintof Elsevier) 2004.

5. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2nd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.

6. C.F.A Bryce and EL. Mansi, Fermentation microbiology & Biotechnology, 1999.

7. K. G. Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S. Chand publications.

Course Name: Fluid Mechanics and Heat Transfer

Course Code: FT403A

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre-requisites: Engineering Mathematics, Basic Physics

Course Objective:

O1: To introduce history, importance and components of fluid mechanics & heat transfer, concepts of unit operations and unit processes, and current scenario of chemical & allied process industries.

Course Outcome(s):
By the end of the course, students will be able to:

CO1	Apply conservation laws to describe fluid behavior in food processing systems.
CO2	Evaluate fluid transport systems such as pipelines and pumps used in food plants.
CO3	Apply fundamental principles of conduction, convection, and radiation heat transfer in food processing scenarios.
CO4	Integrate heat and fluid flow analysis in thermal food operations such as pasteurization, sterilization, evaporation, and drying.

CO – PO-PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	1	-	-	-	-	2	3	2	1
CO2	3	3	3	2	3	2	-	-	1	2	2	3	2	1
CO3	3	3	2	2	2	1	-	-	-	-	2	3	2	1
CO4	3	3	3	3	3	2	-	-	1	2	3	3	3	2

Course Contents:

Module 1: Fluid Properties and Fluid Statics (4L)

Properties of fluids: density, viscosity, surface tension, compressibility, Pressure and pressure measurement (manometers, Bourdon gauge), Pascal's law, hydrostatic law, buoyancy and stability

Module 2: Fluid Dynamics and Flow Through Pipes (10L)

Types of fluid flow: laminar and turbulent, Reynolds number, Bernoulli's equation and its applications in food plants, Head loss due to friction, minor losses in fittings, Flow through pipes: Darcy-Weisbach equation, Pumps and fans: types, performance curves, NPSH

Module 3: Introduction to Heat Transfer (10L)

Modes of heat transfer: conduction, convection, radiation, Fourier's law of heat conduction; thermal conductivity of food materials, Newton's law of cooling, heat transfer coefficients, Introduction to radiation heat transfer

Module 4: Conduction and Convection in Food Processing (10L)

Steady and unsteady state heat conduction: slab, cylinder, sphere, Convection heat transfer: natural vs. forced convection, Boiling and condensation heat transfer, Use of extended surfaces (fins) in heat exchangers

Module 5: Heat Exchangers and Thermal Applications in Food Industry (10L)

Classification and types of heat exchangers (plate, shell-and-tube, scraped surface), Log Mean Temperature Difference (LMTD) and NTU methods, Applications: Pasteurizers, evaporators, dryers, blanchers, Design considerations for heat exchangers in food plants

Revision: (4L)

Text Book:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition

2. Transport Processes & Unit operations: Geankopolis, PHI, 3rd edition

3. Introduction to Chemical Engineering: Walter L. Badger, Julius T. Banchero, Julius T. Bancheo

Reference Books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann

2. Heat Transfer: D.Q. Kern, MGH

3. Foust, A.S., Wenzel, L.A., et.al. Principles of Unit Operations, 2nd edition, JWS

Perry, Chilton & Green, Chemical Engineers' Handbook, MGH

Course Name: Mass Transfer I

Course Code: FT403B

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Physics, Chemistry, Mathematics, Engineering Thermodynamics

Course Objective:

O1: To impart knowledge on the fundamentals of mass transfer phenomenon.

O2: To explain the principles of mass transfer and their application to separation and purification processes.

Course Outcome(s):

After Completion of the course, students will be able to:

CO1	Understand the principles of molecular and turbulent diffusion and interphase mass transfer in gas, liquid, and solid systems.
CO2	Apply fundamental mass transfer concepts to analyze and design operations like absorption, stripping, humidification, and crystallization.
CO3	Evaluate the performance of mass transfer equipment using equilibrium relationships, empirical correlations, and theoretical models.
CO4	Design basic mass transfer equipment such as packed columns, cooling towers, and crystallizers, considering operational constraints and efficiencies

CO – PO-PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	2	1	-	-	-	-	2	3	2	1
CO2	3	3	2	2	3	1	-	-	-	-	2	3	2	1
CO3	2	3	2	3	3	2	-	-	1	1	2	3	2	1
CO4	2	2	3	2	3	2	1	1	2	2	3	3	3	2

Course Contents:

Module I: Fundamentals of Diffusion and Interphase Mass Transfer (8L)

Molecular and turbulent diffusion, Fick's Law of diffusion, Diffusion coefficient: dependence on temperature, pressure, and composition, Estimation and measurement of diffusivity, Diffusion in multi-component gas mixtures, Diffusion in solids: molecular, Knudsen & surface diffusion

Module II: Interphase Mass Transfer Applications (10L)

Interphase mass transfer and mass transfer coefficients, Diffusion between phases, Equilibrium solubility of gases in liquids, Mass transfer theories, Mass transfer in fluidized beds, Flow past solids and boundary layers, Simultaneous heat and mass transfer

Module III: Gas Absorption and Stripping Operations (10L)

Gas-liquid equilibrium, Henry's law, Absorption in tray and packed columns, Equipment and solvent selection, HTU, NTU, HETP concepts, Design equations for packed column, Absorption with chemical reaction, Heat and mass transfer in packed columns

Module IV: Humidification and Cooling Techniques (8L)

Vapour-liquid equilibrium and vapour pressure-temperature relationships, Vapour-gas mixtures and humidity relations, Humidification and dehumidification fundamentals, Wet bulb temperature, adiabatic & non-adiabatic operations, Evaporative cooling, Design and classification of cooling towers

Module V: Crystallization Principles and Equipment Design (8L)

Equilibrium yield and theory of crystallization, Heat and mass transfer in crystallization, Nucleation and crystal growth, Factors affecting crystal properties, Controlled crystal growth, Classification and design of crystallizers

Revision: (4L)

Text Books:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5thedition
2. Transport Processes & Unit operations: Geankopolis, PHI, 3rd edition
3. Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY
4. Geankoplis, C.J. ―Transport Processes and Unit Operations‖, 3e, Prentice Hall (I)

Reference Books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
2. Heat Transfer: D.Q. Kern, MGH
3. Foust, A.S., Wenzel, L.A., et.al. Principles of Unit Operations, 2nd edition, JWS
4. Perry, Chilton & Green, Chemical Engineers' Handbook, MGH

Course Name: Mechanical Operations and Separation Process I

Course Code: FT403C

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Physics, Chemistry, Mathematics, Engineering Thermodynamics

Course Objective:

O1: To understand different type of Mechanical operations like crushing and Grinding and Sieve separation technique

O2: To apply their knowledge in different types of separation processes like centrifugation, filtration, extraction, drying and crystallization

Course Outcome(s):

After Completion of the course students will be able to:

CO1	Apply the principles of particle size reduction, mixing, agitation, and mechanical separations like screening and filtration.
CO2	Analyze unit operations such as centrifugation, sedimentation, and crystallization.
CO3	Evaluate the performance of extraction, leaching, and drying operations using material balances and stage-wise analysis.
CO4	Analyze and assess advanced membrane-based separation technologies for specialized industrial applications.

CO – PO-PSO Mapping

COs	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	2	-	-	-	-	-	1	3	2	1
CO2	3	3	2	2	2	-	-	-	1	1	2	3	2	1
CO 3	3	3	2	3	2	-	-	-	1	1	2	3	2	1
CO 4	2	3	2	2	3	-	1	1	1	2	2	3	3	2

Course Contents:

Module I: Fundamentals of Mechanical Operations (8L)

Principles of comminution, Types of comminuting equipment, Energy and power requirement in size reduction, Crushers and grinders, Mixing and agitation

Module II: Mechanical Separation Techniques – I (8L)

Screening and classification, Types of screens and screen effectiveness, Filtration: principles of constant pressure and constant rate filtration, Filtration equipment

Module III: Mechanical Separation Techniques – II (10L)

Centrifugation: principles, devices, types (free and hindered settling), Sedimentation and flocculation, Hydraulic and heavy media separation, Introduction to crystallizer design, Material and energy balances in crystallization

Module IV: Extraction and Drying Operations (10L)

Liquid-liquid extraction: selectivity and solvent choice, Equilibrium stages and graphical methods, Leaching: principles and material balances, Batch drying: mechanism and stages

Module V: Advanced Separation Processes (8L)

Dialysis and ultrafiltration, Reverse osmosis and pervaporation, Electrodialysis, Membrane separation: principles and applications

Revision: (4L)

Text Books:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5thedition
2. Transport Processes & Unit operations: Geankopolis, PHI, 3rdedition
3. Introduction to Chemical Engineering: Walter L. Badger, Julius T. Banchero, Julius T. Bancheo

Reference Books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
2. Foust, A.S., Wenzel, L.A., et.al. Principles of Unit Operations, 2nd edition, J WS
3. Perry, Chilton & Green, Chemical Engineers' Handbook, MGH
4. Fundamentals of Food Process Engineering R.T. Toledo CBS publication
5. Food Processing Technology P.J. Fellows CRC press

Course Name: Bakery, Confectionery and Extruded Foods

Course Code: FT404

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of Food, Food Preservation, Food Microbiology

Course Objective:

O1: To enable students to understand the functional properties of various ingredients used in bakery and confectionery products.

O2: To provide knowledge on the different processing techniques and machinery involved in the production of bakery and confectionery items.

O3: To familiarize students with industry practices related to safety, hygiene, and quality control in bakery and confectionery production.

O4: To develop the ability to apply theoretical knowledge in maintaining operational efficiency and compliance in bakery and confectionery industries.

Course outcome(s):

After completion of the course, the students will be able to

CO1	**Articulate** the operations of different bakery and extrusion process and role of ingredients
CO2	**Analyze** the different bakery confectionery and extruded food items
CO3	**Apply** this knowledge for technological improvement of bakery products
CO4	**Assess** the importance of various operations in extrusion plan

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	-	-	-	-	2	3	2	1
CO2	3	2	2	2	2	3	2	-	2	-	3	3	2	2
CO3	3	3	3	2	2	2	2	2	3	2	3	3	3	3
CO4	3	3	3	3	2	3	3	2	3	2	3	3	3	3

Course Contents:

Module I (10L)

Introduction to baking; Bakery ingredients and their functions; Machines and equipment for batch and continuous processing of bakery products; Testing of flour

Module II (9L)

Preparation techniques of different baked products: bread, cake and biscuits, cookies; pies and pastries, Analysis of bakery products; Maintenance, safety and hygiene of bakery plants.

Module III (9L)

Preparation techniques of confectionary:

Candies: Introduction. Crystalline and non-crystalline candies. Variation of sugar-water ratio at different temperatures to produce crystalline candies. Super-saturation, nucleation, crystal growth dependable factors. The ingredients required for candies.

Chocolates: Introduction. Different ingredients require for chocolate preparation and their functions. Type of chocolates. Description of chocolate preparation by using definite flow diagram. Problems and solutions for chocolate making.

Module IV (8L)

Importance and applications of extrusion in food processing; Pre and post extrusion treatments; Manufacturing process of extruded products: Texturized vegetable protein & meat analogue; Change of functional properties of food components during extrusion. Animal protein replacing by extruded vegetable proteins.

Text Books:

1. Zhou, W., Hui, Y. H., De Leyn, I., Pagani, M. A., Rosell, C. M., Selman, J. D., & Therdthai, N. Bakery Products Science and Technology.

2. Sharma, M., Singla, M., Rani, S., & Noor, N. Technology of Miscellaneous Bakery Products.

3. Hui, Y. H., Corke, H., De Leyn, I., Nip, W. K., & Cross, N. A. (Eds.). (2008). Bakery products: science and technology. John Wiley & Sons.

4. Minifie, B. (2012). Chocolate, cocoa and confectionery: science and technology. Springer Science & Business Media.

5. Harper, J. M. (2019). Extrusion of foods. CRC press.

Reference Books:

1. Up to-date Bread Making; Fance WJ & Wrogg BH; 1968, Maclasen & Sons Ltd.

2. Modern Cereal Chemistry; Kent-Jones DW & Amos AJ; 1967, Food Trade Press Ltd.

Course Name: Food Packaging Technology

Course Code: FT405

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of Food, Food Process Engineering, Principles of Food Preservation

Course Objective: To help the students identify the importance of packaging in the food industry and understand the recent developments in food packaging.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	**Define** food packaging and explain its function for different food packaging materials.
CO2	**Identify** potential use of different packaging materials in context to industry and environment.
CO3	**Perceive** knowledge of bio composite and biodegradable materials for safe food packaging including active and intelligent packaging.
CO4	**Adap**t rules of different statutory and regulatory bodies in food packaging and disposal protocols for food packaging in industries.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	2	2	2	1	3	3	2	2
CO2	3	3	3	3	3	2	3	3	2	2	3	3	2	3
CO3	3	1	2	3	3	3	3	3	3	3	3	3	2	3
CO4	3	3	2	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I: (8L)

Functions of packaging; Type of packaging materials; Selection of packaging material for different foods; Selective properties of packaging film; Methods of packaging and packaging equipment

Module II: (8L)

Mechanical strength of different packaging materials; Printing of packages; Barcodes & other marking; Interactions between packaging material and foods; Environmental and cost consideration in selecting packaging materials.

Module III: (8L)

Manufacture of packaging materials; Potential of biocomposite materials for food packaging; Packaging regulations; Packaging and food preservation; Disposal of packaging materials.

Module IV: (8L)

Testing of packaging; Rigid and semi rigid containers; Flexible containers; Sealing equipment; Labelling; Aseptic and shrink packaging; Secondary and transport packaging. Advances in Packaging Technologies; MAP, CAP, Active packaging, Intelligent Packaging, Nano-Packaging, Irradiated food Packaging.

Revision: (4L)

Text Books:

1. Food Packaging: Principles and Practice by G. L. Robertson. Taylor & Francis Inc.

2. Food Packaging Technology by Richard Coles, Derek MC Dowell and Mark J. Kirwan. Blackwell Publishing, CRC Press.

3. Food and Packaging Interactions by Joseph H. Hotchkiss, (ACS symposium series -365, April 5-10, 1987, American chemical society, Washington DC,1988.)

Reference Books:

1. Food and Packaging Interactions by Joseph H. Hotchkiss, (ACS symposium series -365, April 5-10, 1987, American chemical society, Washington DC,1988.)

2. Packaging foods with plastics by winter A. Jenkins & James P Harrington – Technomic

publishing co. Inc, Lancaster.Basel.

3. Flexible food packaging (Question & Answers) by Arthur Hirsch VNB – Van Nostrand Reinhold, New York (An AVI Book), ISBN0-442-00609-8.

4. Food Packaging and Preservation (theory & practice) by M.Mathlouthi-Elsevier Applied science publisher, London and NewYork.

5. Food Packaging Materials (Aspect of Analysis & Migration of contaminants) by N.T.crosby applied science publishers LTD.London.

6. Plastics in Packaging by A.S Athlye, TMGH, New Delhi.

7. Packaging (specifications, purchasing & Quality Control) 3rd edition by Edmond A Leonard- Marcel Dekker, INC- Newyork &Basel.

8. Plastics in packaging by forwarded by H.B Ajmera & M.R Subramanium – Indian institute of packaging. Published by A.P.Vaidya, Secretary II, E2, MIDC, Industrial Area (Andheri (East),Bombay-400093.

9. Food Packaging- Stanley Sacharois & Roger C. Griffin- The AVI Publishing Company Inc. 1970.

10. Principles of packaging development- Griffin & Sacharow. (The AVI Publishing company, Inc. 1972).

Course Name: Chemical Engineering Thermodynamics and Kinetics

Course Code: CH(FT)401

Contact: 3:0:0

Total Contact

Hours: 36

Credit: 3

Pre-requisites: Physics, Chemistry, and Mathematics

Course Objective:

O1: To introduce the fundamental principles of chemical engineering thermodynamics.

O2: To illustrate the application of thermodynamic principles in the design and operation of chemical process plants.

O3: To develop an understanding of reaction kinetics for single, multiple, isothermal, and non-isothermal reactions.

Course Outcome(s):

After completion of the course, students will be able to:

CO1	**Understand** the basic concept of engineering thermodynamics and its applications in the engineering field
CO2	**Interpret** the phase equilibria in two-component and multi-component systems
CO3	**Analyze** thermodynamic properties of substances in the gas or liquid state of an ideal and real mixture.
CO4	**Identify** the concepts of order and molecularity of chemical reactions.

CO-PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	2	2	–	–	–	–	–	2	3	2	–
CO2	3	2	–	2	2	–	–	–	–	–	2	3	2	–
CO3	3	3	–	2	3	–	–	–	–	–	2	3	3	–
CO4	2	2	–	1	1	–	–	–	–	–	1	2	2	1

Course Contents:

Module I (8L)

PVT behavior of Pure Substances; Virial Equation of State, Generalized Correlations for Gases and Liquids; Application of the Virial Equations; Cubic Equations of State; The Nature of Equilibrium; The Phase Rule; Duhem's Theorem.

Module II (8L)

Simple models for vapour/liquid Equilibrium, Raoult's Law, Henry's Law, Modified Raoult's Law, Vapour Liquid Equilibrium, K-value correlations; VLE from Cubic Equations of State; Equilibrium and Stability; Liquid/liquid equilibrium; Solid/liquid equilibrium; Solid/vapour equilibrium.

Module III (8L)

Thermodynamics and its Applications: The Chemical Potential and Phase Equilibria, Fugacity and Fugacity Coefficient: for pure species and solution; Generalized correlations for Fugacity, the Ideal Solution, Property Changes and Heat Effects of Mixing Processes. The Vapour-Compression Cycle, the Choice of Refrigerant, Absorption, Refrigeration and liquefaction: Low temperature cycle: Linde and Claude.

Module IV (8L)

Kinetics: Rate of chemical reaction; Effect of Temperature on Rate Constant, Arrhenius equation; Transition State Theory; Order and Molecularity of a Chemical reaction, Elementary Reactions, First and Second order reactions, Non-Elementary Reactions, Pseudo-first order reaction,

Determination of rate constant and order of reaction, Half-life method.

Revision: (4L)

Text Book:

1. Smith & Vanness, Thermodynamics for Chemical Engineers, McGraw-Hill

2. Richardson, J.F., Peacock, D. G., Coulson & Richardson's Chemical Engineering- Volume 3rd ed.. First Indian ed. Asian Books Pvt. Ltd.1998

Reference Books:

1. Levenspiel. O., Chemical Reaction Engineering, Wiley Eastern Ltd.

2. Bailey & Olis, Biochemical Engg. Fundamentals, MGH,1990

3. Physical Chemistry: Castellan, Narosa Publishing.

4. Physical Chemistry; Moore, PHI

Course Name: Food Biotechnology Lab

Course Code: FT491A

Contact: 0:0:3

Credit: 1.5

Pre requisites: Principles of Food Preservation, Unit Operation, Food Microbiology

Course Objective:

O1: To help the students understand various methods of isolation, characterization and screening of bacteria, fungi and other related organisms and apply different preservation and fermented food production techniques relative to food safety and spoilage.

Course outcome(s):

After the completion of this course students will be able to:

CO1	Understand biotechnological processing/engineering principles to variety of fermented products.
CO2	Develop new fermented products.
CO3	Interpret the data in scientific format.
CO4	Identify new development in this field with analytical thinking of the various aspects of the new technology.

CO-PO-PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	2	2	-	2	-	-	3	2	2
CO2	3	2	2	-	-	-	1	-	2	2	2	3	2	3
CO3	3	3	2	2	-	-	-	2	1	2	-	3	2	3
CO4	3	2	-	-	2	2	-	1	1	-	1	2	3	1

List of Experiments:

1. Isolation and enumeration of probiotic bacteria from yogurt
2. Fermentation of milk to curd using starter culture and titratable acidity determination.
3. Immobilization of yeast cells / enzymes using alginate beads.
4. Observation of the propagation of the baker's yeast
5. Fortified agar gel preparation
6. Isolation of lycopene from tomato peel and analysis by spectrophotometry
7. Pectin extraction from fruit peels
8. Detection of various types of microorganism in different food items
9. Innovative experiment.

Text Book:

1. Fundamental Principles of Bacteriology – A. J. Salle

Reference Book:

1. Food Microbiology – M. R. Adams, M. O. Moss.

Course Name: Environmental Biotechnology Lab

Course Code: FT491B

Contact: 0:0:3

Credit: 1.5

Pre requisites: Environmental Engineering, Unit Operation, Food Microbiology

Course Objective:

O1: To help the students to measure chemical, and bacteriological parameters of food, water and wastewater. Laboratory methods and interpretation of results with regard to environmental engineering applications such as design and operation of water and wastewater treatment processes, and to the control of the quality of natural water.

Course outcome(s):

After completion of the course students will able to:

CO1	Describe the biochemical processes.
CO2	Explain quality of water and food.
CO3	Interpret data in scientific format.
CO4	Identify development in this field with analytical thinking of the various aspects of the new technology.

COs-POs-PSOs Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	1	3	-	1	-	2	-	-	3	2	3
CO2	3	3	2	-	3	2	2	-	2	-	-	3	2	2
CO3	3	3	3	3	-	-	1	-	2	2	3	2	2	3
CO4	3	-	3	2	3	2	2	2	3	3	3	3	3	2

List of Experiments:

1. To determine an unknown protein concentration by plotting a standard graph of BSA using UV- Vis Spectrophotometer and validating the Beer- Lambert's Law.
2. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
3. Microbial degradation of Oil.
4. Bioaccumulation of dye through phytoremediation.
5. Removal of dye from water by absorption/adsorption.
6. Valorization of fruit/vegetable peel waste.
7. Coliform Test of water.
8. Innovative experiment.

Text Books:

1. An Introduction to Practical Biochemistry – David T. Plummer
2. Fundamental Principles of Bacteriology – A. J. Salle

Reference Book:

1. Food Microbiology – M. R. Adams, M. O. Moss.

Course Name: Industrial Biotechnology Lab

Course Code: FT491C

Contact: 0:0:3

Credit: 1.5

Pre requisites: Food Microbiology

Course Objective:

O1: To help the students understand various methods of isolation, characterization and screening of bacteria, fungi and other related organisms and apply different preservation and fermented food productions techniques relative to food industry standards.

Course outcome(s):

After the completion of this course students will be able to:

CO1	Understand industrial processing/engineering principles to variety of fermented products.
CO2	Develop new fermented products using biological agents.
CO3	Interpret the data in scientific format.
CO4	Identify new development in this field with analytical thinking of the various aspects of the new technology.

CO-PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	2	-	2	-	2	3	2	2
CO2	3	2	2	-	-	-	1	-	2	2	2	3	2	3
CO3	3	3	2	2	-	-	-	2	1	2	2	3	2	3
CO4	3	2	-	-	2	2	-	1	1	-	2	2	3	1

List of Experiments:

1. Preparation of organic bio fertilizer for crop growth
2. Study of the alcohol fermentation process by yeast from raw grape
3. Study of the growth kinetics of baker's yeast
4. Degradation of vegetable oil by microbes.
5. Preparation of cottage cheese
6. Preparation and Preserving Sauerkraut
7. Entrapment of spice extract in hydrogel
8. Inhibition of microbial growth by antibiotics
9. Detection of adulteration in food sample
10. Innovative experiment.

Text Book:

1. Fundamental Principles of Bacteriology – A. J. Salle

Reference Book:

1. Food Microbiology – M. R. Adams, M. O. Moss.

Course Name: Fluid Mechanics and Heat Transfer Lab

Course Code: FT492A

Contact: 0:0:3

Credit: 1.5

Pre requisites: Physics, Chemistry, Mathematics, Engineering Thermodynamics

Course Objective:

O1: To learn analytical experimental methods using sophisticated instruments and interpretation of experimental data.

Course outcome(s):

After the completion of the laboratory course students will be able to:

CO1	Apply the process equipment via hands-on learning.
CO2	Analyze the experiments on flow regime and different flow meter
CO3	Measure the Overall heat transfer coefficient of heat exchangers
CO4	Determine the pressure drop for flow through packed bed.

CO-PO-PSO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	-	2	3	-	-	2	2	-	1	3	2	1
CO2	3	3	-	2	3	-	-	1	2	-	1	3	2	1
CO3	3	2	-	3	3	-	-	1	2	-	1	3	2	1
CO4	3	3	-	3	3	-	-	1	2	-	1	3	3	2

Course Contents:

1. Experiments on Reynolds's Apparatus –Determination of flow regime and construction of friction factor against NRE

2. Experiments on flow measuring device — in closed conduit using (a) Venturimeter, (b) Orifice meter, (c) Rotameter

3. To determine pressure drop for flow through packed bed & verification of Ergun Equation, Kozeny- Karman equation, Blake-Plummer Equation

4. To determine the rate of heat transfer through double pipe heat exchanger with parallel and countercurrent flow

5. To determine the Overall heat transfer coefficient of a concentric pipe heat exchanger based on the inside and outside diameter of the tube

6. To study the viscosity of processed food (Jam, Jelly, Ketchap, Edible oils) with varying shear stress

7. To study the flow characteristics of processed food (Jam, Jelly, Ketchup, Edible oils) by Rheometer and verification of power law with graphical interpretation

8. Innovative Experiments

Text Books:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition
2. Transport Processes & Unit operations: Geankopolis, PHI, 3rd edition

Reference Books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
2. Transfer: D.Q. Kern, MGH

Course Name: Mass Transfer Lab I

Course Code: FT492B

Contact: 0:0:3

Credit: 1.5

Pre requisites: Physics, Chemistry, Mathematics, Engineering Thermodynamics

Course Objective:

O1: To impart knowledge about the basic fundamental principles of mass transfer by performing different experiments

O2: To make them correlate theory and practical process by experimentation.

Course outcome(s):

After the completion of the laboratory course students will be able to:

CO1	Analyze the data on diffusion coefficient and mass transfer coefficient.
CO2	Study the characteristics of packed bed absorption column
CO3	Discuss the working of a cooling tower and temperature drop in a fluid inside it.
CO4	Apply the working mechanism of crystallizer and dryer

CO-PO-PSO Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	3	3	-	-	1	2	-	1	3	2	1
CO2	2	3	-	2	3	-	-	2	2	-	1	3	2	1
CO3	2	2	-	2	3	-	-	2	2	-	1	3	2	1
CO4	2	2	-	2	3	-	-	2	2	-	1	3	3	2

Course Contents:

1. To determine Mass transfer coefficient / kLa
2. To determine the Gas-phase mass-transfer coefficient in wetted wall column
3. To determine the diffusion co-efficient of an organic vapor (naphthalene) in air.
4. To estimate the Solid liquid mass-transfer coefficient for dissolution of benzoic acid in water.
5. To study the absorption of a gas in a packed column and calculation of NTU and HTU
6. To study flooding and loading characteristic of Packed bed absorption column
7. To find out crystal yield in batch crystallizer
8. To study working and operation of the cooling tower
9. Innovative Experiments

Text books:

1. Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY,
2. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition
3. Transport Processes & Unit operations: Geankopolis, PHI, 3rd edition

Reference books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
2. J.D. Seader & Henley E. J., "Separation Process Principles‖ 2e, Wiley India Pvt. Ltd

Course Name: Mechanical Operations and Separation Process I Lab

Course Code: FT492C

Contact: 0:0:3

Credit: 1.5

Pre requisites: Physics, Chemistry, Mathematics, Engineering Thermodynamics

Course Objective:

O1: To learn analytical experimental methods using sophisticated instruments and interpretation of experimental data.

Course Outcome:

After the completion of the course students will be able to:

CO1	Plan experiments and present the experimental data meaningfully
CO2	Apply theoretical concepts for data analysis and interpretation
CO3	Analyze chemical engineering unit operations related to comminution
CO4	Apply different separation processes like centrifugation, filtration, extraction, drying, and crystallization.

CO-PO-PSO Mapping:

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	-	3	3	-	-	2	2	-	1	3	2	1
CO2	3	3	-	3	3	-	-	2	2	-	1	3	2	1
CO3	3	3	-	2	3	-	-	2	2	-	1	3	2	1
CO4	3	3	-	3	3	-	-	2	2	-	1	3	3	2

Course Contents:

1. To study the working characteristics of a Jaw Crusher, calculate the energy consumption as a function of size reduction and compare it with the actual energy requirements
2. To study the working characteristics of a Ball Mill, calculate the energy consumption as a function of size reduction and determine the critical speed
3. To determine filter medium resistance & cake resistance in cake filtration.
4. To determine separation coefficient in centrifugation.
5. To determine separation coefficient by vacuum evaporation using Rotary Vacuum Evaporator
6. To determine drying rates of food using different types of driers (Tray Drier, Fluidized bed Drier, Freeze Drier, Spray Drier
7. Innovative Experiment

Text Books:

1. Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY,
2. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition
3. Transport Processes & Unit operations: Geankopolis, PHI, 3rd edition

Reference Books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
2. J.D. Seader & Henley E. J., "Separation Process Principles‖ 2e, Wiley India Pvt. Ltd.

3rd Year 5th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT501	Food Process Technology–III (Milk and Milk Products)	3	0	0	3	3
2	ENGG	Major	FT502A/B/C	A. Mass Transfer II B. Mechanical Operation and Separation Process II C. Transport Phenomena	3	1	0	4	4
3	ENGG	Major	FT503	Applied Microbial Technology for Industry	4	0	0	4	4
4	ENGG	Major	FT504	Food Process Technology–IV (Edible Fats and Oils)	3	0	0	3	3
5	HUM	Value Added Course	HU501	Research Methodology and IPR	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	FT591	Food Processing Lab I	0	0	3	3	1.5
2	ENGG	Major	FT592A/B/C	A. Mass Transfer II lab B. Mechanical Operation and Separation Process II Lab C. Transport Phenomena Lab	0	0	3	3	1.5
3	ENGG	Major	FT593	Applied Microbial Technology for Industry Lab	0	0	3	3	1.5
4	ENGG	Major	FT594	Food Analysis and Quality Control Lab-1	0	0	4	4	2
5	PRJ	Project	FT581	Project-II	0	0	4	4	2
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC581	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives	0	0	0	0	0
Total of Theory, Practical								32	23.5

Course Name: Food Process Technology – III (Milk and Milk products)

Course Code: FT501

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of Food, Food Preservation, Food Microbiology

Course Objective:

O1: To provide an opportunity for students to classify different processing techniques required for preservation of milk and classify the different by products related to this industry.

Course outcome(s):

After completion of the course, the students will be able to

CO1	Explain the definition, composition, and types of milk, along with various methods used to detect adulterants in milk.
CO2	Demonstrate an understanding of thermal processing techniques for milk and milk products, and explain the procedures for cleaning and sanitizing dairy industry equipment.
CO3	Apply basic problem-solving skills related to milk drying processes and classify various types of dried milk products.
CO4	Design and prepare a range of milk-based and traditional Indian dairy products.

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	3	-	-	-	3	3	2	3
CO2	3	2	2	1	-	1	2	1	-	-	3	3	2	3
CO3	3	3	2	2	-	-	2	-	-	-	3	3	3	2
CO4	3	3	2	1	-	3	3	2	-	-	3	3	2	2

Course Content:

Module I (10L)

Definition of milk, Composition of milk, Varieties of milk, Nutritional values, Checks for purity of milk and adulteration in milk, Cleaning and sanitization, HACCP of processing unit.

Module II (10L)

Thermal processing of fluid milk – Pasteurization (LTLT, HTST & UHT), Packaging of fluid milk, Fermentation of milk and fermented milk products – Cheese, Yogurt, Curd, Kefir, Kumis, Flavored yogurt, Therapeutic value of Fermented Products, concept of Probiotics, prebiotics and probiotics dairy products

Module III (8L)

Processing of evaporated and dried milk products – Milk powder, Malted milk and Infant formulae. Manufacturing and standardization of Cream, butter/butter oil, ghee, ice cream, Cheese, Simple problems based on milk drying, standardization, etc.

Module IV (4L)

Traditional Indian sweets- Kheer, Paneer, Channa, Srikhand, Dairy processing by-products: and Production of lactose and protein from whey. Application of technologies in dairy industry

Revision: (4L)

Text Books:

1. Outlines of Dairy Technology, De S; Oxford.
2. Milk & Milk Processing; Herrington BL; 1948, McGraw-Hill Book Company.

Reference Books:

1. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.
2. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.
3. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.

Course Name: Mass Transfer II

Course Code: FT502A

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Engineering Thermodynamics, Mass Transfer I

Course Objective:

O1: To impart knowledge on fundamentals of mass transfer phenomena and to apply those concepts to real engineering problems.

O2: To explain the principles of mass transfer and their application to separation and purification processes

Course Outcome(s):

After Completion of the course students will be able to:

CO1	Apply the thermodynamic and phase equilibrium principles of distillation and their practical applications.
CO2	Apply analytical and graphical methods to design and analyze multistage distillation systems and special distillation operations.
CO3	Analyze extraction systems (liquid-liquid, solid-liquid) using equilibrium data and stage-wise mass transfer concepts.
CO4	Evaluate and design drying systems based on drying rate curves, equilibrium, and material characteristics.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	-	-	1	3	2	1
CO2	3	3	3	3	2	-	-	-	1	1	2	3	2	3
CO3	3	3	2	2	2	-	-	-	1	2	2	3	2	1
CO4	3	2	3	3	3	-	-	1	1	2	2	3	3	2

Course Contents:

Module I: Fundamentals of Distillation (8L)

Vapor-liquid equilibrium: Raoult's Law and its applications, Pressure-composition, Temperature-concentration, and Enthalpy-concentration diagrams for ideal and non-ideal systems, Relative volatility, azeotropes (maximum and minimum boiling mixtures), Single stage distillation: Differential distillation, flash vaporization, Special distillation types: Vacuum, molecular, and steam distillation

Module II: Continuous and Multistage Distillation (10L)

Multistage contact operations, McCabe-Thiele method for binary mixtures, Reflux: minimum, maximum, and optimum, Tray efficiency, height of tower, and column diameter, Multistage batch distillation, Azeotropic and extractive distillation

Module III: Liquid–Liquid Extraction and Supercritical Fluid Extraction (10L)

Ternary liquid equilibria and triangular diagrams, Concept of theoretical/ideal stages, Equipment for single and multistage continuous extraction, Analytical and graphical solution for extraction operations, Introduction to supercritical fluid extraction

Module IV: Solid–Liquid Extraction (Leaching) (8L)

Fundamentals of leaching, Solid-liquid equilibria, Leaching equipment, Single-stage and multistage cross-current and counter-current leaching operations

Module V: Drying Operations (8L)

Solid-gas equilibrium and drying fundamentals, Moisture content definitions: bound vs. unbound moisture, Batch and continuous dryers: classification and operation, Rate and time of drying; drying mechanisms, Design aspects of continuous dryers

Revision: (4L)

Text Books:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5thedition
2. Transport Processes & Unit operations: Geankopolis, PHI, 3rdedition
3. Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY
4. Geankoplis, C.J. ―Transport Processes and Unit Operations‖, 3e, Prentice Hall (I)

Reference Books:

1. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
2. Heat Transfer: D.Q. Kern, MGH
3. Foust, A.S., Wenzel, L.A., et.al. Principles of Unit Operations, 2nd edition, JWS
4. Perry, Chilton & Green, Chemical Engineers' Handbook, MG

Course Name: Mechanical Operation and Separation Process II

Course Code: FT502B

Contact: 3:1:0

Total Contact

Hours: 48

Credit: 4

Pre requisites: Thermodynamics, Separation Process I

Course Objective:

O1: To learn conceptual design of separation processes and design of equipment involved.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	Apply advanced comminution, mixing, and filtration techniques
CO2	Apply knowledge of particle technology and solid handling in process design
CO3	Analyze complex drying systems and scale-up methodologies.
CO4	Evaluate modern hybrid and emerging separation technologies for industrial problems.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	1	3	2	1
CO2	3	3	2	-	2	-	-	-	-	1	2	3	2	1
CO3	3	2	3	2	3	-	-	-	1	1	2	3	2	3
CO4	2	3	3	3	3	1	-	-	-	2	3	3	3	2

Course Contents:

Module I: Advanced Comminution and Mixing (8L)

Mechanisms of fine grinding and ultrafine grinding, Design and operation of ball mills, jet mills, and fluid energy mills, Scale-up and energy considerations in size reduction, Mixing indices and mixing of pastes and powders, Industrial mixers and mixing equipment design

Module II: Advanced Filtration and Cake Washing (8L)

Filtration media and selection criteria, Compressible vs. incompressible cakes, Washing and drying of filter cakes, Filter aids and their industrial application, Advanced filter equipment: rotary drum filters, pressure leaf filters

Module III: Particle Technology and Transport (10L)

Particle size distribution and measurement techniques, Flow of solids through chutes and hoppers, Pneumatic and hydraulic conveying systems, Design of storage bins and silos, Erosion and attrition in particulate transport

Module IV: Drying Equipment and Scale-up (10L)

Continuous and multistage drying systems, Design and performance analysis of rotary, spray, and fluidized bed dryers, Drying of heat-sensitive materials, Scale-up principles in drying, Industrial case studies in food, pharma, and chemical sectors

Module V: Hybrid and Emerging Separation Techniques (8L)

Supercritical fluid extraction, Simulated moving bed and SMB chromatography, Freeze drying and lyophilization, Hybrid separation processes (membrane-distillation, adsorption-crystallization), Advances in nano-filtration and bio-separation

Revision: (4L)

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International student Edition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
3. Unit Operations in Chemical Engineering : McCabe, Smith, and Harriot. MGH, Sth Edn.

Reference books:

1. Multicomponent Distillation: Holland, C. D., PHI.
2. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
3. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.
4. Separation Processes: King, C. J. MGH.
5. Design of Equilibrium Stage Processes: Smith, B. D. MGH.

Course Name: Transport Phenomena

Course Code: FT502C

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Engineering Thermodynamics, Mass Transfer, Separation Process

Course Objective:

O1: To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	Apply the unified approach to Momentum, Heat, and Mass Transport and the underlying assumptions of Transport Phenomena.
CO2	Analyze the transport of momentum in different fluid systems, including both Newtonian and non-Newtonian fluids.
CO3	Evaluate the mechanisms and modes of heat transfer, including conduction and related phenomena.
CO4	Examine mass transport phenomena, including diffusion and related concepts.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	2	3	2	1
CO2	3	3	2	-	2	-	-	-	-	-	2	3	2	3
CO3	3	2	2	-	2	-	-	-	-	-	2	3	2	1
CO4	3	2	1	-	2	-	-	-	-	-	2	3	3	2

C**ourse Contents**:

Module I: Introduction to Transport Phenomena (8L)

Concept of unified approach to Transport Phenomena, Assumptions of Transport Phenomena, Similarity of Mass, Momentum, and Energy transfer, Diffusivities and Transport Theorem

Module II: Momentum Transport (10L)

Viscosity and Newton's law of viscosity, Calculation of momentum flux, Non-Newtonian fluids – Bingham model, Flow of a falling film with constant/variable viscosity, Flow through a circular tube, Laminar flow between two flat stationary/moving plates, Shape of the surface of a rotating fluid, Concept of Boundary layer and Boundary layer theory, Concept of turbulence

Module III: Energy Transport (10L)

Modes of heat transfer, Thermal conductivity – constant and temperature dependent, Thermal diffusivity and heat transfer coefficient, Fourier's law of heat conduction, Shell energy balance and boundary conditions, Heat conduction with electrical, nuclear, viscous, and chemical heat sources, Heat conduction through composite walls

Module IV: Mass Transport (8L)

Concentrations, Velocities, and Mass/Molar fluxes, Concept of Mass diffusivity and Mass transfer coefficient, Fick's law of diffusion, Shell mass balance and boundary conditions, Diffusion through stagnant gas film

Module V: Applications and Advanced Concepts in Transport Phenomena (8L)

Advanced transport models and applications, Coupled momentum, heat, and mass transport, Reactive and non-reactive systems, Real-world applications in chemical and industrial systems

Revision: (4L)

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International student Edition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
3. Unit Operations in Chemical Engfueering : McCabe, Smith, and Harriot. MGH, SthEdn.
4. Multicomponent Distillation: Holland, C. D., PHI.

Reference books:

1. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH. 2. Mass Transfer: Sherwood, Pigford, and Wilke, MGH
2. Separation Processes: King, C. J.MGH
3. Design of Equilibrium Stage Processes: Smith, B. D.MGH.

Course Name: Applied Microbial Technology for Industry

Course Code: FT503

Contact: 4:0:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Chemistry of Food, Food Preservation, Food Microbiology

Course Objective:

O1: To provide foundational knowledge of industrial microbial technology, including classification, screening, isolation, and maintenance of industrially important microorganisms.

O2: To develop an understanding of fermentation processes and bioreactor operations, emphasizing process parameters, control strategies, and reactor design.

O3: To impart knowledge on downstream processing techniques and product recovery methods used in microbial biotechnology for ensuring product quality.

O4: To explore the production, applications, and recent advancements in microbial products and technologies, focusing on sustainability, waste valorization, and regulatory considerations.

Course Outcomes (COs):

CO1	**Understand** and **explain** the role of industrially important microorganisms and their applications in bioprocess industries.
CO2	**Analyze** and **design** upstream and downstream processes used in microbial fermentations for various industrial products.
CO3	**Evaluate** microbial production processes and their optimization for industrial applications.
CO4	**Assess** the applications of recombinant DNA and probiotics in improving strains and enhancing bioprocesses.
CO5	**Discuss** recent advances, challenges, and ethical considerations in industrial microbial technology, including sustainability and waste utilization.

CO PO PSO mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	3	2	2	-	2	-	-	3	2	2
CO2	3	2	2	-	-	-	1	-	2	2	2	3	2	3
CO3	3	3	2	2	-	-	-	2	1	2	-	3	2	3
CO4	3	2	-	-	2	2	-	1	1	-	1	2	3	1
CO5	3	2	-	-	-	2	-	2	2	-	2	2	2	2

Course Contents:

Module I: (10L)
Fundamentals of Industrial Microbial Technology & Biotechnology, Classification of industrially important microorganisms, Screening, isolation, and preservation of industrial strains, Maintenance of microbial cultures (lyophilization, cryopreservation), Criteria for selecting industrial strains (yield, stability, safety).

Module II: (10L)
Fermentation Processes and Bioreactor Technology, Principles of microbial fermentation (batch, fed-batch, and continuous processes), Types of bioreactors: stirred tank, airlift, packed bed, fluidized bed, Bubble column. Process parameters: aeration, agitation, pH, temperature control, Monitoring and control in fermentation processes

Module III: (8L)
Downstream Processing and Product Recovery, Steps in downstream processing: cell harvesting, cell disruption, concentration, purification, filtration, centrifugation, solvent extraction, precipitation, chromatography, membrane separation, Product quality control

Module IV: (10L)
Production and Applications of Microbial Products, Microbial enzymes, Antibiotics, Organic acids, Amino acids, vitamins, polysaccharides (Agar, Alginate, Xanthan), Biofuels (ethanol, biogas, biodiesel) and microbial production of bioplastics, Antibodies.

Module V: (10L)

Advances and Trends in Applied Microbial Technology, Recombinant DNA technology and strain improvement, Probiotics: mechanisms and applications, Immobilized cell and enzyme technology, SCP, Use of agro-industrial residues and waste valorization, Environmental sustainability, regulatory aspects, and biosafety in industrial microbial processes

Text Books:

1. Crueger & Crueger – *Biotechnology: A Textbook of Industrial Microbiology*

2. Casida – *Industrial Microbiology*

3. Stanbury, Whitaker & Hall – *Principles of Fermentation Technology*

Reference Books:

4. Glazer & Nikaido – *Microbial Biotechnology*

5. Moo-Young – *Comprehensive Biotechnology*

Course Name: Food Process Technology–IV (Edible Fats and Oils)

Course Code: FT504

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of Food, Principles of Food Preservation

Course Objective:

O1: To introduce the significance of fats and oils in foods and familiarize students with various extraction techniques from plant sources, including conventional and advanced methods.

O2: To provide an understanding of oil refining and processing operations, including degumming, bleaching, deodorization, enzymatic treatment, and the evaluation of oil quality and safety.

O3: To explore the modification and application of fats in food products, by-product utilization, antioxidant use, and quality standards relevant to fats and fatty foods.

Course outcome(s):

After completion of the course, students will be able to:

CO1	**Analyze** the various properties of fats and oils in processing, non-processing, and storage conditions.
CO2	**Explain** the different production and refining processes of vegetable oil.
CO3	**Identify** different technologies for the manufacture of designer fats.
CO4	**Formulate** newer methods for analysis of non-oil constituents of oil-bearing materials.

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO9	PO10	PO1 1	PSO 1	PSO 2	PSO3
CO1	3	3	2	3	3	2	–	–	–	–	2	3	2	2
CO2	3	2	2	2	2	–	–	–	–	–	2	3	2	2
CO3	2	2	3	2	2	–	–	–	–	–	2	2	3	2
CO4	3	3	3	3	3	2	–	–	–	–	3	3	3	3

Course Contents:

Module I: (8L)

Importance of fats and oils in foods; Extraction of fats and oils from plant sources by rendering, pressing, solvent extraction, supercritical fluid extraction, enzyme- derived oil extraction.

Module II: (8L)

Processing of oils – Degumming, refining, dewaxing, bleaching, deodorization, fractionation; Pyrolysis of fats, toxicity of frying oil. Application of enzymes in the oil refining process.

Module III: (8L)

Plastic fat –hydrogenation, esterification, inter-esterification, and emulsification; Application of plastic fat in bakery, confectionery (including cocoa butter replacers), shortenings, margarine processing. Multi-source edible oil.

Module IV: (8L)

By-products of fat/oil processing industries; Oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.

Revision: (4L)

Text Book:

1. Bailey's Industrial Oil and Fat Products, Vol 1 & 2; Swern D; 4th ed, 1982, John Wiley &Sons.

2. The Chemistry & Technology of Edible Oils and Fats; Devine J & Williams PN; 1961, Pergamon Press.

Reference books:

1. Food Oils and their Uses; Weiss TJ; 1983, AVI.

Course Name: Research Methodology and IPR

Course Code: HU501

Contact: 1:0:0

Total Contact Hours: 12

Credit: 1

Course Objective(s):

O1: To introduce the fundamentals of research methodology and techniques for identifying research problems.

O2: To provide awareness on literature review and ethical conduct in research.

O3: To develop understanding of intellectual property rights (IPR) and its implications in academia and industry.

Course Outcome(s):

After completion of the course, students will be able to:

CO1	Define and formulate a research problem.
CO2	Perform a basic literature review and identify research gaps.
CO3	Demonstrate awareness of ethical practices in research and publication.
CO4	Understand the importance of IPR in safeguarding innovations.

CO-PO-PSO Mapping:

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO9	PO10	PO1 1	PSO 1	PSO 2	PSO3
CO1	3	2	1	-	-	-	-	-	-	2	-	3	3	3
CO2	3	2	2	-	-	-	-	-	-	2	-	3	3	3
CO3	2	-	-	-	-	3	3	2	-	2	-	3	3	3
CO4	2	-	-	-	-	2	3	2	-	2	-	3	3	3

Course Contents:

Module I: Introduction to Research Methodology (2L)

Definition, objectives, and significance of research; types of research; steps in research process; formulating research problem; importance of literature review; primary and secondary sources; identifying research gaps.

Module II: Research Ethics and Integrity (2L)

Research misconduct (Falsification, Fabrication, Plagiarism); conflict of interest; predatory journals; ethical publishing practices; citation practices; tools for plagiarism detection.

Module III: Basics of Report Writing (2L)

Structure of a research report; academic referencing; bibliography; abstracting and summarizing techniques.

Module IV: Intellectual Property Rights (6L)

Introduction to IPR: patents, copyrights, trademarks, GI. Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), Legal requirements for patents — Granting of patent. Patent application process: Searching a patent- Drawing of a patent- Filing of a patent- Types of patent applications- Patent document: specification and Claims. Govt. Schemes of IPR

Trademarks- Concept of Trademarks - Different kinds of marks (brand names, logos, signatures,

symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks.

Copyrights Right and protection covered by copyright - Law of copy rights: Fundamental of copyright law. Originality of material, rights of reproduction, rights to perform the worth publicly, copy right ownership issues, obtaining copy right registration.

Geographical Indication of Goods, GI Protection.

Textbooks:

1. R. Kothari – Research Methodology: Methods and Techniques, New Age International.

2. Catherine J. Holland – Intellectual Property: Patents, Trademarks, Copyrights, Trade Secrets, Entrepreneur Press, 2007.

Reference Books:

1. The Institute of Company Secretaries of India – Professional Programme: Intellectual Property Rights, Law and Practice, Sept 2013.

2. Miro Todorovich, Paul Kurtz, Sidney Hook – The Ethics of Teaching and Scientific Research.

Course Name: Food Processing Lab I

Course Code: FT591

Contact: 0:0:3

Credit: 1.5

Pre requisites: Principles of Food Preservation, Unit Operation

Course Objectives:

O1: To assist the students in using laboratory techniques common to basic Food Processing O2: To provide an opportunity to the students to evaluate the effective test methods used in sensory evaluation and analyze the resulting information.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	Apply the principles that make a food product safe for consumption.
CO2	Use laboratory techniques common to basic Food Processing.
CO3	Interpret government regulations pertaining to food manufacturing.
CO4	Evaluate the effective test methods used in sensory evaluation and analyze the resulting information.

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	2	3	2	-	2	3	1	1	3
CO2	2	2	1	1	3	2	2	-	-	1	2	1	2	2
CO3	2	1	1	-	-	2	3	-	-	-	3	1	1	3
CO4	3	2	2	2	2	-	-	-	3	-	3	2	2	2

List of Experiments:

1. Preparation of citrus fruit squash/nectar/concentrated juice.
2. Preparations of fruit jam/mixed jam/marmalade.
3. Preparation of jelly/synthetic jelly.
4. Preparation of tomato ketchup/puree/sauce.
5. Preparation of fruit/vegetable pickles.
6. Preparation of dried vegetables.
7. Design and layout of various food processing systems
8. Preparation of value added different soups
9. Preparation of fermented cereal/vegetable (Sauerkraut) food products

Text Books:

1. Food Science by B. Srilakhsmi
2. Essentials of Food & Nutrition by Swaminathan, Vol. 1 &2

Reference Books:

1. Hand Book of Analysis of fruits & vegetables by S. Ranganna

Course Name: Mass Transfer II Lab

Course Code: FT592A

Contact: 0:0:3

Credit: 1.5

Pre requisites: Engineering Thermodynamics, Mass Transfer, Separation Process

Course Objectives:

O1: To impart knowledge of the basic fundamental principles of mass transfer by performing different experiments

O2: To make them correlate theory and practical process by experimentation.

Course Outcome:

After the completion of the course students will be able to:

CO1	Analyze the data on vapor-liquid equilibrium and Boiling point diagram
CO2	Discuss the performance of distillation column
CO3	Apply the separation process by Liquid- Liquid Extraction and solid liquid extraction.
CO4	Apply different type of dryers

CO-PO-PSO Mapping

COs	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	3	2	-	-	-	-	-	2	3	2	1
CO2	3	3	2	3	2	-	-	-	-	-	2	3	2	1
CO3	3	3	3	3	2	-	-	-	-	-	2	3	2	1
CO4	3	2	3	3	3	-	-	-	-	-	2	3	3	2

Course Contents:

1. To study vapor-liquid equilibrium and prepare Boiling point diagram for a binary liquid mixture.
2. To determine relative volatility of solvent mixtures by distillation.
3. To determine the ternary curve for the system acetic acid-water-carbon tetrachloride
4. To study the solid –liquid extraction system- Soxhlet's experiment
5. To study the operation on extraction of oil from seed.
6. To determine drying rates of food using different types of driers

(i) Tray Drier,

(ii) Fluidized bed Drier,

(iii) Freeze Drier,

(iv) Spray Drier

7. Innovative Experiment

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International student Edition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
3. Unit Operations in Chemical Engfueering : McCabe, Smith, and Harriot. MGH, SthEdn.
4. Multicomponent Distillation: Holland, C. D.,PHI.

Reference Books:

1. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
2. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.
3. Separation Processes: King, C. J.MGH.
4. Design of Equilibrium Stage Processes: Smith, B. D.MGH.

Course Name: Mechanical Operation and Separation Process II Lab

Course Code: FT592B

Contact: 0:0:3

Credit: 1.5

Pre requisites: Engineering Thermodynamics, Mass Transfer, Separation Process

Course Objectives:

O1: To impart knowledge of the basic fundamental principles of mass transfer by performing different experiments

O2: To make them correlate theory and practical process by experimentation.

Course Outcome:

After the completion of the course students will be able to:

CO1	Analyze particle size distribution and separation efficiency using mechanical size reduction and classification equipment (e.g., jaw crusher, ball mill, sieve shaker).
CO2	Determine resistance parameters and separation coefficients in solid-liquid and liquid-liquid separation processes such as filtration, centrifugation, and vacuum evaporation.
CO3	Evaluate mass transfer coefficients and operational parameters in gas-liquid contact operations like absorption in packed columns.
CO4	Analyze drying behavior and compare performance of various drying methods under controlled and varying operating conditions.

CO-PO-PSO Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	-	-	-	2	3	2	1
CO2	3	3	3	3	2	-	-	-	-	-	2	3	2	1
CO3	3	3	3	3	2	-	-	-	-	-	2	3	2	1
CO4	3	3	3	3	2	-	-	-	-	-	2	3	3	2

Course Contents:

1. To evaluate particle size distribution and separation efficiency of crushed material using a sieve shaker post jaw crushing.
2. To assess the separation efficiency and fineness of ground particles using a sieve shaker after ball milling.
3. To determine filter medium resistance & cake resistance in cake filtration.
4. To determine separation coefficient in centrifugation.
5. To determine separation coefficient by vacuum evaporation using Rotary Vacuum Evaporator
6. To determine the absorption coefficient in a packed tower.
7. To determine the drying characteristics of a material under constant drying air condition
8. To compare of drying rates of food using different types of driers Innovative Experiments

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International student Edition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn.,PHI.

3. Unit Operations in Chemical Engfueering : McCabe, Smith, and Harriot. MGH, SthEdn.

4. Multicomponent Distillation: Holland, C. D., PHI

Reference Books:

1. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
2. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.
3. Separation Processes: King, C. J.MGH.
4. Design of Equilibrium Stage Processes: Smith, B. D.MGH.

Course Name: Transport Phenomena

Lab Course Code: FT592C

Contact: 0:0:3

Credit: 1.5

Pre requisites: Engineering Thermodynamics, Mass Transfer, Separation Process

Course Objectives:

O1: To learn analytical experimental methods using sophisticated instruments and interpretation of experimental data.

Course Outcome:

After the completion of the course students will be able to:

CO1	Plan experiments and present the experimental data meaningfully
CO2	Apply theoretical concepts for data analysis and interpretation
CO3	Understand chemical engineering unit operations related to fluid and particle mechanics, and mass transfer
CO4	Understand the experimental techniques related to chemical reaction engineering

CO-PO-PSO Mapping

COs	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	2	-	-	-	-	-	3	3	2	1
CO2	3	3	3	3	2	-	-	-	-	-	3	3	2	1
CO3	3	3	3	3	2	-	-	-	-	-	3	3	2	1
CO4	3	3	3	3	2	-	-	-	-	-	3	3	3	2

Course Contents:

1. To determine Drag Coefficient
2. Experiments on Tubing, interconnects flow measurement
3. To determine flow measurement
4. Experiments on Industrial-scale equipment, valving
5. Experiments on Temp and flow control, calibration
6. Experiments on Psychrometric chart, vapor pressure, flow control,humidity sensors
7. Experiments on Dissolved oxygen sensors, spargers
8. Innovative Experiment

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International student Edition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn.,PHI.
3. Unit Operations in Chemical Engineering : McCabe, Smith, and Harriot. MGH, SthEdn.
4. Multi component Distillation: Holland, C. D.,PHI.

Reference Books:

1. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
2. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.
3. Separation Processes: King, C. J.MGH.
4. Design of Equilibrium Stage Processes: Smith, B. D.MGH.

Course Name: Applied Microbial Technology for Industry Lab

Course Code: FT593

Contact: 0:0:3

Total Contact Hours: 36

Credit: 1.5

Pre requisites: Chemistry of Food, Food Preservation, Food Microbiology

Course Objective:

O1: The objective of this laboratory course is to provide hands-on experience in industrially relevant microbial techniques, enabling students to understand, apply, and optimize microbial processes for commercial applications.

Course Outcomes (COs):

CO1	**Understand** and **explain** the role of industrially important microorganisms and their applications in bioprocess industries.
CO2	Analyze and design upstream and downstream processes used in microbial fermentations for various industrial products
CO3	**Evaluate** microbial production processes and their optimization for industrial applications.
CO4	Discuss recent advances, challenges, and ethical considerations in industrial microbial technology, including sustainability and waste utilization

CO-PO-PSO mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	-	3	-	-	-	2	3	3	1
CO2	3	3	2	3	2	2	-	-	-	-	2	3	2	2
CO3	2	2	2	2	2	2	3	-	2	-	2	3	3	1
CO4	3	3	2	2	3	-	-	-	-	-	2	3	3	2

List of Experiments:

1. Preparation and Subculturing of probiotic strain pure culture
2. Preparation of lactic acid stock culture and biomass preparation
3. Determination of yield coefficient (Yx/s) and calculate biomass produced per gram of substrate consumed.
4. Fermentation of lactic acid and estimation by titration

[Let's say you used 10.5 mL of 0.1 N NaOH to titrate a 10 mL milk sample, and the indicator changed color. Moles of NaOH: 0. 0105 L * 0.1 mol/L = 0.00105 moles NaOH. Moles of lactic acid: Since the reaction is 1:1, moles of lactic acid = 0.00105 moles. Mass of lactic acid: 0.00105 moles * 90.08 g/mol = 0.0946 g. Concentration of lactic acid in the sample: (0.0946 g / 0.010 L) = 9.46 g/L or 0.946 %]

5. Fermentation of grapes by immobilized yeast and refractive index calculation
6. Antimicrobial activity by agar well diffusion using antibiotics
7. Effect of aeration and agitation on microbial growth
8. Biofilm formation assay by crystal violet staining
9. Testing for microbial spoilage of food.
10. Innovative experiment

Course Name: Food Analysis and Quality Control Lab-I

Course Code: FT594

Contact: 0:0:4

Credit: 2

Pre requisites: Food Chemistry, Biochemistry

Course Objectives:

O1: Develop practical skills for evaluating the physicochemical and sensory quality of various food and beverage products.

O2: Familiarize students with standard laboratory techniques and protocols used in food analysis.

O3: Encourage critical interpretation and analysis of experimental data to support decision-making in food quality assessment.

O4: Foster innovation in experimental design to ensure food safety, authenticity, and quality control in compliance with regulatory standards.

Course outcome(s):

After the completion of the Food Analysis and Quality Control Lab I the students will be able to:

CO1	**Determine** the methods of selecting appropriate techniques for the analysis of food products.
CO2	**Analyze** different components present in various food materials.
CO3	**Interpret** the knowledge of food standards, regulations, and quality control.
CO4	**Identify** the test methods to detect adulterants in various food samples.

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	3	3	-	-	-	-	-	2	3	3	1
CO2	3	3	2	3	2	-	-	-	-	-	2	3	2	2
CO3	2	2	2	2	2	2	3	-	2	-	2	3	3	2
CO4	3	3	-	2	3	-	-	-	-	-	2	3	3	2

List of Experiments:

1. Analysis of portable water.
2. Analysis of jam, jelly, and marmalade.
3. Analysis of spices.
4. Analysis of tea including polyphenols/ antioxidant content
5. Analysis of coffee, including chicory, polyphenols/ antioxidant content
6. Analysis of non-alcoholic beverages (squash, fruit juice, etc.)
7. Analysis (lactic acid content) of Sauerkraut.
8. Innovative Experiments

Text Books:

1. FSSAI Manuals
2. Raghuramulu, N. et al., “A Manual of Laboratory Techniques”. 2nd Edition. NIN, 2003.
3. Nielson, S. Suzanne. “Food Analysis” 3rd Edition. Springer, 2003.

Reference Books:

1. Pomeranz, Yeshajahu and Clifton E. Meloan “Food Analysis : Theory and Practice”. 3rd Edition. Springer, 2000.

3rd Year 6th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT601	Principles of Biochemical Engineering	3	1	0	4	4
2	ENGG	Major	FT602	Food Process Engineering	3	0	0	3	3
3	ENGG	Major	FT603A/B/C	A. National and Global Food Regulation B. Supply Chain Management and Food Marketing C. Food Security and Sustainability	3	0	0	3	3
4	ENGG	Major	FT604A/B/C	A. Functional Foods and Nutraceuticals B. Protein Technology C. Enzyme Technology	3	0	0	3	3
5	ENGG	Minor	ECS(FT)601A	Process Instrumentation and Control	3	0	0	3	3
			EE(FT)601B	Renewable Energy Technology					
			EC(FT)601C	Introduction to Nanotechnology					
6	ENGG	Minor	CS(FT)602A/ B/C	A. Digital Image Processing B. Introduction to Machine Learning C. Introduction to Internet of Things	3	0	0	3	3
B. PRACTICAL									
1	ENGG	Major	FT691	Food Processing Lab II	0	0	3	3	1.5
2	ENGG	Major	FT692	Food Analysis and Quality Control Lab-II	0	0	4	4	2
3	PRJ	Project	FT681	Project-III	0	0	6	6	3
C. MANDATORY ACTIVITIES / COURSES									
1	Mandatory Course	MC	MC681	NSS/NCC/ Physical Activities / Meditation & Yoga / Club Activities/Environmental Protection Initiatives	0	0	0	0	0
Total of Theory, Practical								32	25.5
Total Credit in 3rd Year									**49**

Course Name: Principles of Biochemical Engineering

Course Code: FT 601

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Basic knowledge of Food Engineering, Food Processing, Unit Operations

Course Objective:

O1. To introduce the fundamental concepts of biochemical engineering, including enzyme kinetics, microbial growth, and stoichiometry of biochemical reactions.

O2. To familiarize students with the design and operation of bioreactors, and the principles governing mass and energy balances in biochemical systems.

O3. To develop an understanding of downstream processing techniques for product recovery and purification in industrial bioprocesses.

Course outcome(s):

After the completion of the course students will be able to:

CO1	**Explain** the fundamental principles of biochemical processes, including enzyme kinetics and microbial growth, in the context of bioreactor operations.
CO2	**Apply** mass and energy balance principles to analyze and design biochemical processes involving fermentation and cell culture systems.
CO3	**Analyze** the performance of different types of bioreactors and evaluate the effects of operating parameters on product yield and process efficiency.
CO4	**Evaluate** various downstream processing techniques for product recovery and purification, considering efficiency, cost, and product quality.

CO-PO-PSO Mapping:

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	-	1	2	3	2	1
CO2	3	3	3	2	3	1	1	1	1	2	2	3	3	2
CO3	3	3	3	3	3	2	1	1	1	2	2	3	3	2
CO4	3	2	3	3	3	2	1	1	1	2	2	3	3	2

Course Contents:

Module I (6L)

Introduction to Biochemical Engineering and its relevance to industries, Enzyme kinetics: Michaelis-Menten model, inhibition types, Immobilized enzymes: methods and applications

Module II (10L)

Microbial Growth and Stoichiometry : Microbial growth kinetics: batch, fed-batch, and continuous cultures, Monod equation and growth phases, Yield coefficients and stoichiometry of microbial growth, Material and energy balances in biological systems, Oxygen requirement and transfer: OTR, OUR, and KLA

Module III (10L)

Bioreactor Design and Scale-Up: Types of bioreactors: stirred tank, airlift, packed bed, fluidized bed, Design equations for batch, CSTR, and plug flow bioreactors,

Module IV (10L)

Downstream Processing and Bioprocess Integration: Cell disruption methods: mechanical and non-mechanical, Different separation processes, Purification techniques

Module V (8L)

Commercial production of various bioprocess-based products (Bioethanol, butanol, citric acid, acetic acid); antibiotics-penicillin, streptomycin, tetracycline. Single cell protein; amino acids: glutamic acid, lysine, types and nature of wastes generated from bioprocesses

Revision (4L)

Text Books:

1. Biochemical Engineering Fundamentals: J.E Bailey, D F Olli, MGH

2. Biochemical Engineering: Aiba S; Academia press, NY

3. Michael L. Shuler and Fikret Kargi: Bioprocess Engineering: Basic Concepts, 2nd Edition

Reference Books:

1. Bioprocess Engineering Principles, Pauline M. Doran

2. Principles of Bioseparation Engineering, Raja Ghosh

Course Name: Food Process Engineering

Course Code: FT602

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Mass balance, Unit Operation

Course Objective:

O1: To help the students design the process parameters for thermal processing, freezing, evaporation, dehydration, separation, extraction and to develop skills in formulating solutions to solve problems in food industry.

Course outcome(s):

After the completion of the course students will be able to:

CO1	**Apply** sterilization, pasteurization, and evaporation principles to operate food preservation systems
CO2	**Interpret** various refrigeration principles to solve food storage and transport challenge
CO3	**Outline** the drying kinetics to operate industrial dryers for specific food products.
CO4	**Evaluate** heat transfer and extrusion principles to optimize food processing operations

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	-	-	-	-	2	3	2	1
CO2	3	3	2	2	2	3	2	-	2	-	3	3	2	2
CO3	3	2	3	2	2	2	2	2	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	2	3	2	3	3	3	3

Course Contents:

Module I (9L)

Batch and continuous sterilization processes (including steps and various machineries involved) used in canning of foods; Commercial sterilization, Constructional and operational features of pasteurizer; homogenizer; Constructional features and principles of single effect evaporators (including mass and energy balances) used for concentration of liquid foods.

Module II (9L)

Constructional features of cold storage and basic design approach; Different types of freezers including plate contact freezer, air blast freezer; Cryogenic freezing; Refrigerated mobile vans.

Module III (9L)

Drying kinetics and constant & falling rate periods in drying; Constructional & operational features of various types of cross-flow, through flow and recirculatory dryers – Tray dryer, roller dryer, drum dryer, spray dryer, fluidized bed dryer, freeze dryer and solar dryer, rotary dryer, tunnel dryer, other grain dryers (LSU-type).

Module IV (9L)

Heat exchangers (Co-current and counter-current heat exchanger); Constructional features of various types of heat exchangers – DPHE; Theory and operation of extrusion systems used in food industry; Cold extrusion and Extrusion cooking systems; Single and twin-screw extruders – constructional and operational features including advantages/disadvantages with case studies.

Text Books:

1. Fundamentals of Food Process Engineering (3rd Ed.) – R. T. Toledo, Springer, 2007.

2. Unit Operations of Chemical Engineering – W.L. McCabe, J. C. Smith & P. Harriott, McGraw Hill International, 1993.

3. Introduction to Chemical Engineering – S. K. Ghosal, S. K. Sanyal, S.Datta.

Reference Books:

1. Introduction to Food Engineering (5th Ed.) – R. P. Sing & D. R. Heldman, Academic Press, 2014

2. Food Process Engineering & Technology (2nd Ed.) – Z. Berk, Academic Press, 2014

3. Food Process Engineering Operations – G. D. Saravacos& Z. B. Maroulis, CRC Press, 2011.

4. Transport Processes & Separation Process Principles – C. J. Geankoplis, PHI, 2003

5. Introduction to Food Process Engineering – A. Ibraz & G. V. Barbosa-Canovas – CRC Press

6. Introduction to Food Process Engineering (2nd Ed.) – P. G. Smith, Springer, 2011.

7. Postharvest Technology and Food Process Engineering- Amalendu Chakraverty& R. Paul Singh, CRC Press, 2014.

8. Fundamentals of Food Engineering – D. G. Rao, PHI Learning, 2014.

9. Food Process Engineering & Technology – Md. Iffan A. Ansari – Jain Brothers

10. Processing & Food Engineering – M. K. Garg& P. Chandra, Jain Brothers

11. Solved Problems in Food Engineering –Stavros Yanniotis, Springer

Course Name: National and Global Food Regulation

Course Code: FT603A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Food preservation**,** food processing, food packaging

Course Objective:

O1: Demonstrate comprehensive knowledge of national and international food laws, regulatory frameworks, and the roles of key authorities and organizations governing food safety, quality, and trade.

O2: Apply understanding of testing, certification, and labeling requirements to assess compliance of food products with relevant legal, safety, and quality standards in domestic and export markets.

O3: Critically evaluate global trade agreements and food standardization bodies to analyze their impact on food business operations, international trade, and consumer protection.

Course outcome(s):

After completion of the course students will be able to:

CO1	**Interpret** the food laws in professional life
CO2	**Explain** the function of different functional bodies in food export promotion
CO3	**Explain** the food standard and dietary supplements framework
CO4	**Interpret** the importance of food safety certification, trade agreements

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	3	-	2	-	3	3	2	2
CO 2	3	1	-	-	-	1	3	-	-	-	3	3	2	3
CO 3	3	-	-	-	-	-	3	-	-	-	3	3	2	3
CO 4	3	1	-	-	-	2	2	-	2	-	3	3	3	3

Course Contents:

Module I (8L)

Understanding of food laws- (South Asian Region, in particular India / ASEAN countries / EU / USA (USDA, USFDA) / Canada / Japan / Australia / New Zealand / CIS / China); regulations of South Asian countries in detail, their scope, roles and responsibilities; Regulatory structure and general awareness about main regulations.

Module II (8L)

Testing and certification authorities; National Standards Bodies in South Asian countries; Export Promotion Bodies in India, AGMARK, BIS, EIC; Codex Focal Points; Agencies/authorities responsible for risk assessment, Regulations concerning Imports/Export

Module III (8L)

Overall understanding of food standards framework, proprietary foods, novel foods, dietary supplements/health supplements in their legislations; Broad overview of labeling requirements

Module IV (8L)

Logos of major authorities; Certification marks and logos used to characterize food products (for example- logo for organic food products); Mandatory quality and safety certification

requirements for foods; WTO, SPS / TBT / TFA / Codex, OIE / IPPC; FTAs and Trade Agreements - EU, SAFTA, SAARC, BIMSTEC, ASEAN, GCC, Mercosur, FSANZ.

Revision: (4L)

Text Book:

1. Neal D. Fortin, FOOD REGULATION: LAW, SCIENCE, POLICY, AND PRACTICE, THIRD EDITION; Wiley, 2022.

Reference Book:

1. Gabriela Steier (Editor), Kiran K. Patel (Editor), INTERNATIONAL FOOD LAW AND POLICY, Springer Nature, 2016.
2. Aleksandra Martinovic (Editor), Sangsuk Oh (Editor), Huub Lelieveld (Editor), ENSURING GLOBAL FOOD SAFETY : EXPLORING GLOBAL HARMONIZATION, 2ND EDITION, Academic Press Inc, 2022.

Course Name: Supply Chain Management and Food Marketing

Course Code: FT603B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Basic understanding of management principles and tools, Food Preservation

Course Objective:

O1: To impart knowledge and understanding on supply chain management and its relevance to today's business decision making

O2: To enable students to be aware of marketing techniques, schemes, and practices related to food products in place- and nationally and globally.

Course outcome(s):

After completion of the course students will be able to:

CO1	**Understand** principles of supply chain management to find the scope of food businesses
CO2	**Interpret** the tools and solutions to solve arising in a supply chain during food processing problems
CO3	**Apply** sequential strategic planning involved in managing effective production, operation and distribution, keeping concerned existing laws, regulations, and policies concerning
CO4	**Develop** system tools to meet the specific need of Food Product Development and Commercialization with effective supply chain mapping and traceability systems.

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	3	-	2	-	3	3	2	2
CO2	3	1	-	-	-	1	3	-	-	-	3	3	2	3
CO3	3	-	-	-	-	-	3	-	-	-	3	3	2	3
CO4	3	1	-	-	-	2	2	-	2	-	3	3	3	3

Course Content:

Module I: (8L)

Supply Chain definition, Objectives and Types, Various definitions, Drivers and Need for SCM, SCM decisions and skills, Strategy formulation in SCM, Value in Supply Chain and Tradeoffs, CRM Strategy relationship matrix, Strategic Sourcing, Source evaluation – collaborative perspective, Buyer-Supplier Relationship, Partner Selection, develop of Partnership, the importance of inventory, imbalances and uncertainties, inventory costs

Module II: (8L)

Transportation Selection, Trade off, modes of transportation, models for transportation and distribution, factors affecting network effectiveness, 3 PL advantages, Indian transport infrastructure, IT solutions, EDI, e-Commerce, e-Procurement, Barcoding and RFID, Critical business processes and information systems, reverse Vs forward supply chain, types of reverse flows, collaborative SCM's and CPFR, agile systems, sources of variability, characteristics

Module III: (8L)

Supply Chain Mapping (based on quantification of customer sensitivity and risk), Supply Chain Management and profitability, quality management, mass customization and globalization, Ethical Supply Chains, e-business and SCM, Balanced Scorecard, Benchmarking

Module IV: (8L)

Food marketers act (Advertising law and regulation), Policymakers, food marketing practices, Product Development and Commercialization, Manufacturing Flow Management, Supplier Relationship Management regulation of food markets (e.g. food safety, false advertising, etc.)

Revision: (4L)

Text Books:

1. Mohanty R.P, S.G Deshmuki "Supply Chain Management" Biztantra, New Delhi 936 PAPER IV S

Reference Books:

1. Jacobs F.R, Berry W.L, Whybark D.C, Vollmann T.E,. Manufacturing Planning and Control for Supply Chain Management: The CPIM Reference, Second Edition
2. Chopra S., Supply Chain Management: Strategy, Planning, and Operation (7th Edition) (What's New in Operations Management)

Course Name: Food Security and Sustainability

Course Code: FT603C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Environmental science, basic biology, agriculture, geography, microbiology, food processing, quality control, and food regulations

Course Objective:

O1: To enable the students to learn about the severity of depletion of natural resources and its effect on food security and also enlighten about the different practices, policies, and initiatives to ensure food security and sustainability

Course outcome(s):

After completion of the course students will be able to:

CO1	**Identify** the importance of utilization and preservation of land, water, and other natural resources for Food Security and Sustainability.
CO2	**Analyze** the different existing and proposed technologies to set up sustainable food eco-systems with compliance to principles to aid in Food Security and Sustainability
CO3	**Evaluate** food production trends to monitor and explore various avenues to cater to the development of sustainable practices in society
CO4	**Develop** mass awareness and contribute at various levels as individuals or as active members of organizations to uphold the magnitude of Food Security and Sustainability

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	3	-	2	-	3	3	2	2
CO2	3	1	-	-	-	1	3	-	-	-	3	3	2	3
CO3	3	-	-	-	-	-	3	-	-	-	3	3	2	3
CO4	3	1	-	-	-	2	2	-	2	-	3	3	3	3

Course Contents:

Module I: (8L)

Food Security and Sustainability - Definition, Elements, Prospects and Challenges, Food production and nutritional aspects, Food –ecosystems, Factors affecting agriculture and crop yield, Indicators of Sustainable food availability, Population pressure and agricultural productivity, GMO, organic farming, vertical farming – principles and practices, Subsistence Food Production Practices, Security of foods of animal origin and its implications

Module II: (8L)

Performance of major categories of food over the past decades, trends in food production, Decline in total factor productivity growth, Demand and supply projections, Impact of market forces, Sustainable food security indicators and index, Indicator of sustainability of food Security, Path to sustainable development.

Module III: (8L)

Impact of depletion of water resources, Land Resources of India, Population and land, Land utilization, Net Area Sown, changes in cropping pattern, land degradation, Rainfall forecasting - Adequacy of Rainfall for crop growth – Rainfall, Drought and production instability – Irrigation potential – Available, created and utilized – River basins; Watersheds and Utilizable surface water – Utilizable water in future (Groundwater & Surface water)

Module IV: (8L)

International and National policies for Food Security and Sustainability, Schemes, initiatives, and mass awareness programs by Government, PSUs, Case studies on CSR activities of different organizations related to Food Security and sustainability

Revision: (4L)

Text Books:

1. B.K.Desai and Pujari, B.T. Sustainable Agriculture: A vision for future, New India Publishing Agency, New Delhi, 2007.

2. Saroja Raman, Agricultural Sustainability – Principles, Processes and Prospects, CRC Press, 2013

Reference Books:

1. Swarna S.Vepa etal., Atlas of the sustainability of food security. MSSRF, Chennai, 2004. 2.Sithamparanathan, J., Rengasamy, A., Arunachalam, N. Ecosystem principles and sustainable agriculture, Scitech Publications, Chennai, 1999.

4. Gangadhar Banerjee and Srijeet Banerji, Economics of sustainable agriculture and alternate production systems, Ane Books Pvt Ltd., 2017

5. M. S. Swaminathan, Science and sustainable food security, World Scientific Publishing Co., Singapore, 201

Course Name: Functional Foods and Nutraceuticals

Course Code: FT604A

Contact: 3:0:0

Total Contact Hours: 36

Credits: 3

Pre requisites: Basic biology, food chemistry, biochemistry, nutrition, food processing, quality control and food regulations

Course Objective:

O1: To develop an understanding of the concept of Nutraceuticals & Functional Foods

O2: To enable the students to learn about the health-beneficial properties of Nutraceuticals & Functional Foods

O3: To enable the students to learn about the manufacturing processes, regulatory challenges, and market trends of Nutraceuticals & Functional Foods.

Course outcome(s):

After Completion of the course, students will be able to:

CO1	**Understand** the fundamental concept of Nutraceuticals and Functional Foods on their origin, presence, and functionality.
CO2	**Analyze** the disease-preventing and health-enhancing properties of Nutraceuticals and Functional Foods**.**
CO3	Apply the principles of food fortification, enrichment, and value addition in developing nutrient-rich processed food products.
CO4	**Evaluate** the methods of extraction, processing, stability, and regulatory compliance of functional ingredients and dietary supplements, considering safety and toxicological aspects.

CO – PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	-	-	-	-	2	3	2	1
CO2	3	3	2	2	2	3	2	-	2	-	3	3	2	2
CO3	3	2	3	2	2	2	2	2	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	2	3	2	3	3	3	3

Course Contents:

Module I: (7L)

Definitions of Functional Foods and Nutraceuticals, Types of functional foods and nutraceuticals, Components like nutrients such as lipids, fibers, amino acids, spices, herbs, polyphenols, and bioactive properties, Vitamins and Health, Minerals and Health, Concepts and of Probiotic, prebiotics, synbotics, Supplements like antioxidants and their biochemical functions

Module II: (7L)

Nutritional significance: Role of nutraceutical / functional foods in cardiovascular health, diabetes, obesity, immunity, neurodegenerative and age-related muscular degeneration, stress management; Nutrition and nutraceuticals for targeted populations such as children, women, adults, and the elderly.

Module III: (7L)

Enrichment, value addition, fortification, supplementation, Sources, Significance, Fortification and Enrichment in different foods (MSG; Bakery and confectionary products e.g. bread, biscuit and cookies; Breakfast and ready to eat cereals; Infant formulas; Protein mixes; Vegetable Mixes; Dairy product e.g. ice cream; Beverages including diet beverages, Sports drink, Value addition in processed food products

Module IV: (11L)

Functional ingredients: Extraction/purification of lycopene, essential oils, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols, and their stability in processing conditions.

Manufacturing of dietary supplements in the form of liquid, rehydration powder, tablet, pill, capsule or mix. Principles of toxicology and risk assessment of Nutraceuticals, Dosage levels; adverse effects and toxicity of nutraceuticals Principles of toxicology and risk assessment of Nutraceuticals, Dosage levels; Adverse effects and toxicity of nutraceuticals, Regulatory and labeling issues, CODEX, FDA, FSSAI, Global nutraceuticals/Functional food market. Recent research and patents on nutra-ingredients.

Revision: (4L)

Text Books:

1. Handbook of Nutraceuticals and Functional Foods, Robert E.C. Wildman, CRC Press
2. Nutraceutical and Functional Food Components, Charis Galanakis, Academic Press

Reference Books:

1. Functional Foods and Nutraceuticals (Food Science Text Series), Rotimi E. Aluko, Springer; 2012 edition

Course Name: Protein Technology

Course Code: FT604B

Contact: 3:0:0

Total Contact Hours: 36

Credits: 3

Pre-requisites: Engineering Chemistry, Chemistry of Food

Course Objective:

O1: To help the students develop an advanced idea about protein utilization in food and its importance in our daily diet.

Course outcome(s):

After Completion of the course, students will be able to:

CO1	**Explain** the structural, nutritional, and functional properties of proteins, including their sources and folding mechanisms.
CO2	**Apply** the techniques of protein concentration and isolation for developing food and non-food protein products.
CO3	**Analyze** the role of hydrolysates, textured proteins, and restructured proteins in the development of value-added protein-based products.
CO4	**Evaluate** the protein purification systems using advanced separation methods such as chromatography, ultrafiltration, and electrophoresis.

CO-PO-PSO Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	-	-	-	2	3	2	1
CO2	3	2	3	2	2	1	-	1	1	-	2	3	3	2
CO3	2	3	3	2	2	2	1	1	1	1	2	3	2	3
CO4	3	3	2	3	3	1	1	1	2	1	3	3	3	2

Course Contents:

Module I: (8L)

Determination of protein structure; Nutritional and commercial importance of proteins; Physical, chemical and functional properties of proteins; Folding of proteins; Commercial sources of proteins; Creation of new proteins by bio-composite synthesis technique, Introduction to protein engineering; salient features of amino acids and their –R groups; conformation of proteins, the Ramachandran plot, tertiary structure and structural domains and motifs of proteins

Module II: (8L)

Process of making protein isolates and concentrates; Factors affecting quality of isolates and concentrates; Treatment to isolate and concentrate; Packaging of protein isolates and concentrates; Food and nonfood uses of isolates and concentrates.

Module III: (**8L)**

Methods of manufacturing protein hydrolysates; Factors affecting quality of hydrolysates; Food uses of hydrolysates; Fiber spinning process of proteins; Textured protein gels and expanded products; Simulated milk products; Restructured protein; Nonconventional sources of protein.

Module IV: (8L)

Centrifugation; Cell disruption; Protein precipitation and its recovery; Aqueous two-phase separation; Ion exchange chromatography; Gel filtration; Affinity chromatography; Electrophoresis; Cross filtration; Ultrafiltration.

Revision: (4L)

Text Books:

1. Altschul, A.M and Wilcke, H.L Ed 1978. new protein Foods. Vol III. Academic Press, New York

2. Bodwell, C.E.Ed. 1977. evaluation of proteins for Humans. AVI, Westport

3. Milner, M., Scrimshaw, N.S and Wang, D.I.C.Ed. 1978. Protein Resources and Technology. AVI, Westport

4. Salunkhe, O.K and Kadam, S.S Eds. 1999. Handbook of world legumes; Nutritional Chemistry, Processing Technology and Utilization. Volume I to III, CRC Press, Florida

5. Salunkhe, D.K. Chavan, J.K., Adsule, R.N Kadam, S.S 1992. World Oilseeds: Chemistry, Technology and Utilization, Van Nostrand Reinhold, New York

Reference Books:

1. Bioseparation Engineering: Principles, Practice and Economics, M. Ladish; Wiley Interscience

2. Proteolytic enzymes: a practical approach, Beynon, R.J. and Bond, J.S.; IRL Press, Oxford, Protein Biotechnology, Franks, F.; Humana Press

Course Name: Enzyme Technology

Course Code: FT604C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Chemistry of food, food microbiology, food biotechnology

Course Objective:

O1: To develop a comprehensive understanding of enzyme technology

O2: To equip students with knowledge and skills in enzyme production, purification, and process design

O3: To enable students to apply enzyme technology for industrial-scale applications

Course outcome(s):

After completion of the course, students will be able to:

CO1	**Apply** the knowledge of catalytic properties and sources of enzymes to explain their industrial relevance, particularly in food industries.
CO2	**Analyze** the enzyme production and reactor design processes, including the use of recombinant DNA techniques.
CO3	**Evaluate** the effectiveness of various enzyme purification methods and cell disruption techniques used in enzyme recovery.
CO4	**Design** enzyme-based processes using free and immobilized enzymes for applications in biochemical and food industries.

COs-POs-PSOs Mapping

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	-	-	1	-	-	2	3	2	1
CO2	2	3	2	2	2	-	-	1	1	-	2	3	2	2
CO3	2	2	2	3	3	1	-	1	1	1	3	3	3	2
CO4	2	2	3	2	3	1	-	2	2	2	3	3	3	3

Course Contents:

Module I: (8L)

Introduction to enzyme technology; Industrial enzymes – present status and opportunities with special reference to food industries; Catalytic properties of enzymes; Intracellular and extracellular enzymes.

Module II: (10L)

Enzyme production technology: Introduction of enzyme reactors and process design. Application of recombinant DNA technique in enzyme technology.

Module III: (7L)

Cell disintegration by physical, chemical, and biological methods; Enzyme purification methods: Salting out, organic solvent precipitation, dialysis, reverse osmosis, etc.

Module IV: (7L)

Application of enzymes for production in biochemical and food processing industries; Application of immobilized enzymes and cells. Production of Commercial Enzymes.

Revision: (4L)

Text Books:

1. Biochemical Engg. Fundamentals-Baily, Ollis. MGH

2. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi

Reference Books:

1. Prescott & Dunn‘s Industrial Microbiology, Macmiller

2. Principles of Fermentation Technology- Wittaker and Stanby

3. Methods in Enzymology, Edited by Dan S. Tawfik, Science Direct

Course Name: Process Instrumentation and Control

Course Code: ECS(FT)601A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Basic Physics

Course Objective(s):

The objective of the course is to make the students able to –

O1: gather knowledge on sensors & transducers

O2: understand the procedures of different process variable measurement

O3: acquainted with basic control system concept

O4: have knowledge of process control loops & controllers

Course Outcomes (COs):

After Successful completion of the course, students will be able to

CO1	Describe the operation of sensors & transducers
CO2	Demonstrate the fundamentals of control systems
CO3	Describe operation of different process parameter measurement
CO4	Apply the knowledge of controller in process control loop design

CO-PO-PSO Mapping:

COs	**Program Outcome (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1 1	1 1	1 1	1 1	2 2	1 1	1 1	1 1	1 1	3	2	2
CO2	3	2	1	1	2	2	2	2	1	3	2	2	3	3
CO3	2	1	3	1	2	1	1	1	2	2	1	3	2	3
CO4	3	2	2	3	2	3	2	3	3	1	1	3	3	3

Course Content:

Module 1: Introduction (6L)

Operational aspect of instrument system, Control and requisites; Sensors & Transducers. Active and Passive transducer. Difference between Sensors & Transducers, Types & classification and selection criteria, Basic principles, Construction and applications of transducer elements, Transducer: Strain gauge with bridge circuits and calibration procedure

Module 2: Measurement (12L)

Temperature Measurement: Temperature measurement by bi-metal thermometers – resistance thermometers, thermistors and thermocouples. Radiation and optical pyrometers Flow measurement: Variable area type flowmeter, variable head type flow meter, magnetic flow meters Pressure Measurement: Low pressure measurement by McLeod Gage and Pirani Gage Moisture measurement cells for granular material, infrared, transmission measurement of moisture.

Module 3: Control system (6L)

Control system, Open and closed loop system, transfer function of open loop and closed loop control systems; Concept of Block diagram; Block diagram algebra. Block diagram reduction. Mathematical modeling of electrical circuit.

Module 4: Process Control (12L)

Basic Process Control Loop, Process characteristics, Controller, Controller modes, Pneumatic Controllers, Final control Element, Control valve, Control valve accessories, Actuators, Application of control in heat- exchangers. Advanced control strategies.

Text book:

1. Instrumentation, Measurement and Analysis; Nakra BC & Chaudhury KK; TMH
2. Process System Analysis & Control; Coughanowr DR; MGH

Reference Books:

1. Surekha Bhanot, Process Control Principal & Application , Oxford
2. G. Stephanopoulos, Chemical process Control, PHI
3. C. D. Johnson, Process Control Instrumentation Technology, PHI
4. 3. D. P. Eckman, Automatic Process control, John Wiley, New York

Course Name: Renewable Energy Technology

Course Code: EE(FT)601B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Basic Environmental Engineering, Food Process Engineering, Unit Operation.

Course Objective:

To help the students develop an overview on the application of non-conventional energy and realize its role in sustainable development.

Course outcome(s):

After completion of the course, the students will be able to

CO1	Define the different biological fuels and biomass as a source of renewable energy
CO2	Describe the process of hydrogen production by photosynthetic bacteria.
CO3	Identify the fundamental principles solar and wind power generation
CO4	Understand the working principles of geothermal energy.

CO-PO-PSO Mapping:

COs	**Program Outcome (PO)**											**Program Specific Outcomes (PSO)**		
	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	1	3	1	-	-	-	2	2	2	1
CO2	3	2	1	1	1	2	1	-	-	-	2	2	2	1
CO3	3	2	2	1	1	3	1	-	-	-	2	2	2	1
CO4	3	2	1	1	1	3	1	-	-	-	2	2	2	1

Course Contents:

Module I: (10L)

Biological fuel generation; Biomass as a renewable energy source; Types of biomass: forest, agricultural and animal residues; Industrial and domestic organic wastes; Conversion of biomass to clean fuels and petrochemical substitutes by physicochemical and/or fermentation processes. Biogas from anaerobic digestion; Thermal energy from biomass combustion; Ethanol from biomass.

Module II: (8L)

Hydrogen production by photosynthetic bacteria, biophotolysis of water and by fermentation; Microbial recovery of petroleum by biopolymers (Xanthum gum), biosurfactants.

Module III: (8L)

Solar energy; Solar collectors, Solar industrial heating system, solar refrigeration and air conditioning, solar cookers, solar furnaces, solar green house, solar dryer, solar distillation, Operating principles of different types of wind energy mills;

Module IV: (6L)

Ocean energy resources, ocean energy routes; principles of ocean thermal energy conversion systems; principles of ocean wave energy conversion and tidal energy conversion; Ocean power generation: tidal energy estimation, components of tidal power plant.

Revision: (4L)

Text Books:

1. J. E. Smith – Biotechnology, 3rd edn. Cambridge Univ Press.
2. S. Sarkar – fuels and combustion, 2nd edn., University Press.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.

Reference Books:

1. Biochemical Engg. Fundamentals-Baily, Ollis. MGH
2. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi
3. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

Course Name: Introduction to Nanotechnology

Course Code: EC(FT)601C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Pre requisites: Basic knowledge of physics, mathematics, mechanics, electronics and chemistry

Course Objective:

O1: To learn about basis of nano material science, preparation method and different types of nano materials

O2: To enable the students to learn about potential applications of nano materials in food research

Course outcome(s):

After the completion of the course students will be able to:

CO1	**Explain** the fundamental concepts, size-dependent properties, and significance of nanomaterials in various scientific and industrial domains.
CO2	**Demonstrate** the ability to apply principles of physics and chemistry to analyze the behavior of materials at the nanoscale.
CO3	**Analyze** the structural, electrical, and mechanical properties of nanomaterials using appropriate characterization techniques.
CO4	**Evaluate** the advantages, limitations, and potential environmental impacts of nanotechnology-based products and processes.

CO-PO-PSO Mapping:

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	1	1	-	1	-	2	3	2	1
CO2	3	2	1	2	3	1	-	-	1	1	2	3	3	2
CO3	3	1	3	1	3	2	1	1	2	1	3	3	3	3
CO4	2	3	3	2	2	3	2	1	2	2	3	3	3	3

Course Contents:

Module I (6L)

Introduction to Nanotechnology: Introduction to nano particles and nanotechnology, naturally occurring food nano substances, challenges for nutrient nano encapsulation, nano food particles and their bioavailability, designing food nano structures, public perception of nanotechnology food products.

Module II (10L)

Synthesis of Nano Materials: Introduction to synthesis of nanostructure materials, Bottom-up approach and Top-down approach. Physical methods - ball milling, sputtering, evaporation. Chemical methods - photochemical synthesis, electrochemical synthesis, coprecipitation method. Thermolysis route - spray pyrolysis. Biological methods – bacteria, fungi and actinomycetes, sample pre-treatment methods, characterization of nano materials in food and biological matrices, nanomaterial detection and quantification method.

Module III (10L)

Nanotechnology in different industries food: Nanoparticles in functional foods, engineered nanoparticles in beverages, nanotechnology in meat processing, nanoemulsion formation,

potential applications of milk nanotubes, nano engineered membranes, application of nanoparticles in delivery of flavors and aroma compounds,

Module IV (10L)

Nanotechnology in Food Packaging: Bionano composites for food preservation, intelligent packaging, high barrier plastics, biodegradable food packaging nanocomposites, bioactive food packaging with nano diamond particles, nano materials incorporated flexible packaging materials for high pressure processing, new approaches in antibacterial food packaging, nano sensors for food quality, Nanotechnology in Food Safety and Challenges in Nanomaterials Analysis: Nano technology based rapid detection of chemical and biochemical contents in food

Text Books:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo,"Nanoscale Charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.
3. "Introduction to Nanotechnology" by Charles P. Poole, Jr. Frank J. Owens

Reference Books:

1. G Timp, "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

Course Name: Digital Image Processing

Course Code: CS(FT)602A

Contact: 3:0:0

Total Contact Hours: 36

Credits: 3

Prerequisite:

Mathematics, Computer Programming.

Course Objective:

O1: The aim of this course is to introduce to the students the basics of digital image processing. The students will gain overview about the available techniques and possibilities of this field. They will learn basic image transformation, segmentation algorithms and problems of object measurements.

Course Outcome:

After completion of this course students will be able to

CO1	Review the fundamental concepts of a digital image processing.
CO2	Identify images in the spatial as well as frequency domain using various transformation techniques for improving the image quality.
CO3	Analyse various image compression techniques.
CO4	Evaluate and analyse image segmentation techniques.
CO5	Understand various image representation technologies.

CO-PO-PSO Mapping:

COs	Program Outcome (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	--	--	--	--	--	--	--	--	--	--	3	1	3
CO2	2	2	2	1	3	2	2	--	--	--	--	2	1	3
CO3	2	2	2	1	3	2	2	--	--	2	--	3	2	3
CO4	2	2	2	1	3	2	2	--	1	--	3	3	2	2
CO5	2	2	2	1	3	2	2	--	1	--	3	2	3	3

Course Contents:

Module I: [3L]

Introduction to Digital Image Processing: Elements of digital image processing systems, Elements of visual perception Brightness, contrast, hue, saturation, match band effect, Image sampling and quantization.

Module II: [8L]

Image Enhancement: Spatial Basic grey level transformation, Histogram equalization, Histogram specification techniques, Noise Distributions, Image subtraction and Image averaging, Smoothing, sharpening filters, Frequency Domain methods: Introduction to Fourier Transform and DFT, Discrete Cosine Transform (DCT) and its properties, Smoothing in Frequency- Domain, Sharpening in Frequency- Domain, Homomorphic filtering.

Module III: [5L]

Image Restoration: Model of Image Degradation/restoration process, Noise models, Unconstrained restoration, Lagrange multiplier, least mean square filtering, Constrained least mean square filtering, Wiener filtering.

Module IV: [3L]

Color Image Processing: Different color Models, Color Transformations, Smoothing & Sharpening Color Image, Color Segmentation, Noise.

Module V: [6L]

Image Compression: Need for data compression, Different types of compression, Variable length

coding- Huffman Coding, Run Length Encoding, Arithmetic coding, Lossy Compression: Vector Quantization, Transform coding, Basics of Image compression standards: JPEG.

Module VI: [6L]

Image Segmentation: Thresholding, Region Base2d2qx2d segmentation, Region growing, Region splitting and Merging, Edge detection, Canny edge detector.

Module VII: [3L]

Image registration: Geometric transformations: translation, rotation, scaling, homomorphic coordinate system; ground control points, affine transformation.

Module VIII: [2L]

Representation & Description: Representation of segmented image, Boundary & Regional Descriptors, Use of Principal components for description.

Text books:

1. Digital Image Processing by Woods, Gonzalves, Pearson.
2. Digital Image Processing & Analysis by Chanda & Majumder, PHI.

Reference books:

1. Digital Image Processing by Jahne by Springer India.
2. Image Processing, Analysis & Machine Vision by Sonka, VIKAS.
3. Fundamentals of Digital Image Processing by Jain, PHI.

Course Name: Introduction to Machine Learning

Course Code: CS(FT)602B

Contact: 3:0:0

Total Contact

Hours: 36

Credits: 3

Prerequisite:

1. Basic programming skills, Algorithm design.

2. Probability, Axioms of Probability, Conditional Probability, Bernoulli Distribution, Binomial Distribution, Multinomial Distribution, Uniform Distribution, Normal (Gaussian) Distribution, Chi- Square Distribution, t Distribution, F Distribution. Probability Distribution and Density Functions, Joint Distribution and Density Functions, Conditional Distributions, Bayes' Rule, Expectation, Variance, Weak Law of Large Numbers.

3. Linear Algebra; Convex Optimization; Statistics; Calculus.

Course Objective(s)

O1: To learn the concept of how to learn patterns and concepts from data without being explicitly programmed

O2: To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.

O3: Explore supervised and unsupervised learning paradigms of machine learning.

To explore Deep learning technique and various feature extraction strategies.

Course Outcome(s):

After completion of this course students will be able to:

CO1	Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
CO2	Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
CO3	Understand how to evaluate models generated from data.
CO4	Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models

CO-PO-PSO–PSO Mapping

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	2	-	-	1	-	-	2	3	2	3
CO2	-	3	3	2	-	2	1	-	2	-	-	3	1	3
CO3	2	3	3	2	1	-	-	2	3	2	3	3	2	3
CO4	2	2	3	3	-	-	2	-	1	-	-	2	2	2

Course Contents:

Module 1: (8L)

Supervised Learning (Regression/Classification) • Basic methods: Distance-based methods, Nearest- Neighbours, Decision Trees, Naive Bayes • Linear models: Linear Regression, Logistic Regression, Generalized Linear Models • Support Vector Machines, Nonlinearity and Kernel Methods • Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Module 2: (5L)

Unsupervised Learning • Clustering: K-means/Kernel K-means • Dimensionality Reduction: PCA and kernel PCA • Matrix Factorization and Matrix Completion • Generative Models (mixture models and latent factor models)

Module 3: (4L)

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Module 4: (7L)

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

Module 5: (7L)

Scalable Machine Learning (Online and Distributed Learning): A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

Module 6: (4L)

Recent trends in various learning techniques of machine learning and classification methods.

Text Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer

References Books:

1. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
2. Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018

Course Name: Introduction to Internet of Things

Course Code: CS(FT)602C

Contact: 3:0:0

Total Contact Hours: 36

Credits: 3

Prerequisite:

1. Fundamental knowledge in computer networking.
2. Basic knowledge of Microcontroller fundamentals.

Course Objective:

Students will understand the concepts of Internet of Things and can able to build IoT applications

Course Outcome:

After completion of this course students will be able to

CO1	Understand and differentiate the concepts of Internet of Things and Internet
CO2	Identify appropriate MAC protocols and routing protocols while solving a problem
CO3	Analyze and compare the basic protocols in wireless sensor network and IoT
CO4	Solve different real life problems in different domains based upon the concept of IoT and sensor networks
CO5	Implement basic IoT applications on embedded platform

CO-PO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	--	--	2	--	--	--	--	--	3	-	3	-
CO2	3	3	-	-	3	-	-	--	--	--	2	-	3	-
CO3	3	3	-	-	3	-	-	--	--	-	3	-	3	-
CO4	2	3	3	2	2	2	-	2	2	2	3	2	3	3
CO5	3	2	2	-	3	-	-	--	2	--	3	2	3	2

Course Contents:

Module1: (7L)

Fundamentals of IoT

The Internet of Things, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Design challenges, Development challenges, Security challenges, Other challenges.

Module2: (6L)

Wireless Sensor Network

Network & Communication aspects, Wireless medium access issues, MAC protocol, routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.

Module 3: (7L)

IoT and M2M

A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module 4: (7L)

IoT Architecture

Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module 5: (5L)

IoT Applications for Value Creations

Introduction to Arduino and Raspberry Pi, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT in health care, Value for Industry, smart home Management.

Module 6: (4L)

Internet of Things Privacy, Security and Governance

Introduction, Overview of Governance, Privacy and Security Issues, Trust in IoT-Data- Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in smart cities, Security.

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.

Reference Books:

1. Cuno Pfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978- 1- 4493-9357-1
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

Course Name: Food Processing Lab II

Course Code: FT691

Contact: 0:0:3

Credit: 1.5

Pre requisites: Principles of Food Preservation, Unit Operations, Chemistry of Food

Course Objectives:

O1: To assist the students in using laboratory techniques common to basic Food Processing and to provide an opportunity to the students to evaluate the effective test methods used in sensory evaluation and analyze the resulting information.

Course Outcome(s):

After Completion of the course students will be able to:

CO1	**Use** of laboratory techniques common to basic Food Processing
CO2	**Apply** the principles that make a food product safe for consumption.
CO3	**Interpret** Statutory & Regulatory body pertaining regulations to food manufacturing.
CO4	**Evaluate** the effective test methods used in sensory evaluation and the resulting information

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PSO3
CO1	3	1	3	3	2	3	-	2	2	1	2	3	1	1
CO2	3	3	2	1	-	2	2	3	3	3	3	3	2	1
CO3	3	3	2	2	3	2	3	1	2	2	3	3	3	3
CO4	3	2	2	2	3	-	-	2	1	3	3	3	3	3

List of Experiments:

1. Preparation of dry onion/ chilli/ garlic.
2. Preparation of bread
3. Manufacture of macaroni by extruder.
4. Manufacture of potato powder.
5. Manufacture of ice cream.
6. Manufacture of Rosogolla and Sandesh.
7. Manufacture of candied fruits.
8. Production of milk powder by spray drying
9. Preparation of sponge cake.
10. Preparation of fruit leathers
11. Study and characteristics different herbs and spices
12. Comparison of shelf life (nutritional Value and sensory test) of slow frozen and quick frozen food.
13. Innovative experiment.

Text Books:

1. Food Science by B. Srilakhsmi
2. Essentials of Food & Nutrition by Swaminathan, Vol. 1 &2

Reference Books:

1. Hand Book of Analysis of fruits & vegetables by S. Ranganna

Course Name: Food Analysis and Quality Control Lab-II

Course Code: FT692

Contact: 0:0:4

Credit: 2

Pre-requisites: Food Chemistry, Biochemistry, Microbiology

Course Objectives:

O1: To develop practical skills and analytical proficiency in assessing the physicochemical and sensory quality of diverse food and beverage products.

O2: To familiarize students with standard laboratory techniques for food analysis and promote critical interpretation of experimental data.

O3: To foster innovation through experimental design aimed at ensuring food safety, authenticity, and quality control in alignment with regulatory standards.

Course outcome(s):

After the completion of the Food Analysis and Quality Control Lab I the students will be able to:

CO1	**Determine** the methods of selecting appropriate techniques for the analysis of food products.
CO2	**Analyze** different components present in various food materials.
CO3	**Interpret** the knowledge of food standards, regulations, and quality control.
CO4	**Identify** the test methods to detect adulterants in various food samples.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PSO3
CO1	3	2	-	3	3	-	-	-	-	-	2	3	3	1
CO2	3	3	2	3	2	-	-	-	-	-	2	3	2	2
CO3	2	2	2	2	2	2	3	-	2	-	2	3	3	2
CO4	3	3	-	2	3	-	-	-	-	-	2	3	3	2

List of Experiments:

1. Analysis of wheat flour
2. Analysis of bread, biscuit, and extruded food products
3. Analysis of milk, milk powder, and condensed milk
4. Determination of adulteration in milk and dairy products
5. Analysis of oil samples: a) acid value, b) peroxide value, c) iodine value, d) saponification value, e) para-Anisidine value, f) Reichert-Meissl value, g) Polenske value
6. Analysis of canned fish or meat products
7. Innovative experiments.

Text Books:

1. FSSAI Manuals
2. Raghuramulu, N. et al., “A Manual of Laboratory Techniques”. 2nd Edition. NIN, 2003.
3. Nielsen, S. Suzanne. “Food Analysis” 3rd Edition. Springer, 2003.

Reference Books:

1. Pomeranz, Yeshajahu and Clifton E. Meloan “Food Analysis: Theory and Practice”. 3rd Edition. Springer, 2000.

4th Year 7th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	FT701	Waste Management of Food Industries	3	1	0	4	4
2	ENGG	Minor	HU(FT)701 A	Entrepreneurship Development and Start-Up Management	3	0	0	3	3
			HU(FT)701 B	Quality Management System					
			CS(FT)701 C	Smart Technologies					
3	ENGG	Minor	HU(FT)702 A	Consumer Behavior Research	3	0	0	3	3
			HU(FT)702 B	Product Design and Development					
			HU(FT)702 C	Business Research Method					
4	HUM	Skill Enhancement Course	HU(FT) 703	Project Management and Finance	2	0	0	2	2
B. PRACTICAL									
1	ENGG	Skill Enhancement Course	PR(FT)791	Rapid Prototyping Lab	0	0	3	3	1.5
2	PRJ	Project	FT781	Project-IV	0	0	0	12	6
Total of Theory, Practical								27	19.5

Course Name: Waste Management of Food Industries

Course Code: FT701

Contact: 3:1:0

Total Contact Hours: 48

Credit: 4

Pre requisites: Basic Engineering Principles**,** Basic Environmental Engineering, Unit Operations,
Thermodynamics and Kinetics

Course Objective:

O1. To understand the sources, types, and characteristics of waste generated in food processing industries, and to evaluate their potential environmental impacts.

O2. To explore various waste treatment and management techniques, including physical, chemical, biological, and advanced technologies suitable for the food industry.

O3. To promote sustainable practices and circular economy concepts by focusing on waste minimization, recovery, reuse, and valorization strategies in food processing operations.

Course outcome(s):

After the completion of the course students will be able to:

CO1	**Apply** appropriate waste management techniques to minimize solid, liquid, and gaseous waste generated in food processing industries.
CO2	**Demonstrate** the utilization of food industry by-products for value-added product development and environmental sustainability**.**
CO3	**Analyze** the operational principles of various physical, chemical, and biological waste treatment methods relevant to food industries**.**
CO4	***Evaluate*** waste minimization and by-product recovery strategies for enhancing sustainability and regulatory compliance in food industries.

CO-PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	2	-	-	-	-	2	3	2	3
CO2	2	3	-	2	-	3	2	-	-	-	-	3	3	2
CO3	2	2	2	3	3	2	-	-	-	-	-	3	2	2
CO4	2	3	3	3	2	3	2	-	-	2	3	3	3	2

Course Contents:

Module I: (8L)

Introduction: Types of Pollution, Waste disposal methods – physical, chemical and biological. Classification and characterization of food industrial wastes from fruit and vegetable processing industry, beverage industry, fish, meat and poultry industry, sugar industry and dairy industry; Waste disposal methods – physical, chemical and biological

Module II: (12L)

Treatment methods for liquid wastes from food process industries; Design of activated sludge process, Rotating biological contactors, Trickling filters, UASB, Numerical Problem.

Module III: (8L)

Biofilters/ bioclarifiers, Biogas plant, Ion exchange treatment of waste water, Bioremediation, Adsorption process in waste treatment, Recovery of useful materials from effluents by different methods**.**

Module IV: (12L)

Treatment methods of solid wastes: Biological composting, drying and incineration; Design of solid waste management system: Landfill digester, Vermicomposting pit, Biomanure, Numerical Problem.

Module V: (4L)

Identification and classification of hazardous waste, hazardous waste treatment, pollution prevention and waste minimization, hazardous wastes management in India. E-waste recycling

Revision: (4L)

Text Books:

1. Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University Press.

2. Water & Wastewater Engineering; Fair GM, Geyer JC & Okun DA; 1986, John Wiley & Sons, Inc.

Reference Book:

1. Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.

2. Wastewater Treatment; Bartlett RE; Applied Science Pub Ltd.

3. Symposium: Processing Agricultural & Municipal Wastes; Inglett GE; 1973, AVI.

4. Food Processing Waste Management; Green JH & Kramer A; 1979, AVI.

5. Environmental Biotechnology: Principles and Applications; Rittmann BE & McCarty PL; 2001, Mc- Grow-Hill International editions.

Course Name: Entrepreneurship Development and Start-Up Management

Course Code: HU(FT)701A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Food Process Engineering, Unit Operations in Food Technology, Food Processing Technology

Course Objective:

O1: Acquire knowledge in Entrepreneurship Development

O2: Able to study and prepare the business plan for any organization

O3: Classify and study the organizational structure between small, medium, and large scale manufacturing industries

Course outcome(s):

After completion of the course students will be able to:

CO1	**Understand** opportunities to set-up Food processing industries
CO2	**Identify** the market competitors and conduct and prepare survey reports accordingly
CO3	**Design** the finance, human resource, and operations strategy for effective market growth
CO4	**Develop** the effective business ecosystem

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	2	1	-	1	1	3	3	3	1
CO2	3	3	3	3	3	2	2	2	1	2	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I (8L)

Entrepreneurship concept- Entrepreneurship as a Career- Entrepreneur Personality Characteristics- Knowledge- Skills- Attitude Requirement; Business Environment- Role of Family and Society- Entrepreneurship Development Training and Other Support Organizational Services- Central and State Government Industrial Policies and Regulations, MoFPI scheme and support to budding food entrepreneurs, Skill Development by Central Government, International Business.

Module II (8L)

Sources of Product for Business- Pre Feasibility Study- Criteria for Selection of Product- Ownership- Capital- Budgeting Project Profile Preparation- Matching Entrepreneur with the Project- Feasibility Report Preparation and Evaluation Criteria; legal aspect; Selection of land and factory sheds

Module III (8L)

Finance and Human Resource Mobilization- Operations Planning- Market and Channel election- Growth Strategies- Product Launching

Module IV (8L)

Monitoring and Evaluation of Business- Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business, Overview of Startup food business and challenges.

Revision: (4L)

Text Books:

1) Hisrich, “Entrepreneurship”, Tata McGraw Hill, New Delhi,2005.

2) Saravanavel, P., ‘Entrepreneurial Development’, Ess Pee key publishing House, Chennai,2005.

References Books:

1. Khanka, S S., “Entrepreneurial Development”, S.Chand and Co Limited, New Delhi,2001.

2. Jain, P C., “Handbook for New Entrepreneurs”, Second Edition, Oxford University Press, New Delhi,2002.

Course Name: Quality Management System

Course Code: HU(FT)701B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Basic mathematics, basic biology, food preservation, quality control and assurance

Course Objective:

O1: To develop the knowledge of students regarding quality control and management principles, tools and their application

O2: To enable the students to be aware of the voluntary and mandatory food standards and certifications in place- globally and nationally

Course outcome(s):

After completion of the course students will be able to:

CO1	**Interpret** engineering fundamentals with basics food safety and quality management.
CO2	**Apply** food safety management principles in food quality and safety maintenance
CO3	**Analyze** existing food laws and quality management techniques for safe food to consumers.
CO4	**Develop** system tools to meet specific needs of food safety taking into consideration public health and safety, cultural, societal and environmental issues.

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	3	-	2	1	-	2	2	3	3	3	1
CO2	3	3	3	3	3	2	2	2	1	2	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I (8L)

Definition of quality, Quality specifications and quality attributes of different foods, Statistical quality control, Quality control programs: History and development, Total quality management (TQM), Quality assurance, Management Principles, ISO 9000 Family (QMS), principles and requirements

Module II (8L)

Food Safety Management System ISO-22000 – Family, Key role, Principles of FSMS and requirements, HACCP- Prerequisites; GMP/C-GMP, GHP, GLP, Cleaning and Sanitation, Safety practices in the production areas, Pest Control, Withdrawal and Recall Procedures, traceability system, Principles and steps of HACCP Plan, Hazard Identification, Risk assessment, CCP Decision Tree, CAPA Plan, document and records

Module III (8L)

Mandatory and voluntary regulations world-wide, CODEX, FDA, WHO, EFSA, WTO, (TBT, SPSs), GATT. Role of regulatory authorities in India - functioning, legal acts and their enforcements- FSSAI (in detail), BIS, AGMARK, Legal Metrology Act, Industry Specific Regulations, ASCI, EPA, Export Quality Control and Inspection Act

Module IV (8L)

Certification, Certification procedures, Certifying bodies, Accrediting bodies, International bodies. GFSI benchmarking, FSSC 22000, BRC, SQF, IFS, FSMA, OSHA, Auditing procedures-types of audit, Surveillance; Mock audit, third party quality certifying audit, Auditors and Lead auditors.

Revision: (4L)

Text Books:

1. Total Quality Management, M.P. Poonia & S.C. Sharma, Khanna Publishing House (AICTE Recommended Textbook - 2018)
2. Total Quality Management, Poornima M. Charantimath, Pearson Education India
3. Total Quality Management for the Food Industries. WA Gould, Woodhead Publishing
4. Management and control of quality. James R Evans, William M Lindsey. Thomson Southwestern
5. Bioethics and Biosafety, M. K. Sateesh, I. K. International Pvt Ltd

References Books:

1. The Essentials of Quality Control Management, Peter N T Pang, Trafford publishing
2. Guide to Quality Management system for the food industry. Ralph Early

Course Name: Smart Technologies

Course Code: CS(FT)701C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Sensors, System Integration, Cloud and Network Security, Basic Engineering Mathematics, Automation and Control

Course Objective:
O1: To impart necessary and practical knowledge of components of the Internet of Things and develop skills required to build real-life IoT-based projects

Course outcome(s):
After completion of the course students will be able to:

CO1	**Understand** the Internet of Things and its hardware and software components
CO2	**Develop** real-life IoT based projects
CO3	**Integrate** mechanical and electrical hardware for a real prototype of the robotic device
CO4	**Select** a robotic system for a given application

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO1	PO2	PO 3	PO4	PO5	PO 6	PO 7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	2	1	-	1	1	3	2	3	1
CO2	3	3	3	3	3	2	2	2	1	2	3	2	2	1
CO3	2	3	3	3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	2	3	3	2	3	2	3	3

Course Contents:

Module I (8L)

Introduction to IoT, Architectural Overview, Design principles and needed capabilities, IoT applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology, Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT

Module II (8L)

Introduction to Robotics Types and components of a robot, Robot Actuation Systems, Classification of robots, closed-loop and open-loop control systems. Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

Module III (8L)

IoT Application Development and case studies, Solution framework for IoT applications- Implementation of Device Integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

Module IV (8L)

Sensors and Vision System Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Vision applications in robotics

Revision: (4L)

Text Books:

1. Vijay Madisetti, ArshdeepBahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
5. CunoPfister, "Getting Started with the Internet of Things", O Reilly Media
6. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

References Books:

1. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
2. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
3. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.2018
4. Jeeva Jose, Internet of Things, Khanna Publishing House, 2018.

Course Name: Consumer Behavior Research

Course Code: HU(FT)702A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites:

Course Objective:

O1: To impart knowledge of psychological, cultural, and environmental factors influencing consumer behavior in the context of food science and technology.

O2: To develop competency in applying consumer research methods to design, conduct, and interpret studies related to food products.

O3: To enable students to utilize consumer insights for product development, marketing strategies, and ethical food innovation.

Course outcome(s):

After completion of the course students will be able to:

CO1	**Understand** the fundamentals of consumer behaviour and its significance in food marketing
CO2	**Analyze** the consumer decision-making process and identify factors influencing food choices
CO3	**Design** market research studies, including data collection and analysis.
CO4	**Apply** consumer insights to develop effective marketing strategies for food products

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	2	-	-	-	-	1	3	2	2	2
CO2	-	3	-	2	2	2	-	-	-	-	3	2	3	1
CO3	-	-	3	2	-	-	-	-	3	1	3	2	2	3
CO4	-	2	3	-	-	-	2	2	-	1	3	2	2	2

Course Contents:

Module I (8L)

Tools and methods to conduct and interpret market research, Consumer behaviour and the consumer decision-making process, Factors affecting consumer buying behaviour.

Module II (8L)

Marketing research fundamentals, Importance of market research. How to acquire data. Different types of experimental research and design.

Module III (8L)

Questionnaire and sampling design, Tools to collect, analyze, and present data, Hypothetical group project on consumer research: Prepare a hypothesis based on current trends in consumer buying. Devise the tool, inclusion/exclusion criteria, Collect data and present a report.

Module IV (8L)

Applying Consumer Insights to Marketing Strategy: Translating research findings into marketing strategies, Developing product, pricing, promotion, and distribution strategies, Evaluating the effectiveness of marketing strategies.

Revision: (4L)

Text Books:

1. "Consumer Value: A Framework for Analysis and Research" by Morris B. Holbrook and Morris Holbrook (2002). Routledge Interpretive Market Research Series.

2. "Qualitative Consumer and Marketing Research" by Russell W. Belk (2013). Eileen Fischer and Robert Kozinets.

Reference Books:

1. "Marketing Management" by Philip Kotler (2016). Pearson Education.

2. "Consumer Behaviour: A European Outlook" by Leon G. Schiffman and Leslie Kanuk (2011). Pearson Education.

Course Name: Product Design and Development

Course Code: HU(FT)702B

Contact: 3:0:0

Total Contact

Hours: 36

Credit: 3

Prerequisite: Process technologies, designing, communication and management.

Course Objectives:

O1: To provide an understanding of the characteristics, processes, timelines, costs, and challenges associated with successful product development in the food and allied industries.

O2: To develop skills in product planning by identifying customer needs, evaluating and prioritizing opportunities, allocating resources, and applying pre-project planning techniques.

O3: To equip students with the ability to establish product specifications, generate innovative concepts, and apply systematic methods for concept screening and selection.

O4: To familiarize students with design for manufacturing principles, cost optimization strategies, prototyping methods, and their integration into efficient product development.

Course Outcomes: After successful completion of the course, student will be able to

CO1	Understand the product design and development process.
CO2	Apply creative thinking skills for idea generation.
CO3	Translate conceptual ideas into products.
CO4	Present ideas using various types of prototypes

CO-PO-PSO Mapping:

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	-	-	2	-	-	2	3	2	1
CO2	2	2	3	2	1	-	-	-	-	1	2	3	2	2
CO3	2	1	2	1	1	-	-	-	1	-	-	3	2	3
CO4	2	3	2	3	3	-	-	-	-	-	-	3	2	3

Course Contents

Module I (8L)

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Module II (8L)

Product Planning and Identifying Customer Needs: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. Gather raw data from customers, establish the relative importance of the customer needs and reflect on the results and the process.

Module III (8L)

Product Specifications and Concept Generation: What are specifications, when are specifications established, setting the final specifications. The activity of concept generation, clarify the problem, Concept Selection, Overview of methodology and concept screening.

Module IV (8L)

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping, Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Text Books:

1. Product Design and Development - Karl.T. Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.

2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.

Reference Books

1. New Product Development - Timjones. Butterworth Heinmann -Oxford. UCI -1997

2. Product Design for Manufacture and Assembly – Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002

Course Name: Business Research Method

Course Code: HU(FT)702C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Prerequisites: Management principles, business ethics and environment

Course Objectives:

O1: To familiarize students with the techniques and tools of Business Research.

O2: To develop research report writing skills among students.

Course Outcome(s):

After completion of the course students will be able to:

CO1	**Describe** the concept of research methodology
CO2	**Interpret** the research design and research focus
CO3	**Explain** the research hypothesis and sampling technique
CO4	**Apply** data analysis and statistical methods in professional research

CO-PO-PSO Mapping:

COs	**Program Outcomes (PO)**											**Program Specific Outcomes (PSO)**		
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	-	-	-	-	2	-	-	2	3	2	1
CO2	2	2	3	2	1	-	-	-	-	1	2	3	2	2
CO3	2	1	2	1	1	-	-	-	1	-	-	3	2	3
CO4	2	3	2	3	3	-	-	-	-	-	-	3	2	3

Course Contents:

Module I: (8L)

Introduction to Research Methodology: Meaning and purpose, Types of research: Exploratory, Analytical, Descriptive, Experimental and Case study**,** Scientific Method of Research, Recent Trends in Usage of Research in Indian Corporate Sector.

Module II: (8L)

Research Focus: Problem definition, Selection and formulation, Review of Literature, Delimitation of the scope of the study, Setting Objectives, Definition of the concepts, Sources of Data: Nature and Types, Sampling Techniques, Nature and Types, Sampling Errors.

Module III: (8L)

Meaning of Hypothesis, Types of Hypothesis, Sources of hypothesis, Testing of Hypothesis, Errors in Testing, Measurements, Scaling techniques and Scale Construction, Sample size, Sampling error, Sampling Methods and Applications.

Module IV: (8L)

Advance Techniques of Data Analysis: Factor analysis, Cluster Analysis, Correlation and Regression analysis, Pareto chart, fishbone diagram, Histogram, ANOVA.

Revision: (4L)

Text Books

1. Krishnaswamy O R and Ranganatham M. (2014) Methodology of Research in Social Sciences, Himalaya Publication, India.
2. Kothari C R (2014), "Research Methodology: Methods and Techniques", New Age India.
3. Sekaran Uma And Bougie Roger (2010) Research Methods For Business: A Skill Building Approach John Wiley & Sons,2010

Reference Books:

1. Kerlinger Fred And Lee Bhoward (1999), Foundations Of Behavioral Research, S.Chand
2. Hatt K Paul and Goode J William, (2016), Methods InSocial Research, Asia Law House.

3. Cooper R Donald And Schindler (1998) Pamela Business Research Method, sirwin Professional Publishing

Paper name: Project Management and Finance

Code: HU(FT)703

Contact: 2:0:0

Total Contact Hours: 28

Course Objectives

O1: To introduce students to the fundamental concepts and components of Project Management.

O2: To develop the ability to perform preliminary project screening and appraisal, enabling students to identify viable project opportunities and assess their potential.

O3: To provide knowledge and analytical skills for conducting comprehensive feasibility studies.

O4: To impart foundational knowledge of Financial Management principles.

O5: To enhance decision-making abilities related to financial management, particularly in areas such as investment analysis, cost control, and project financing.

Course Outcomes:

CO1	Understand and explain the fundamental principles, tools, and techniques of project management including planning, scheduling, monitoring, and control in engineering projects.
CO2	Apply project screening and feasibility analysis methods to assess the technical, market, and operational viability of engineering projects.
CO3	Analyze financial data to evaluate project investments, including concepts such as time value of money, break-even analysis, and risk-return trade-off.
CO4	Demonstrate decision-making capabilities in project financing and resource allocation, using basic financial management principles and tools.

CO-PO-PSO mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	2	2	2	2	2	2	3	2	1
CO2	2	2	3	2	1	2	-	-	-	1	2	3	2	2
CO3	2	1	2	1	1	-	-	-	1	-	-	3	2	3
CO4	2	3	2	3	3	-	-	-	-	-	-	3	2	3

Course Content:

UNIT I: BASICS OF PROJECT MANAGEMENT: Meaning, Definition and scope and Need for Project Management - The Project Life Cycle - Phases of Project Management Life Cycle - Project Management Processes. **(2L)**

UNIT II: PROJECT IDENTIFICATION AND SELECTION: Preliminary Screening of Projects. Project Identification Process- Sources of Financial resources - Pre-Feasibility Study - Feasibility Studies: Market Feasibility, Financial Feasibility and Technical Feasibility (3L)

UNIT III: PROJECT ORGANIZATION AND PLANNING: Project manager, Cross-functional team, Dedicated project organization, Influence project organization, Matrix organization, Advantages and disadvantages of project organizations, Selection of project organization, Work Breakdown Structure (WBS), Integration of project organization and WBS, WBS and responsibility matrix. **(3L)**

UNIT IV: PROJECT SCHEDULING AND RESOURCE MANAGEMENT: Gant chart, Milestone chart, Network techniques: PERT and CPM, AON and AOA representation. **(4L)**

UNIT-V: NATURE AND SCOPE OF FINANCIAL MANAGEMENT

Role of financial management in business decision, the Firm and its Environment: Forms of business ownership. **(2L)**

UNIT-VI: BALANCE SHEET AND PROFIT AND LOSS STATEMENTS

Tools of Financial Analysis: Funds flow analysis - sources and uses of funds, measurements of

cash flow, Revenue costs. **(3L)**

Investment Management: Capital Budgeting Techniques. PBP, ARR, Time Value of Money, NPV v/s IRR. Risk Analysis. **(3L)**

UNIT-VII: PROFIT RELATIONSHIPS

Break even analysis, ratio analysis, of operating and financial leverages, Working Capital Management, Credit Policy. **(3L)**

Financial Decision Making: Sources of raising capital, Internal financing, Cost of capital, Balanced Capital Structure. Capital Structure Theories, Dividend Policy & its Theories. (5L)

Textbooks:

1. R. Paneerselvam, P. Senthil Kumar, Project Management, PHI.

2. S. N. Maheshwari, Financial Management: Principles and Applications , Sultan Chand & Sons

Reference Books:

1. Prasanna Chandra, Projects, Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill Pvt. Ltd., New Delhi.

2. K. Nagrajan, Project Management, New Age International Publishers,

3. Vasanth Desai, Project Management, Himalaya Publications.

4. Clifford F. Gray, Erik W. Larson, Project Management, the Managerial Emphasis, Tata McGraw Hill.

6. 7. M.Y. Khan and P. K. Jain, Financial Management: Text, Problems and Cases, Tata McGraw Hill Pvt. Ltd., New Delhi.

Course Name: Rapid Prototyping Lab

Course Code: PR(FT)791

Contact: 0:0:3

Credit: 1.5

Course Objectives:

O1: To impart fundamental knowledge on the principles, processes, and significance of rapid prototyping in food technology, including material selection for food-grade applications and compliance with safety standards.

O2: To develop practical skills in designing, fabricating, post-processing, and optimizing customized prototypes through systematic experimentation and parameter optimization.

O3: To enhance problem-solving and innovation capabilities by engaging in cost–time analysis, iterative design through case studies, and critical evaluation of functional prototypes for real-world food technology applications.

Course outcome(s):

After the completion the course the students will be able to:

CO1	Analyze the fundamental principles of prototype design and evaluate its applications in food technology for product development and innovation
CO2	Select and justify appropriate food-grade materials for rapid prototyping, considering safety, mechanical, and functional requirements
CO3	Design, fabricate, and optimize food packaging prototypes using edible and biodegradable materials, integrating post-processing and finishing techniques.
CO4	Assess cost, time, and performance parameters through iterative design processes, and present innovative prototype solutions for food technology applications

CO – PO-PSO Mapping

COs	Program Outcomes (PO)											Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	–	–	1	–	2	3	2	1
CO2	3	3	2	2	2	2	1	–	–	–	2	3	2	1
CO3	2	2	3	3	3	2	1	1	2	1	2	3	3	2
CO4	2	2	3	2	2	2	–	2	3	3	2	3	3	3

List of Experiments / Practical Activities:

1. Introduction to concept of prototype design and it's utility.
2. Material selection for food-grade applications in rapid prototype design.
3. Testing customized packaging designs for food products [Edible/ Biodegradable packaging material].
4. Post-processing of parts (finishing, coating, assembling).
5. Study of effect of different processing parameters and optimization using different tools
6. Cost estimation and time analysis for prototype development.
7. Case study: Iterative design of a functional prototype for a food technology application.
8. Evaluation and presentation of final prototypes.
9. Innovative

Suggested Readings:

1. Gibson, I., Rosen, D., & Stucker, B. *Additive Manufacturing Technologies*. Springer.
2. Chua, C. K., Leong, K. F., & Lim, C. S. *Rapid Prototyping: Principles and Applications*. World Scientific.
3. Selected research articles on RP in food technology.

4th Year 8th Semester									
Sl. No.	Broad Category	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
B. PRACTICAL									
1	PRJ	Project	FT881	Grand Viva	0	0	0	0	4
2	PRJ	Project	FT882	Internship/ Entrepreneurship	0	0	0	0	4
Total of Theory, Practical									8
Total Credit in 4th Year									27.5