B. TECH (Food Technology)

2022 Regulations, Curriculum & Syllabi (Revised)

(Candidates admitted during the Academic year 2023-2024)

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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VISION OF THE DEPARTMENT

To develop technically sound human resources who can make a difference in thefield of Food Technology and to cater the needs of industry as well as society.

MISSION OF THE DEPARTMENT

- Produce technically well versed and socially responsive professionals who would take up the national and international positions in government and private Food Processing sectors.
- Develop partnerships with industries and communities to share the knowledge and also to train the Food Technologists.
- Produce Food Technologist who can develop novel technologies for better processing, storage and value addition of agricultural products with the ultimate aimto prevent post-harvest losses which in turn helps in increasing the country's economy and also ensures the food security of our nation

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Acquire theoretical and practical knowledge of food engineering and technology to become a qualified food process engineer.

II. Apply the skills of food technology in research, industry and entrepreneurship toensure food safety and nutrition security.

III. Improve the standard of living and economy of the nation through convenience and novel food products with professional ethics.

PROGRAMME OUTCOMES (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communicate effectively on complex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give andreceive clear instructions.
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

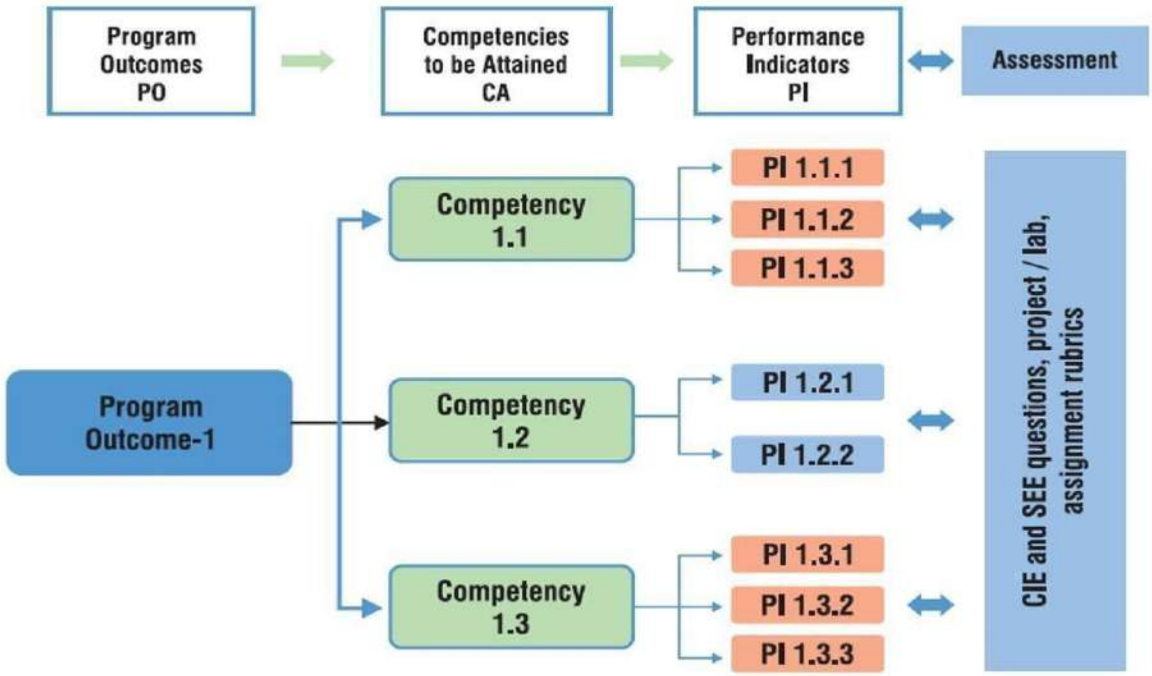
PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Students will be able to conduct innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
2. Practical and research training imparted to the students will pave the way for introducing novel technologies in food processing sectors for global sustenance.

MAPPING OF PEOs AND POs

	Program Outcomes											
PEO(s)	1	2	3	4	5	6	7	8	9	10	11	12
I	X	X	X	X							X	
II		X		X	X		X	X				X
III						X	X	X	X	X		

Connectivity chart



Connecting POs to Assessment

DEPARTMENT OF FOOD TECHNOLOGY
Minimum Credits to be Earned:163

I SEMESTER

Code No.	Course	L	T	P	C	Hours / Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
22PH102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
22CH103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
22GE001	FUNDAMENTALS OF COMPUTING	3	0	0	3	4	40	60	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	60	40	100	HSS
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22GE005	ENGINEERING DRAWING	1	0	2	2	3	50	50	100	ES
22HS003	தமிழர் மரபு / HERITAGE OF TAMILS	1	0	0	1	1	40	60	100	HSS
Total		**15**	**1**	**10**	**21**	**27**	-	-	-	**-**

II SEMESTER

Code No.	Course	L	T	P	C	Hours / Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
22PH202	ELECTROMAGNET ISM ANDMODERN PHYSICS	2	0	2	3	4	50	50	100	BS
22CH203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
22GE002	COMPUTATIONAL PROBLEM SOLVING	3	0	0	3	3	40	60	100	ES
22GE004	BASICS OF ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	50	50	100	EEC
	LANGUAGE ELECTIVE	1	0	2	2	3	50	50	100	HSS
22HS006	தமிழரும் தொழில்நுட்பம் / TAMILS AND TECHNOLOGY	1	0	0	1	1	40	60	100	HSS
Total		**15**	**1**	**10**	**21**	**26**	-	-	-	**-**

III SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours / Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD301	NUMERICAL METHODS AND STATISTICS	3	1	0	4	4	40	60	100	BS	Only FD
22 FD302	FOOD CHEMISTRY	3	0	2	4	5	50	50	100	PC	Only FD
22 FD303	ENGINEERING THERMODYNAMICS	3	1	0	4	5	40	60	100	ES	Only FD
22FD304	FLUID MECHANICS AND MACHINERY	3	0	2	4	4	50	50	100	ES	Only FD
22 FD305	FOOD MICROBIOLOGY	3	0	2	4	5	50	50	100	PC	Only FD
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS	Common
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	60	0	100	EEC	Common
22HS003*	தமிழர் மரபு / HERITAGE OF TAMILS*	1	0	0	1	1	40	60	100	HSS	
Total		**17**	**2**	**10**	**24**	**28**	-	-	-	-	-
IV SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours / Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD401	SENSORY EVALUATION OF FOOD	3	0	0	3	3	40	60	100	PC	Only FD
22FD402	HEAT AND MASS TRANSFER	3	0	2	4	5	50	50	100	PC	Only FD
22FD403	REFRIGERATION AND COLD CHAIN MANAGEMENT	3	1	0	3	3	40	60	100	PC	Only FD
22FD404	FOOD PROCESSING AND PRESERVATION	3	0	2	4	5	50	50	100	PC	Only FD
22FD405	UNIT OPERATIONS IN FOOD PROCESSING	3	0	2	4	5	50	50	100	PC	Only FD
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	ES	Only FD
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HSS	Common
22HS008	ADVANCED ENGLISH AND TECHNICALEXPRESSION	0	0	2	1	2	60	40	100	EEC	Common
22HS006*	தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY *	1	0	0	1	1	40	60	100	HSS	
Total		**19**	**1**	**8**	**22**	**30**	-	-	-	-	-

*Applicable only for Lateral Entry Students

V SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours / Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD501	BAKING AND CONFECTIONERY TECHNOLOGY	3	0	2	4	5	50	50	100	PC	Only FD
22FD502	FRUITS AND VEGETABLES TECHNOLOGY	3	0	2	4	5	50	50	100	PC	Only FD
22FD503	MEAT, POULTRY AND FISH TECHNOLOGY	3	0	0	3	4	40	60	100	PC	Only FD
22FD504	DAIRY TECHNOLOGY	3	0	2	4	4	50	50	100	PC	Only FD
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE	Only FD
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	PE	
22FD507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC	Only FD
Total		**18**	**0**	**8**	**22**	**26**	-	-	-	**-**	**-**

VI SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD601	FOOD PROCESSING PLANT DESIGN ANDLAYOUT	3	0	2	4	5	50	50	100	PC	Only FD
22FD602	FOOD EQUIPMENT DESIGN	3	1	0	4	4	40	60	100	PC	Only FD
22FD603	FOOD INSTRUMENTATION AND ANALYSIS	3	0	2	4	5	50	50	100	PC	Only FD
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE	Only FD
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE	Only FD
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE	Only FD
22FD607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC	Only FD
Total		**18**	**1**	**6**	**22**	**25**	-	-	-	**-**	**-**

VII SEMESTER											
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category	Eligibility
							CIA	SEE	Total		
22FD701	FOOD LAWS AND SAFETY STANDARDS	3	0	0	3	4	40	60	100	PC	Only FD
22FD702	FOOD WASTE MANAGEMENT	3	0	2	4	5	50	50	100	PC	Only FD
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE	Only FD
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE	Only FD
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE	Only FD
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE	Only FD
22FD707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC	Only FD
Total		**18**	**0**	**6**	**21**	**25**	-	-	-	**-**	**-**
VIII SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD801	Project Work II	0	0	20	10	20	60	40	100	EEC	Only FD
Total		**0**	**0**	**20**	**10**	**20**	-	-	-	**-**	**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
22HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
22HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
22HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
22HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS

ELECTIVES											
PROFESSIONAL ELECTIVES											
Vertical 1 - Innovations in Food Packaging											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD001	FOOD PACKAGING TECHNOLOGY	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD002	FOOD PACKAGING DESIGN AND DEVELOPMENT	3	0	0	3	3	40	60	100	PE	
22FD003	DIVERSE MATERIALS IN FOODPACKAGING	3	0	0	3	3	40	60	100	PE	
22FD004	EMERGING TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY	3	0	0	3	3	40	60	100	PE	
22FD005	PACKAGING PERFORMANCE TESTING AND MACHINERY	3	0	0	3	3	40	60	100	PE	
22FD006	NEXT GENERATION PACKAGING	3	0	0	3	3	40	60	100	PE	

Vertical 2- Advanced Food Processing											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD007	RADIATION PRESERVATION AND PROCESSING OF FOOD PRODUCTS	3	0	0	3	3	40	60	100	PE	Only FD, BT,AG
22FD008	NON- THERMAL PROCESSING TECHNIQUES	3	0	0	3	3	40	60	100	PE	Only FD, BT
22FD009	THERMAL PROCESSING TECHNIQUES	3	0	0	3	3	40	60	100	PE	Only FD, BT,AG
22FD010	FOOD SENSORS	3	0	0	3	3	40	60	100	PE	Only FD, BT,AG
22FD011	3D PRINTING OF FOODS	3	0	0	3	3	40	60	100	PE	Only FD, BT,AG
22FD012	APPLICATION OF NANOTECHNOLOGYAND CRYOGENICS IN FOOD PROCESSING	3	0	0	3	3	40	60	100	PE	Only FD, BT,AG

Vertical 3- Bakery and Confectionery Technology											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD013	TRADITIONAL CONFECTIONERIES	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD014	RHEOLOGICAL PROPERTIES OF BAKERYAND CONFECTIONERY PRODUCTS	3	0	0	3	3	40	60	100	PE	
22FD015	DESIGN OF BAKERY AND CONFECTIONERY EQUIPMENT	3	0	0	3	3	40	60	100	PE	
22FD016	INDUSTRIAL PRODUCTION OF BAKED GOODS	3	0	0	3	3	40	60	100	PE	
22FD017	SUGAR TECHNOLOGY	3	0	0	3	3	40	60	100	PE	
22FD018	BAKERY SCIENCE AND INGREDIENT TECHNOLOGY	3	0	0	3	3	40	60	100	PE	

Vertical 4- Spices, Plantation and Herbs Technology											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD019	TEA AND COFFEE PROCESSING	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD020	AROMATIC SPICES PROCESSING	3	0	0	3	3	40	60	100	PE	
22FD021	PROCESSING OF CHOCOLATE AND ITS PRODUCTS	3	0	0	3	3	40	60	100	PE	
22FD022	VALUE ADDED SPICE PRODUCTS	3	0	0	3	3	40	60	100	PE	
22FD023	PROCESSING OF COCONUTAND ITS PRODUCTS	3	0	0	3	3	40	60	100	PE	
22FD024	AROMATIC HERBS PROCESSING	3	0	0	3	3	40	60	100	PE	

Vertical 5 - Food Safety and Quality Management											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD025	NATIONAL AND INTERNATIONAL FOOD LAWS	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD026	RISK ANALYSIS	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD027	FOOD ADULTERATION AND ITSCONTROL	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD028	FOOD SAFETY MANAGEMENT SYSTEMS	3	0	0	3	3	40	60	100	PE	Only FD, BT
22FD029	FOOD SUPPLY CHAIN MANAGEMENT LOGISTICS	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG
22FD030	QUALITY ASSURANCE AND QUALITYCONTROL IN FOOD INDUSTRIES	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG

Vertical 6- Food Biotechnology											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22FD031	MICROBIAL PRESERVATION AND PROCESSING	3	0	0	3	3	40	60	100	PE	Only FD, AG
22FD032	BIOPROCESS TECHNOLOGY	3	0	0	3	3	40	60	100	PE	Only FD, AG
22FD033	FOOD ALLERGENS AND TOXICOLOGY	3	0	0	3	3	40	60	100	PE	Only FD, AG, BT
22FD034	ENZYME TECHNOLOGY	3	0	0	3	3	40	60	100	PE	Only FD, AG
22FD035	FOOD FERMENTATION TECHNOLOGY	3	0	0	3	3	40	60	100	PE	Only FD, AG
22FD036	CELLULAR AGRICULTURE	3	0	0	3	3	40	60	100	PE	Only FD, BT, AG

Vertical 7- Fruit and Vegetable Technology											
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category	Eligibility
							CIA	SEE	Total		
22FD037	FRUIT SCIENCE	3	0	0	3	3	40	60	100	PE	
22FD038	POST-HARVEST MANAGEMENT OF FRUITS AND VEGETABLE	3	0	0	3	3	40	60	100	PE	
22FD039	FRUIT AND VEGETABLE PROCESSING	3	0	0	3	3	40	60	100	PE	
22FD040	BEVERAGE TECHNOLOGY	3	0	0	3	3	40	60	100	PE	
22FD041	VALUE-ADDED PRODUCTS FROM FRUITSAND VEGETABLES	3	0	0	3	3	40	60	100	PE	
22FD042	FRUIT AND VEGETABLE WASTE MANAGEMENT	3	0	0	3	3	40	60	100	PE	

HONOURS VERTICAL COURSES										
Vertical 1 - Innovations in Food Packaging										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22FDH01	FOOD PACKAGING TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22FDH02	FOOD PACKAGING DESIGN AND DEVELOPMENT	3	0	0	3	3	40	60	100	PE
22FDH03	DIVERSE MATERIALS IN FOOD PACKAGING	3	0	0	3	3	40	60	100	PE
22FDH04	EMERGING TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22FDH05	PACKAGING PERFORMANCE TESTING ANDMACHINERY	3	0	0	3	3	40	60	100	PE
22FDH06	NEXT GENERATION PACKAGING	3	0	0	3	3	40	60	100	PE

MINOR VERTICAL COURSES										
Vertical 1 - Innovations in Food Packaging										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22FDM01	FOOD PACKAGING TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22FDM02	FOOD PACKAGING DESIGN AND DEVELOPMENT	3	0	0	3	3	40	60	100	PE
22FDM03	DIVERSE MATERIALS IN FOODPACKAGING	3	0	0	3	3	40	60	100	PE
22FDM04	EMERGING TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22FDM05	PACKAGING PERFORMANCE TESTING AND MACHINERY	3	0	0	3	3	40	60	100	PE
22FDM06	NEXT GENERATION PACKAGING	3	0	0	3	3	40	60	100	PE

OPEN ELECTIVES											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**	**Eligibility**
							CIA	**SEE**	**Total**		
22OCE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE	
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE	
22OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE	
22OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE	
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE	
22OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE	
22OEC01	BASICS OF ANALOG AND DIGITAL ELECTRONICS	3	0	0	3	3	40	60	100	OE	
22OEC02	MICROCONTROLLER PROGRAMMING	3	0	0	3	3	40	60	100	OE	
22OEC03	PRINCIPLES OF COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	OE	

22OEC04	PRINCIPLES OF COMPUTER COMMUNICATIONAND NETWORKS	3	0	0	3	3	40	60	100	OE	
22OEI01	PROGRAMMABLE LOGIC CONTROLLER	3	0	0	3	3	40	60	100	OE	
22OEI02	SENSOR TECHNOLOGY	3	0	0	3	3	40	60	100	OE	
22OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	OE	

22OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	OE	
22OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE	
22OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	OE	
22OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE	
22OME04	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	OE	
22OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE	
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE	Eligible to all, Except FD
22OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE	Eligible to all, Except FD, AG
22OFD03	POST HARVEST TECHNOLOGY OF FRUITS ANDVEGETABLES	3	0	0	3	3	40	60	100	OE	Eligible to all, Except FD, AG
22OFD04	CEREALS, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE	Eligible to all, Except FD, AG
22OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE	
22OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE	
22OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE	
22OPH01	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	OE	
22OPH02	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	40	60	100	OE	
22OPH03	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	OE	
22OPH04	BIO-PHOTONICS	3	0	0	3	3	40	60	100	OE	
22OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE	
22OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE	
22OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE	
22OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	OE	
22OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE	
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE	
22OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	OE	
22OGE03	ENTREPRENEURSHIP	3	0	0	3	3	40	60	100	OE	

	DEVELOPMENT II										
22OGE04	NATION BUILDING: LEADERSHIP AND SOCIALRESPONSIBILITY	3	0	0	3	3	40	60	100	OE	
22OAI01	FUNDAMENTALS OF DATA SCIENCE	3	0	0	3	3	40	60	100	OE	

22OAM01	COMPUTER VISION IN HEALTHCARE APPLICATION	3	0	0	3	3	40	60	100	OE	
22OAM02	NEURAL NETWORKS	3	0	0	3	3	40	60	100	OE	
22OBM01	OCCUPATIONAL SAFETY AND HEALTH IN PUBLICHEALTH EMERGENCIES	3	0	0	3	3	40	60	100	OE	
22OBM02	AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT	3	0	0	3	3	40	60	100	OE	
22OBM03	HOSPITAL AUTOMATION	3	0	0	3	3	40	60	100	OE	
22OIT01	DATA STRUCTURES	3	0	0	3	3	40	60	100	OE	
22OIT02	OBJECT ORIENTED PROGRAMMING USING C++	3	0	0	3	3	40	60	100	OE	
22OIT03	OBJECT ORIENTED PROGRAMMING USING JAVA	3	0	0	3	3	40	60	100	OE	
22OAG01	RAIN WATER HARVESTING TECHNIQUES	3	0	0	3	3	40	60	100	OE	
22OEE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE	
22OEE02	ELECTRICAL SAFETY	3	0	0	3	3	40	60	100	OE	
22OIT04	DATABASE MANAGEMENT SYSTEMS	3	0	0	3	3	40	60	100	OE	

ONE CREDIT COURSES

Code No.	Course	L	T	P	C	Hours	Maximum Marks			Category	Eligibility
							Test	Quiz/Asign	Total		
22FD0XA	FUNCTIONAL FOOD PROCESSING	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XB	ANALYTICAL METHOD FOR FOOD QUALITYASSESSMENT	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XC	FOOD PROCESSING AUTOMATION	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XD	NATURAL COMPOUNDS AND BIOPOLYMERS IN FOOD PROCESSING	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XE	FSSC V6 & ISO 22000:2018	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XF	TECHNOLOGICAL AND HEALTH ASPECTSOF NUTRACEUTICALS AND FUNCTIONAL FOODS	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XG	DATA ANALYTICS IN THE FOOD INDUSTRY	1	0	0	1	15	50	50	100	OC	Only FD

22FD0XH	FOOD ADDITIVES AND CONTAMINANTS	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XI	STARCH CHEMISTRY	1	0	0	1	15	50	50	100	OC	Only FD
22FD0XJ	STARCH WASTE MANAGEMENT AND VALORIZATION	1	0	0	1	15	50	50	100	OC	Only FD

SUMMARY OF CREDIT DISTRIBUTION

S.No	EGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	ge of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	10	4	-	-	-	-	-	24	15	15%	20%
2	ES	8	6	8	3	-	-	-	-	25	15	15%	20%
3	HSS	2	3	3	-	-	-	-	-	8	5	5%	10%
4	PC	-	-	8	18	15	12	7	-	60	36.8	35%	45%
5	PE	-	-	-	-	6	9	12	-	27	16.5	15%	20%
6	EEC	1	2	1	1	1	1	2	10	19	11.6	5%	10%
Total		21	21	24	22	22	22	21	10	163	100	-	-

BS - Basic Sciences
ES - Engineering Sciences
HSS -
Humanities and Social Sciences
PC -
Professional Core
PE - Professional Elective
EEC -
Employability Enhancement Course
CA -
Continuous Assessment
ES - End Semester Examination

22MA101 **ENGINEERING MATHEMATICS I** **3 1 0 4**

Course Objectives

- To impart mathematical modeling to describe and explore real-world phenomena and data.
- To provide basic understanding on Linear, quadratic, power and polynomial, exponential, and multi variable models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Implement the concepts of mathematical modeling based on linear functions in Engineering.
2. Assess the real-world problems as a quadratic function model.
3. Resolve the real-world phenomena and data into Power and Polynomial functions.
4. Outline the concept of mathematical modeling of exponential functions in Engineering.
5. Generate the identification of multivariable functions in the physical dynamical problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	1	2					1	2	1	1
2	1	2	1	1	1	2					2	2	1	1
3	2	3	1	2	1	2					1	2	1	1
4	2	2	1	1	1	2					1	2	1	1
5	2	3	1	1	1	2					2	2	1	1

UNIT I **9 Hours**

MATHEMATICS MODELING OF LINEAR FUNCTIONS

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors

UNIT II **9 Hours**

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orthogonality - Canonical form and its nature

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylors series, radius and interval of convergence- Tests of convergence for series of positive terms - comparison test, ratio test

9 Hours

UNIT IV

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decline - Exponential equations have a variable as an exponent and take the form y = abx through least square approximation - Calculus of exponential functions - Exponential series - Characteristics

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

Graphing of functions of two variables - Partial derivatives - Total derivatives - Jacobians – Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints

Tutorial : 15 Hours
Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
2. B. S. Grewal, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, Khanna, 2014.

3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2020.
4. Thomas and Finney, Calculus and analytic Geometry, Fourteenth Edition, By Pearson Paperback,2018.

22PH102 **ENGINEERING PHYSICS** **2 0 2 3**

Course Objectives

- Understand the concept and principle of energy possessed by mechanical system.
- Exemplify the propagation and exchange of energy.
- Identify the properties of materials based on the energy possession.

Programme Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Predict the concept and principles of energy to understand mechanical systems.
2. Assess the types of mechanical oscillations based on vibrational energy.

3. Outline the concept of propagation of energy as transverse and longitudinal waves.
4. Analyze the exchange of energy and work between the systems using thermodynamic principles.
5. Evaluate the concept of energy and entropy to understand the mechanical properties of material.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	2		1	1	2				1		1
2	2	1	1		1			2					2	
3	2	1	1	1				2	2					2
4	2	1			1	1		2						
5	2	1		1		1		2					2	

UNIT I **6 Hours**
CONSERVATION OF ENERGY
Concept of energy - types of energy - conservation of energy Mechanical energy: - translation - rotation - vibration - Kinetic and potential energies - conservation - work and energy - laws of motion- minimization of potential energy - equilibrium - dissipative systems - friction

UNIT II **5 Hours**
VIBRATIONAL ENERGY
Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types – Damped oscillations - forced oscillations - natural frequency - resonance

UNIT III **6 Hours**
PROPAGATION OF ENERGY
Transfer of energy - material medium - Transverse wave - Longitudinal wave - standing wave - interference - Doppler effect. Sound waves and its types - characteristics - human voicere - reflection - refraction - beats.

UNIT IV **7 Hours**
EXCHANGE OF ENERGY
Energy in transit - heat - Temperature - measurement - specific heat capacity and water – thermal expansion - Heat transfer processes. Thermodynamics: Thermodynamic systems and processes – Laws of thermodynamics - Entropy - entropy on a microscopic scale - maximization of entropy.

UNIT V **6 Hours**
ENERGY IN MATERIALS
Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy

EXPERIMENT 1 **5 Hours**
Assess the physical parameters of different materials for engineering applications like radius, thickness and diameter to design the electrical wires, bridges and clothes

EXPERIMENT 2 **5 Hours**

Evaluate the elastic nature of different solid materials for modern industrial applications like shock absorbers of vehicles

EXPERIMENT 3 **5 Hours**

Analyze the photonic behavior of thin materials for advanced optoelectronic applications like adjusting a patient’s head, chest and neck positions as a medical tool

EXPERIMENT 4 **5 Hours**

Investigate the phonon behavior of poor conductors for thermionic applications like polymer materials and textile materials

EXPERIMENT 5 **5 Hours**

Assess the elongation of different solid materials for industrial applications like buildings, bridges and vehicles

EXPERIMENT 6 **5 Hours**

Measure the compressibility of different liquids for modern industrial applications like navigation, medicine and imaging

Total: 60 Hours

Reference(s):

1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019.
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018.
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

22CH103 **ENGINEERING CHEMISTRY I** **2 0 2 3**

Course Objectives

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyze the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Understand nuclear transmutation reactions that lead to the formation of elements in the universe
2. Illustrate atomic structure of elements in the periodic table and interpret the periodic trends in properties of elements with its anomaly
3. Apply the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyze endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyze whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	1			1					1	2	
2	2	1	1	1		1								
3	2	1	1	1			1					1		2
4	2	1	1			1						1		
5	2	1	1	1			1						1	

UNIT I **6 Hours**

ORIGIN OF ELEMENTS

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements.

UNIT II **6 Hours**

ATOMIC STRUCTURE AND PERIODICITY

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

UNIT III **6 Hours**

CHEMICAL BONDING

Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

UNIT IV **6 Hours**

REACTION THERMODYNAMICS

Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

UNIT V **6 Hours**

STATES OF MATTER

Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

LABORATORY EXPERIMENTS

Lab safety rules and guidelines for students - OSHA Guidelines

EXPERIMENT 1 **5 Hours**

Evaluate the dissolved oxygen (DO) levels in effluent samples collected from sewage treatment plants in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes)

EXPERIMENT 2 **5 Hours**

Investigate the amount of Iron (Fe2) in a mild steel alloy sample using a spectrophotometer.

EXPERIMENT 3 **4 Hours**

Estimate the amount of chromium present in industry effluent samples and bottled beverages.

EXPERIMENT 4 **5 Hours**

Ensure the suitability of drinking water in the RO water supply in BIT based on the presence of chloride ions.

EXPERIMENT 5 **3 Hours**

Assess the acidic nature of effluent water from industries using the conductometric titration method.

EXPERIMENT 6 **4 Hours**

Measure the stain removal efficiency of the prepared soaps from stained clothes.

EXPERIMENT 7 **4 Hours**

Assess the purity of commercially available active pharmaceutical ingredients (aspirin) as per the government-prescribed standards.

Total: 60 Hours

Reference(s):

1. Peter Atkins, Physical Chemistry, Oxford university press, 2019
2. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, Oxford university press, 2020
3. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017
4. J.D. Lee, Concise inorganic chemistry, Blackman Science Ltd, France, Wiley-India, 5th edition (Reprint), 2016
5. Gareth Price, Thermodynamics of chemical processes, Oxford university press, 2019
6. D Tabor, Gases, liquids and solids and other states of matter, Oxford University press, 2018

22GE001 **FUNDAMENTALS OF COMPUTING** **3 0 0 3**

Course Objectives

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the hidden languages and inner structures of computer hardware and software through codes and combinations.
2. Predict the organizational and architectural issues of a digital computer with concepts of various data transfer techniques in digital computers and the I/O interfaces.
3. Analyze programming problems and apply assembly instructions to solve simple problems.
4. Outline the fundamentals of operating system and System programs basics.
5. Determine the software development methodologies to various real life scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1		1	1				1			1	1	1
2	3	3		3	1				1			1	1	1
3	2	2		2	1				1			1	1	
4	2	2		2	1				1			1	1	1
5	2	2		2	1				1			1	1	1

UNIT I **8 Hours**
CODES AND COMBINATIONS
Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition of binary codes.

UNIT II **9 Hours**
COMPUTATION USING COMPUTER
Communication to computing devices through various input sources - Computational operation - its flow, functions and control - communication to output devices - Basic communication protocol.

UNIT III **11 Hours**
ASSEMBLY LANGUAGE PROGRAMMING
Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input-Output - Loops - Simple programs.

UNIT IV **9 Hours**
OPERATING SYSTEM AND APPLICATION GENERATION
BIOS - Device Drivers - Resources -. Scheduler - Applications .Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.

UNIT V **8 Hours**
SOFTWARE DEVELOPMENT
Phases of application life cycle management - Software Development Methodologies - Web Page Development.

Total: 45 Hours

Reference(s)

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Press books, 2009.
2. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew ELiaz,"Little Man-Computer Programming: For the Perplexed from the Ground Up", The Internet Technical Bookshop; 1st edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition, John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S.Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill International edition, Seventh edition, 2010

22HS001 **FOUNDATIONAL ENGLISH** **1 0 2 2**

Course Objectives

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential in formal and informal contexts
- Improve reading fluency and increased vocabulary
- Prowess in interpreting complex texts
- Fluency and comprehensibility in self-expression
- Develop abilities as critical readers and writers
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas

Programme Outcomes (POs)

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2	3		2		
2									2	3		2		
3									2	3		2		
4									2	3		2		
5									2	3		2		

UNIT 1 **15 Hours**
SELF-EXPRESSION

Self-Introduction-Recreating Interview Scenarios (with a focus on verbal communication)-Subject Verb Concord-Tenses-Common Errors in verbal communication Be-verbs Self-Introduction-Recreating interview scenarios-Haptics-Gestures-Proxemics-Facial expressions Paralinguistics/Vocalics- Body Language- Appearance-Eye Contact-Artefacts Self-Introduction-Powerful openings and closings at the interview-Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH- questions-Prepositions-Listening to Ted talks-Listening for specific information

UNIT II **15 Hours**

CREATIVE EXPRESSION

Descriptive Expression-Picture Description and Blog Writing -Vocabulary-One word substitution-Adjectives-Similes, Metaphors, Imagery & Idioms -Link words - Inclusive language Narrative Expression- Travelogue and Minutes of Meeting -Verbal analogy-Sequence & Time order words -Jumbled paragraph, sentences, Sequencing-Text & Paragraph completion-Past tense -Using quotation marks

UNIT III **15 Hours**

FORMAL EXPRESSION

Formal Letters and Emails-Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to newspapers-Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail- Conjunctional clause Punctuation-Formal Idioms-Phrases-Articles - Definite & Indefinite-Types of sentences-Modal verbs Precision in comprehension, Summary writing, Selective summary-Reading: Active reading- short paragraphs, excerpts, articles and editorials-Skimming and Scanning Reading comprehension & analysis- Tenses, QP/ PQ approach. Identifying the central themes/ crux-Interpreting tone - formal/informal/semi-formal-Note-taking-Listening: Listening for data, for specific information, for opinion-Active and passive Listening-Transcription-Paraphrasing and summarising information-Agreeing & disagreeing-Note-taking-Writing: Summary writing, selective summary, paraphrasing, note-making, opinion pieces-Finding synonyms in the context Paraphrasing-Sentence Transformation - simple, compound, complex. Sentence substitution-Sentence completion- Interpreting paragraphs.

Total: 45 Hours

Reference(s):

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010
4. Reynolds, John. Cambridge IGCSEÃ,Â® First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges
- To illustrate the concept of magnetic fields due to revolving electron
- To illustrate the force on moving charges in electric and magnetic field
- To understand the energy transfer in electro mechanical conversion.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Predict the behavior of electric charges in different medium using coulombs law.
2. Assess the electric field due to different charge distributions.
3. Analyze the magnetic field intensity due to long conductor, solenoid, toroid and magnetic dipoles.
4. Outline the force on conductors due to the moving charges.
5. Evaluate the energy conversion concepts in electromagnetic fields.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		2								2	1	3
2	2	2		2	3				1			2	2	2
3	2	2		1	3				1			2	3	2
4	3	2		1	2				1			2	1	3
5	2	2										2	2	2

UNIT I **5 Hours**

ELECTRIC CHARGE

Properties of charge, additivity of charges, quantization of charge, conservation of charge , Forces between multiple charges, Electric charge in conductors, Drift of Electrons, Charges in Clouds.

UNIT II **7 Hours**

ELECTRIC FIELD

Electric field due to system of charges, Significance of Electric field line. Electric Dipole and its significance, Continuous charge distribution, Field in infinite long uniform straight conductors, field in uniform charged uniform infinite plane sheet, field due to uniform thin spherical sheet.

UNIT III **7 Hours**

MAGNETIC FIELDS

Concept of magnetic field, magnetic fields in infinitely long straight wire, straight and toroidal solenoids, Magnetic dipole moment of a revolving electron, Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis, Induced Electric field due to changing Magnetic Field.

UNIT IV **6 Hours**

FORCE ON CHARGES

Force on a moving charge in uniform magnetic and electric fields, Force on a current carrying conductor in a uniform magnetic field, Force between two parallel current carrying conductors.

UNIT V **5 Hours**

ELECTRO MECHANICAL ENERGY CONVERSION

Energy transfer in electromagnetic fields, Energy storage in magnetic field, Electromagnetic induction, induced emf, Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

EXPERIMENT 1 **15 Hours**

Analyze and design of Electromechanical energy conversion system.

EXPERIMENT 2 **15 Hours**

Develop an electrical machine and analyze its performance with supplied input of AC from 0 V to 230 V.

Total: 60 Hours

Reference(s):

1. Mathew N. O. Sadiku, Principles of Electromagnetics, 6th Edition, Oxford University 2020
2. William H. Hayt and John A. Buck, Engineering Electromagnetics, McGraw Hill 2020
3. Kraus and Fleisch, Electromagnetics with Applications, McGraw Hill International Editions, 2017
4. S.P.Ghosh, Lipika Datta, Electromagnetic Field Theory, First Edition, McGraw Hill Education(India) Private Limited 2017

22GE005 **ENGINEERING DRAWING** **1 0 2 2**

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Understand the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1			1			2		2			2	
2	2	1			1			2	1	2		1	2	
3	1	1			2			2		2			2	
4	1	1			1			2		2			2	1
5	1	1			1			2		2			2	

UNIT – I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

Definition, standards, drawing tools, drawing sheets, scales, line and its types. Practices on lettering, numbering, dimension of drawings. Construction of conic sections - ellipse, parabola and hyperbola using eccentricity method.

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

Principles of projection, projection of points in four quadrants, first angle projection of straight lines - perpendicular to one plane, parallel and inclined to both planes.

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

Projection of simple planes and projection of simple solids - parallel, perpendicular and inclined to one plane using change of position method, inclined to both the planes.

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

Section of Solids - simple position with cutting plane parallel, perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications.

Total: 45 Hours

Reference(s)

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited,2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2013.

22HS003 **HERITAGE OF TAMILS** **1 0 0 1**

Course Objectives

- Describe the linguistic diversity in India, highlighting Dravidian languages and their features.
- Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures.
- Examine the role of sports and games in promoting cultural values and community bonding.
- Discuss the education and literacy systems during the Sangam Age and their impact.
- Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture.

Programme Outcomes (POs)

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Access the concept of language families in India, with a focus on Dravidian languages.
2. Find the evolution of art from ancient rock art to modern sculptures in Tamil heritage.
3. Analyze various forms of folk and martial arts in Tamil heritage.
4. Breakdown the concepts of Flora and Fauna in Tamil culture and literature.
5. Evaluate the contributions of Tamils to the Indian Freedom Struggle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				

UNITI **3 Hours**

LANGUAGE AND LITERATURE

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil–Secular Nature of Sangam Literature–Distributive Justice in Sangam Literature-Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry – Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II **3 Hours**

HERITAGE-ROCK ART PAINTINGS TO MODERN ART–SCULPTURE

Hero stone to modern sculpture – Bronze icons-Tribes and their handicrafts-Art of temple car making-Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Roleof Temples in Social and Economic Life of Tamils.

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENTAND INDIAN CULTURE

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

Total: 15 Hours

Reference(s)

1. Dr.K.K.Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr.S.Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL

22HS003 **தமிழர் மரபு** **1 0 0 1**

பாடத்திட்டத்தின் ந ◌ாக்கம்

1. இந்திய தமொழிக்குடும்பதFள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன் மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளரச் ◌ிமய இயம்புதல்.
3. சங்கொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.

கற்றலின் விளைவு

1. இந்திய தமொழிக்குடும்பதFள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன் மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளரச் ◌ிமய இயம்புதல்.
3. சங்கொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.
4. தமிழ் தமொழியின் சிறப்புகமள அதன் பமடப்பிலக்கியங்கள் மூலம் அறிந்F தகொள்ளுதல்.
5. கற்கொலம் ததொடங்கி, இக்கொலம் வ ம ரசிற்பக்கமல அமடந்த வளரச் ◌ிமய கண் டுதகொள்ளல்.
6. தமிழர் தம் வொழ்வில் எங்கனம் இயற்மகமய வணங்கி பபொற்றினர் என் ப மததிமண பகொட்பொட்டின் வழி ததளிதல்.
7. இந்திய விடுதமல பபொரில் தமிழர் ஆற்றிய பங்கிமன ததரிந்F தகொள்ளுதல்.

அலகு I மொழி மற்றும் இலக்கியம்: 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22MA201 **ENGINEERING MATHEMATICS II** **3 1 0 4**

Course Objectives

- To impart and analyze the concepts of differential equations to describe in real-world phenomena.
- To provide basic understanding on differential equation models and vector field models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Interpret the concept of differential equations through mathematical modeling and analyze its applications in engineering
2. Formulate the real world problems as second order linear differential equations and give solutions for the same
3. Demonstrate the real-world phenomena with magnitude and direction in the form of vector functions
4. Apply the concept of vector fields and line integrals through mathematical modeling in engineering
5. Determine complex functions and apply them to formulate problems arising in engineering

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	1		1							1	1	
2	2	3	1		1							1		2
3	2	3	1			1						1	1	2
4	3	3	1			1						1	1	2
5	3	3	1		1							1	2	1

UNIT I **9 Hours**

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

Formation of differential equations- Solutions of first order linear ODE: Leibnitzs and method of separation of variables- Cooling/Heating of an object - A falling object- Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model

UNIT II **9 Hours**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

Methods of solving second order linear ordinary differential equations -Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits

UNIT III **9 Hours**

VECTOR DIFFERENTIAL CALCULUS

Vector and scalar functions - Fields - Derivative of vector function and geometrical interpretation- Velocity and acceleration - Gradient and its properties- Tangent and normal vectors - Directional derivative- Divergence of a vector field - Curl of a vector field - Projectile motion

9 Hours

UNIT IV

VECTOR INTEGRAL CALCULUS

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

UNIT V **9 Hours**

COMPLEX FUNCTIONS

Basic concepts of Complex numbers Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow Electric flow - Mapping of complex functions

Tutorial : 15 Hours
Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018

3. George B.Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017.

22PH202 **ELECTROMAGNETISM ANDMODERN PHYSICS** **2 0 2 3**

Course Objectives

- Understand the principles and mechanisms of electricity and magnetism.
- Infer the classification of electromagnetic waves.
- Analyze the theory of relativity and energy bands.

Programme Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Predict the principles and mechanism of electrostatics and current
2. Assess the principles and mechanism of magneto statics
3. Classify electromagnetic waves and infer the characteristics of visible light
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Exemplify the electrical properties of semiconductor based on the band theory

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1				1		2				1	
2	2	1	1	1			1	1	2				1	1
3	2	1	1	1				1	2			1		1
4	2	1	1	1			2					1	1	
5	2	1	1					1	2					2

UNIT I **6 Hours**
ELECTRICITY
Electric monopoles - Electric field- Electric flux - Electric potential - electrical energy- capacitor-conductors and insulators-Electric dipole and polarization - electric current -voltage sources- resistance

UNIT II **6 Hours**
MAGNETISM
Sources of magnetism- monopoles-magnetic field and force-magnetic field and current distribution-magnetic dipole-magnetic potential energy-inductor- electric and magnetic field comparison

UNIT III **6 Hours**
ELECTROMAGNETIC WAVES AND LIGHT
Electromagnetism: basic laws-electromagnetic energy-radiation. Electromagnetic waves: origin, nature and spectrum-visible light Principle of least time- geometrical optics-Human eye - Diffraction - Interference - polarization-LASER.

UNIT IV **6 Hours**
MODERN PHYSICS
Special theory of relativity - simultaneity and time dilation - length contraction - relativistic mass variation. Matter waves - de-Broglie hypothesis - wave nature of particles

UNIT V **6 Hours**
ENERGY BANDS IN SOLIDS
Band theory of solids - classification of materials - semiconductors - direct and indirect semiconductor - fermi energy -Intrinsic and extrinsic semiconductor - carrier concentration - electrical conductivity

EXPERIMENT 1 **5 Hours**
Determination of V-I characteristics of a solar cell for domestic applications

EXPERIMENT 2 **5 Hours**
Determine the carrier concentration of charge carriers in semiconductors for automotive applications

EXPERIMENT 3 **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

EXPERIMENT 4 **5 Hours**

Implement the principle of stimulated emission of laser for grain size distribution in sediment samples

EXPERIMENT 5 **5 Hours**

Assess the variation of refractive index of glass and water for optical communication

EXPERIMENT 6 **5 Hours**

Evaluate the band gap energy of semiconducting materials for display device applications

Total: 60 Hours

Reference(s):

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019
2. P G Hewitt, Conceptual Physics, Pearson education, 2017.
3. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018.
4. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole,
    a. 2019.
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017.

22CH203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand the role of catalyst in the rate of reaction
- Summarize the variation in properties and reactivity of isotopes

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the electrochemical concepts to determine the electrode potential of a metal
2. Assess the working of batteries for the energy storage devices
3. Analyze the mechanism of corrosion and suggest a method to control the corrosion
4. Outline reaction mechanisms and assess the role of catalyst in a chemical reaction
5. Evaluate various types of nuclear transmutation including decay reactions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1		1								1		1
2	2	1	1	1		1						1	1	2
3	2	1	1	1			1							1
4	2	1	1			1						1	2	1
5	2	1										1	2	2

UNIT I **6 Hours**
ELECTROCHEMISTRY
Origin of potential - Electromotive force - Electrical double layer - Transport of charge within the cell - Cell description - Prediction of cell potentials

UNIT II **6 Hours**
ENERGY STORING DEVICES
Relation between electrical energy and energy content of a cell - Reversible and irreversible cell - Charging and discharging reactions in a reversible cell - Current challenges in energy storage technologies

UNIT III **6 Hours**
METAL CORROSION AND ITS PREVENTION
Oxidation of metals: Electrochemical origin of corrosion - Electromigration - Electron transfer in the presence and absence of moisture - Galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

UNIT IV **6 Hours**
CATALYSIS
Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

UNIT V **6 Hours**
NUCLEAR REACTIONS
Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - recent applications of radioactive isotopes.

EXPERIMENT 1 **4 Hours**
Measure industrial effluent water pH and assess water quality against allowed standards

EXPERIMENT 2 **4 Hours**
Iron (Fe^{2+}) in Bhavani River water: Potentiometric Analysis & Pollution Assessment (CPCB Standards)

EXPERIMENT 3 **4 Hours**

Construct a Zn-Cu electrochemical cell and validate the output by connecting the LED light

EXPERIMENT 4 **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars.

EXPERIMENT 5 **4 Hours**

Determination of the percentage of corrosion inhibition in plain-carbon steel using natural inhibitors.

EXPERIMENT 6 **4 Hours**

Electroplating of copper metal on iron vessels for domestic application.

EXPERIMENT 7 **5 Hours**

Determination of acid-catalyzed hydrolysis kinetics in locally sourced fruit extracts.

Total: 60 Hours

Reference(s):

1. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
2. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012
3. E. McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010
4. S. Vairam, Engineering Chemistry, John Wiley & Sons, 2014
5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th edition, (revised) New Age International Publishers, 2011
6. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, Wiley- VCH, 2017

22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

Course Objectives

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Analyze a problem and formulate algorithms, pseudocodes and flowcharts.
2. Develop algorithmic solutions to simple computational problems and explore algorithmic approaches to problem solving.
3. Design and apply appropriate data structures for solving computing problems.
4. Compare the various storage devices used in a computer system.
5. Analyze the requirements for a given organizational structure and establish the connection between two or more computers to form a network.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1		1	2				1			1		1
2	3	3		3	3				1			1	1	
3	2	2		2	3				1			1	1	
4	2	2		2	2				1			1		1
5	2	2		2	2				1			1	1	

UNIT I **6 Hours**
VISUAL PROCESS MODELING
Scenario decomposition - logical sequencing - drawing flowchart - preparing visual process model.

UNIT II **12 Hours**
ALGORITHMIC DESIGN THINKING
Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

UNIT III **12 Hours**
DATA ORGANIZATION
Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

UNIT IV **7 Hours**
DATA STORAGE
Flat File and Relational database- Data Read & Write in Local Storage, Server Storage and Cloud storage - Database Query Methods.

UNIT V **8 Hours**
NETWORKING ESSENTIALS
Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - Network Security - Firewalls.

Total: 45 Hours

Reference(s)

1. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education,2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

- To Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the use of PN Junction Diode and BJT for signal conditioning.
- To apply the working principle of PN Junction Diode and BJT for the design of basic Digital Logic.
- To analyze the working and characteristics of Special Purpose Semiconductor Electronic Devices.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Understand the need for electrical and electromagnetic signal transmission.
2. Analyze the working principle and characteristics of PN junction diode.
3. Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. Apply the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. Analyze the energy conversion needs and working principle of Special purpose electronic devices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	1		1						1	1	
2	3	3	3	2		1						1		
3	3	3	3	2		1						1	2	
4	3	3	3	2		1						1		3
5	3	3	3	1		1						1	1	2

UNIT 1 **6 Hours**
ENERGY TRANSFER AND SIGNALS
Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

UNIT II **8 Hours**
SIGNAL CONDITIONING USING DIODE
Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode.

UNIT III **6 Hours**
SIGNAL CONDITIONING USING TRANSISTOR
Microbes of importance in food fermentations, Homo & hetero-fermentative bacteria, yeasts & fungi; Biochemistry of fermentations - pathways involved, Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations -Yeast fermentations - characteristics and strain selection, Fungal fermentations. Microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idly, soy products, fermented vegetables and meats.

UNIT IV **6 Hours**
LOGIC SYNTHESIS USING DIODE AND TRANSISTORS
Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

UNIT V **4 Hours**
DEVICES FOR SPECIAL REQUIREMENTS
Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

EXPERIMENT 1 **4 Hours**
Design and Implement a simple device to communicate basic information between two different small distance points using wired and wireless methods.

EXPERIMENT 2 **6 Hours**

Design and Implement different wave shaping Circuits using PN Junction Diodes.

EXPERIMENT 3 **4 Hours**

Design and Implement Voltage Multiplier Circuit using PN Junction Diodes and Capacitors.

EXPERIMENT 4 **4 Hours**

Design and Implement three Stage Circuit to convert 220V 50Hz AC mains supply to 12V DC supply.

EXPERIMENT 5 **4 Hours**

Design and Implement a BJT Amplifier Circuit to amplify audio input signal.

EXPERIMENT 6 **4 Hours**

Design and Implement Basic Logic Gates using PN Junction Diodes.

EXPERIMENT 7 **4 Hours**

Design and Implement Basic Logic Gates using BJTs.

Total: 60 Hours

Reference(s):

1. Thomas L. Floyd ,Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018)

22HS002 **STARTUP MANAGEMENT** **1 0 2 2**

Course Objectives

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behaviour.
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the porotypes to commercial market offering.

Programme Outcomes (POs)

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Generate valid and feasible business ideas
2. Create Business Model Canvas and formulate positioning statement
3. Invent prototypes that fulfills an unmet market need
4. Formulate business strategies and create pitch decks
5. Choose appropriate strategies for commercialization

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							1	2	1		1			
2							2	2	1	1	2			
3							3	3	1	2	2			
4							1	3	1	2	2			
5							2	3	2	2	2			

UNIT I **3 Hours**

BUSINESS MODELS AND IDEATION

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

UNIT II **3 Hours**

UNDERSTANDING CUSTOMERS

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

Prototyping: Methods-Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

UNIT V **3 Hours**

COMMERCIALIZATION

Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors.

EXPERIMENT 1 **1 Hours**

Analysis of various business sectors

EXPERIMENT 2 **2 Hours**

Developing a Design Thinking Output Chart

EXPERIMENT 3 **1 Hours**

Creating Buyer Personas

EXPERIMENT 4 **3 Hours**

Undertake Market Study to understand market needs and assess market potential

EXPERIMENT 5 **2 Hours**

Preparation of Business Model Canvas.

EXPERIMENT 6 **15 Hours**

Developing Prototypes.

EXPERIMENT 7 **2 Hours**

Organizing Product Design Sprints

EXPERIMENT 8 **2 Hours**
Preparation of Business Plans

EXPERIMENT 9 **2 Hours**
Preparation of Pitch Decks

Total: 45 Hours

Reference(s):

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications, 2015
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens, Seed Tree Group, 2021
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2nd Edition, 2021

22HS006 **TAMILS AND TECHNOLOGY** **1 0 0 1**

Course Objectives

1. Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
2. Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing the details of stage constructions in Silappathikaram and their cultural significance.
3. Examine ancient knowledge of oceans and its impact on Tamil society

Programme Outcomes (POs)

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Access the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Access the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the Chola Period.
3. Analyze the architectural designs and structural construction methods used in household materials during the Sangam Age.
4. Breakdown the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Evaluate the development of scientific terminology and vocabulary in Tamil language.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				

UNITI **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Templesof Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel - Copper and gold - Coinsas source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V **3 Hours**

SCIENTIFIC TAMIL & TAMIL COMPUTING

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Total: 15 Hours

Reference(s)

1. Dr.K.K.Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr.S.Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

பாடத்திட்டத்தின் ந ோக்கம்

4. சங்க கொலத்தில் வரலொறு மற்றும் கலொச்சொர ஆவணங் களின் ஒரு வடிவமொக, மட்பொண் டங் கள் மீதொன கிரொஃபிட்டிமய பகுப்பொய் வு தசய் தல் .
5. சிலப்பதிகொரத்தில் கட்டப்பட்ட பமமட கட்டுமொனங் களின் விவரங் கமளயும் அவற்றின் கலொச்சொர முக்கியத்Fவத்மதயும் பகுப்பொய் வு தசய் வதன் மூலம் , சங் க கொலத்தில் மொவீரர் கற்களின் கட்டுமொனப் தபொருட்கள் மற்றும் வரலொற்று சூழமல ஆரொய் தல் .
6. சமுத்திரங் கள் பற்றிய பண் மடய அறிமவயும் , தமிழ் சமூகத்தில் அதன் தொக்கத்மதயும் ஆரொய் வF ஆகியமவ இப்பொடத்திட்டத்தின் பநொக்கம் ஆகும் .

கற்றலின் விளைவு

1. சங் க கொலத்தில் தநசவுத் ததொழிலின் முக்கியத்Fவத்மதயும் அதன் கலொச்சொர முக்கியத்Fவத்மதயும் புரிந்தகொள்ளல் .
2. பசொழர் கொல விவசொய மற்றும் நீ ர்ப்பொசன நமடமுமறகளில் அமணகள் , குளங் கள் மற்றும் மதகுகளின் முக்கியத்Fவத்மதப் புரிந்F தகொள்ளல் .
3. சங் க கொலத்தில் வீட்டுப் தபொருட்களில் பயன் படுத்தப்பட்ட கட்டடக்கமல வடிவமமப்புகள் மற்றும் கட்டமமப்பு கட்டுமொன முமறகமள ஆரொய் தல் .
4. பண் மடய தமிழ் கலொச்சொரத்தில் , கப்பல் கட்டும் கமல, கடல் வரத்தகம் மற்றும் பபொக்குவரத்தில் அதன் பங் மக ஆரொய் தல் .
5. தமிழ் தமொழியில் அறிவியல் தசொற்களஞ்சியம் மற்றும் தசொல் லகரொதியின் வளரச் ்சிமயக் கண் டறிதல்.

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III <u>உற்பத்தித் தொழில் நுட்பம்</u>: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV <u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V <u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22FD301 NUMERICAL METHOD AND STATISTICS 3 1 0 4

Course Objectives

- To understand the methods to solve polynomial equations and implement the ideas of numerical interpolation.
- To develop enough confidence to solve differential equations numerically.
- To summarize and apply the concepts of statistics in solving engineering problems.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Understand the basic concepts of solving equations and able to identify the derivative and integration of functions
2. Acquire the knowledge of solving various types of ordinary and partial differential equations, numerically
3. Comprehend the ideas of basics statistics in engineering
4. Apply the knowledge of testing of hypothesis for small and large samples in engineering problems
5. Interpret the knowledge of design of experiments and control charts in the field of Engineering

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1		1	2						2	1	1
2	1	2	1		1	2						2	1	1
3	2	3	1		1	2						2	1	1
4	2	2	1		1	2						2	1	1
5	2	3	1		1	2						2	1	1

UNIT I **14 Hours**

NUMERICAL TECHNIQUES FOR SOLVING EQUATIONS, DIFFERENTIATION AND INTEGRATION

Solution of algebraic and transcendental equations - Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Jacobis method for inverse matrices- Eigenvalues of a matrix by Power method -Interpolation - Lagrange interpolation - Approximation of derivatives using interpolation polynomials- Numerical integration using Simpsons rule

UNIT II **10 Hours**

SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Solution of ordinary differential equation: Fourth order Runge-Kutta method for solving first order equations - Solution of two-dimensional heat equation: Laplace and Poisson equations- One dimensional heat flow equation- Solution of one-dimensional wave equation

UNIT III **12 Hours**

BASIC STATISTICS

Mean-Median-Mode-Variance and Standard deviation -Covariance - Correlation and Regression

10 Hours

UNIT IV

TESTING OF HYPOTHESIS

Sampling distributions-Estimation of parameters- Statistical hypothesis-large sample tests based on Normal distribution for single mean and difference of means-Tests based on t, Chi-square and F distributions-Chi -square distributions (test for independent and Goodness of fit)

UNIT V **14 Hours**

DESIGN OF EXPERIMENTS AND CONTROL CHARTS

One way and two-way classifications-Completely randomized design-Randomized block design-Latin square design- 2x2 factorial design-Control Charts of Variable and Attributes

Tutorial : 15 Hours
Total: 60 Hours

Reference(s)

1. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Fourth Edition, PHI Learning Pvt. Ltd, 2017.
2. Jain M.K, Iyengar S.R.K and Jain R.K Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd, New Delhi, 2005.
3. Navidi, William Cyrus. Statistics for Engineers and Scientists. United States, McGraw-Hill Higher Education, 2014.
4. Johnson, Richard Arnold, et al. Miller & Freund's Probability and Statistics for Engineers. United Kingdom, Pearson Education, 2017.
5. Seymour Lipschutz, Introduction to Probability and Statistics, First Edition, McGraw Hill, 2012

22FD302 **FOOD CHEMISTRY** **3 0 2 4**

Course Objectives

- Understand the properties and composition of food
- Assess the role of nutrients in food
- Evaluate the effect of processing on nutrients in food

Programme Outcomes (POs)

PO2 **Problem analysis:**Identify, formulate, research literature, and analyse complex engineering problems reaching substantiatedconclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:**Design solutions for complex engineering problems and design system components orprocesses that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, andenvironmental considerations.

PO4 **Conduct investigations of complex problems:**Use research-based knowledge and research methods including design ofexperiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineeringand IT tools including prediction and modelling to complex engineering activities with an understanding of thelimitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal,health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professionalengineering practice.

PO7 **Environment and sustainability:**Understand the impact of the professional engineering solutions insocietal and environmental contexts, and demonstrate the knowledge of, and the need for sustainabledevelopment.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independentand life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the metabolic process of food and recommended dietary allowances of nutrients
2. Apply the structural changes in carbohydrates during processing and predict their physiological effects in the body
3. Analyze the functional and nutritional properties of proteins
4. Justify the importance of vitamins and minerals and their physiological role in the human body
5. Evaluate the properties and physio-chemical changes of fats and oil during processing and their industrial importance

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		1	2	2	3	2						2		2
2		1	2	2	2	1	1					2		1
3		1	2	2	2							2	2	2
4		1	2	2		1						2		1
5		1	2	2	2	1	1					2	3	2

UNIT I **9 Hours**
INTRODUCTION TO FOOD COMPONENTS AND IMPORTANCE OF NUTRITION
Nutrients: Sources and functions; Food groups: classification and importance; Metabolism - Digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings; Energy Balance: Basal metabolism- BMR; Body surface area and factors affecting BMR. Water intake and losses; Diet: balanced diet, recommended dietary allowances; Malnutrition

UNIT II **9 Hours**
CARBOHYDRATES IN FOOD
Carbohydrates -Definition, classification, sources, structure, reducing and non-reducing sugars, properties of sugars-sweetness index, caramelization, Maillard reaction. Starch-sources, structure and composition, gelatinization and retrogradation. Modified starches: methods of starch modification; dietary fibers and carbohydrates digestibility

UNIT III **9 Hours**
PROTEINS IN FOOD
Proteins: Sources, Amino acids - classification, structure of protein, Nutritional Aspects: essential amino acids, biological value, Protein Efficiency Ratio (PER), Amino acid score, Protein digestibility, PDCAAS; Functional properties of proteins in food and industrial importance. Processing induced functional and nutritional changes in protein.

UNIT IV **9 Hours**
FATS AND OILS IN FOOD
Fats -Sources, structure and classification of fatty acids, Nomenclature, Isomerism, essential fatty acids; Properties: Crystal formation, polymorphism, melting point, smoke point, Flash point, fire point and emulsification. Deep fat frying: physical, chemical and nutritional changes. Hydrolytic and Oxidative rancidity. Quality analysis: Iodine value, Peroxide value, Saponification value, Free fatty acid test. Fat Modification: Hydrogenation, Winterization and Inter-esterification.

UNIT V **9 Hours**
MICRONUTRIENTS, VITAMINS AND MINERALS
Vitamins and Minerals - Classification, Sources, Physiological role and Deficiency disorders, RDA, Losses of vitamins and minerals during processing, restoration and fortification

EXPERIMENT 1 **3 Hours**
Identification of edible water based on standards

EXPERIMENT 2 **3 Hours**
Proximate analysis of carbonated beverages available in market

EXPERIMENT 3 **6 Hours**
Comparison of vitamin C content in Natural extracted fruit juice and other beverages

EXPERIMENT 4 **6 Hours**
Compare the protein efficiency of different food product by applying the different estimation method

EXPERIMENT 5 **3 Hours**
Identification of starch content in bread and potatoes.

EXPERIMENT 6 **3 Hours**
Analysis of fat content in dairy product

EXPERIMENT 7 **6 Hours**
Verification of nutritional information in different brand biscuits available in the market.

Total: 75 Hours

Reference(s):

1. Cox, M.M. and Nelson, David L. Lehninger, Principles of Biochemistry, Fifth Edition, H. Freeman, 2008
2. Murray, Robert K. et al., Harper's Illustrated Biochemistry, 28th Edition, McGraw Hill Professional, 2009.
3. Satyanarayana, U. Biochemistry Books and Allied, Fourth Revised Edition, Elsevier, 2013.
4. Belitz H-D, Grosch W and Schieberle P, Food Chemistry, Fourth Revised and Extended Edition, Springer- Verlag Berlin Heidelberg, 2009.
5. Vaclavik, V. A. and Christian, E. W, Essentials of Food Science, Third Edition, Springer Science & Business Media, 2007

22FD303 ENGINEERING THERMODYNAMICS 3 1 0 4

Course Objectives

- To study the fundamentals of thermodynamics and zeroth law
- To provide the knowledge on first law of thermodynamics
- To impart the knowledge on second law of thermodynamics and entropy
- To study the thermodynamic properties of pure substances and its phase change processes
- To learn about gas power cycles and properties of gas mixtures

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Exemplify the basic concepts and zeroth law of thermodynamics
2. Apply the first law of thermodynamics to closed and open systems
3. Solve the problems related to cycles and cyclic devices using second law of thermodynamics
4. Determine the thermodynamic properties of pure substances and its phase change processes
5. Evaluate the air standard performance of heat engines and properties of gas mixtures

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3										3	1	1
2	3	3					1				2	3	1	1
3	3	3					2					3	1	1
4	3	3			1		2				2	3	1	1
5	3	3	2	1	1	2	2					2	3	1

UNIT I **8 Hours**

INTRODUCTION AND ZEROTH LAW OF THERMODYNAMICS

Macroscopic and Microscopic approaches, energy, heat, work. Thermodynamic system Types, properties, functions, states, processes and cycle. Zeroth law of thermodynamics temperature scale, perfect gas scale.

UNIT II **8 Hours**

FIRST LAW OF THERMODYNAMICS

First law of thermodynamics, Application of first law - Closed systems and Open systems, Thermodynamic processes in closed systems, Steady state flow processes in open systems.

UNIT III **9 Hours**

SECOND LAW OF THERMODYNAMICS

Limitations of first law of thermodynamics, Second law of thermodynamics - Kelvin - Planck and Clausius statements, Reversible and irreversible processes, Carnot theorem, Carnot engine, Clausius inequality, Entropy, Availability and irreversibility. Heat Engine, heat pump and refrigerator

UNIT IV **10 Hours**

PROPERTIES OF PURE SUBSTANCES

Thermodynamic properties of fluids. Pure substance - Phases - Phase change processes, Steam tables and Property diagrams - (P-V), (P-T), (T-V), (T-S) and (h-s) diagrams. Ideal gas equation, Van derWaals equation and compressibility chart.

UNIT V **10 Hours**

GAS MIXTURES AND GAS POWER CYCLES

Thermodynamics and properties of ideal gas mixture and perfect gas mixture - Dalton"s law of partial pressure, Amagat"s law. Psychrometric properties and processes - Psychrometric chart. Air standard cycles Otto, Diesel and Dual cycles- mean effective pressure and air standard efficiency.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s):

1. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2019.
2. P.K. Nag, Engineering Thermodynamics,Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2018.
3. J.P.Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2016.
4. R.K. Rajput, Engineering Thermodynamics, Laxmi Publications Pvt.Ltd., New Delhi, 2017

22FD304 FLUID MECHANICS AND MACHINERY 3 0 2 4

Course Objectives

- To impart knowledge on the fluid properties and fluid statics principles
- To introduce the basic concept of fluid kinematics and dynamics
- To calculate the rate of flow and energy losses in flow through pipes and open channels
- To emphasize the concepts of boundary layer theory and the importance of dimensional analysis
- To impart the knowledge of pumps and turbines

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the fundamental properties of fluids and methods of pressure measurement in fluid statics
2. Compute the fundamentals of fluid kinematics and dynamics and their applications in hydraulic experiments
3. Breakdown the concept of the boundary layer, Dimensional analysis, and Modal analysis to the fluid structures
4. Resolve the performance of a model by dimensional analysis and similitude
5. Determine the efficiency and performance of pumps and turbines

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3		2					2			1	1	3
2	3	3		2	1				2			1	1	3
3	3	2		2	1				2			1	1	3
4	2	2		2					2			1	1	3
5	2	2		2					2			1	1	3

UNIT I **9 Hours**

FLUID PROPERTIES AND FLUID STATICS

Concept of Continuum, Properties of Fluid, Classification of fluids, Types of fluid flow Streamline, Streamlines, and path line, Pascals Law and Hydrostatic Law, Pressure and its variation in a static Fluid, Measurement of fluid pressure Manometers, Buoyancy and meta-Centre, Stability analysis and applications

UNIT II **8 Hours**

FLUID KINEMATICS AND DYNAMICS

Continuity equation, Velocity Potential and Stream function, Bernoullis equation, and its applications, Impulse-Momentum principle, Impact of Jet , Velocity triangle

UNIT III **9 Hours**

FLOW THROUGH PIPES AND CHANNELS

Laminar and turbulent flows in circular pipes, Major and Minor losses in pipes, Darcy Weisbach equation, Hagen Poiseuille equation,Multi reservoir problems, pipe network design, Types of open Channel flows, Measurement of discharge in open channels, Notches,Most economical channel section.

UNIT IV **9 Hours**

DIMENSIONAL ANALYSIS AND MODEL TESTING

Buckinghams pitheorem and Application of theorem in fluid flow Reynolds, Froude, and Mach number and their applications in model testing, Boundary layer thickness, Momentum integral equation, Drag and lift, Separation of the boundary layer, and Methods of preventing the boundary layer separation

UNIT V **10 Hours**

HYDRAULIC MACHINES

Centrifugal pumps, Work done, Head developed , Pump output and Efficiencies ,priming - minimum starting speed, performance of multistage pumps, Cavitation, methods of prevention, Pump characteristics, Classification of hydraulic turbines, Pelton wheel, Francis turbine, Kaplan and turbines, Specific speed, Performance characteristics, Selection of turbines, Turbine efficiencies.

EXPERIMENT 1 6 Hours

Find the coefficient of discharge by suitable device that is most accurate to measure the fuel and air distribution in the carburetor of an IC engine in a two wheeler Also, in Pasteurization and Sterilization process. Discuss the effects of the Reynolds number and friction factor in relation to the rate of flow.

EXPERIMENT 2 3 Hours

Analyze the friction factor of various pipes in a distribution of a water supply for domestic applications.

EXPERIMENT 3 **3 Hours**

Determine the coefficient of discharge by suitable device used to monitor and control the flow of water and chemicals in water treatment plants.

EXPERIMENT 4 **3 Hours**

Analyze the Lift and drag force of an aerofoil design used in a windmill for power generation.

EXPERIMENT 5 **3 Hours**

Conduct the performance test of a suitable turbine that is used to extract energy from waterfalls whose water drops down from a height of about 500 m to generate power in Hydropower station.

EXPERIMENT 6 **6 Hours**

Conduct the test from which electricity is to be generated has its reservoir fully filled up during the rainy season and the level drops down during summer. A turbine has to be put up such that it can accommodate both cases in a hydropower station.

EXPERIMENT 7 **6 Hours**

Determine the efficiency of a pump to pump water to a very high elevation, say >300 ft, and high viscous fluid used for an irrigation and Chocolate Industry.

Total: 75 Hours

Reference(s)

1. Yunus A Cengel, and John M Cimbala, Fluid Mechanics, Third edition, Mc Graw Hill Education (India) Pvt Ltd, 2014
2. Dr R.K. Bansal , A textbook of Fluid Mechanics and Hydraulic Machines, Tenth Edition, Laxmi Publications, New Delhi, 2018
3. Frank M White, Fluid Mechanics, McGraw Hill Publishing Company Ltd, New Delhi, 8th Edition 2017
4. R C Hibbler, Fluid Mechanics, Pearson, First edition, 2017
5. S K Som and G Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education 2017

22FD305 **FOOD MICROBIOLOGY** **3 0 2 4**

Course Objectives

- To understand the general principles of food microbiology.
- To study the interactions between microorganisms and food and factors influencing their growth and survival.
- To acquire knowledge about pathogens causing food borne infections and their detection methods

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the microorganism and predict the microorganism associated with foods
2. Compute the microorganism responsible for spoilage of foods and its assessments
3. Outline the preservation methods to control the spoilage and assess the microbial growth in foods
4. Analyze the importance of microorganism in food fermentation and fermented products
5. Determine the cause for food borne illness and understand the quality control for safety of foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	3		2						2		2
2	1		2	2		3						2		1
3	2		2	2	2	3	1					2	2	2
4	2		2	2	1	1	1					2		1
5	1		2	2	2	3						2	3	2

UNIT 1 **9 Hours**

MICROBES IN CEREALS, FRUITS AND VEGETABLES

Microbiology of cereal and cereal products, Microbiology of fruits, vegetables and canned foods, Microbiology of sugar and sugar products and salts and spices

UNIT II **9 Hours**

MICROBES IN MILK, MEAT, FISH AND POULTRY

Microbiology of milk and milk products, meat and meat products, poultry and eggs, fish and other sea foods

UNIT III **9 Hours**

MICROBES IN FOOD FERMENTATIONS

Microbes of importance in food fermentations, Homo & hetero-fermentative bacteria, yeasts & fungi; Biochemistry of fermentations - pathways involved, Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations -Yeast fermentations - characteristics and strain selection, Fungal fermentations. Microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idly, soy products, fermented vegetables and meats.

UNIT IV **9 Hours**

CONTROL OF MICROBES IN FOODS

Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbates / propionates naturally occurring antimicrobials; physical methods- low and high temperatures, drying, radiation and high pressure; tolerance of microbes to chemical and physical methods in various foods, Bio-preservatives.

UNIT V **9 Hours**

MICROBIAL EXAMINATION OF FOODS

Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria; Rapid and automated microbial methods - development and impact on the detection of food borne pathogens; Applications of immunological, techniques to food industry; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. botulinum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.

EXPERIMENT 1 **4 Hours**

Preparation and sterilization of agar and broth

EXPERIMENT 2 **2 Hours**

Analyze the cell morphology and size of saccharomyces under microscope

EXPERIMENT 3 **4 Hours**

Analyze the bacterial cell morphology and size present in cheese.

EXPERIMENT 4 **2 Hours**
Analyze the nature of microbe in dairy products

EXPERIMENT 5 **4 Hours**
Prepare the media for the growth of Yeast and mold.

EXPERIMENT 6 **4 Hours**
Prepare the milk sample with serial dilution of 10^-9

EXPERIMENT 7 **6 Hours**
Identification of microbial growth in packaged curd and homemade curd by different plating methods.

EXPERIMENT 8 **4 Hours**

Isolate the pure culture from fermented fruit juice

Total: 75 Hours

Reference(s):

1. Banwart, G.J., Basic Food Microbiology, 2nd Edition. CBS Publishers, 1998.
2. Vijaya Ramesh. Food Microbiology. MJP Publishers, Chennai, 2007.
3. Jay, J.M. Modern Food Microbiology. 4th Edition. CBS Publishers, 2003
4. Adams, M.R. and M.O. Moss. Food Microbiology. New Age International, 2002
5. Khetarpaul, Neelam. Food Microbiology, Daya Publishing House, 2000

22HS004 **HUMAN VALUES AND ETHICS** **2 0 0 2**

Course Objectives

- To understand the concept of good values and comprehend the importance of value-based living.
- To recognize the culture of peace through education.
- To identify and apply the practices for value development and clarification.

Programme Outcomes (POs)

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Demonstrate the importance of human values and ethics in life.
2. Assess the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Resolve intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			1			1	1	3	2	1		1		
2			1			3	2	3	2	1		1		
3			1			3	2	3	2	1		1		
4			1			3	2	3	2	1		1		
5			1			3	2	3	2	1		1		

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics -Openness to change -Self enhancement -Conservation -Self transcendence - Schwartz Value Survey: Self-Assessment

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

Altruism- Integrity-Freedom-Justice-Honesty-Truthfulness-Responsibility-Compassion

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

An overview on basic Human Aspirations- Understanding and living in harmony at various levels of life-Embracing self-love and wellness-Understanding harmony in the family and society

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence. Understanding the challenges in cultural, personal, social, political, and economic environment

UNIT V **6 Hours**

UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO- EXISTENCE

Understanding the harmony in the Nature- Holistic perception of harmony at all levels of existence- Practice Exercises and Case Studies will be taken up in Practice Sessions

Total: 30 Hours

Reference(s):

1. Martin, G. The Little Book of Ethics: A Human Values Approach, Lulu.com, 2011.
2. Gupta, N. L. Human Values For The 21St Century. India: Anmol Publications Pvt. Limited., 2002.
3. Mishra, Ashutosh. Happiness Is All We Want. India, Bloomsbury Publishing, 2017.
4. Sharma K.S, Sachdeva S.K, Universal Human Values, Booksclinic Publishing, 2023.
5. A Textbook on Professional Ethics And Human Values. India, New Age International (P) Limited, 2007

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION 0 0 2 1

Course Objectives

- To communicate proficiently in formal discussions at the workplace.
- To describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- To interact with a degree of fluency and spontaneity that results in efficacious communication
- To convey agreement and disagreement in a polite but firm manner
- To communicate with coherence and imagination in both written and spoken formats

Programme Outcomes (POs)

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Demonstrate confidence in expressing thoughts in grammatically proper language and etiquette in waiting for the opportunity to provide input.
2. Apply the improved spelling and punctuation in writing and heightened understanding of tone, pitch and stress in oral formats.
3. Integrate effective communication in English on formal occasions and proficiency in the use of link words and other discourse markers
4. Analyze the understanding of oral and written communication in real-world situations.
5. Critique constructive feedback and file logical complaints.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			1			1		1	2	3		2		
2			1			1		1	2	3		2		
3			1			1		1	2	3		2		
4						1		1	2	3		2		
5			1			1		1	2	3		1		

UNIT – I - SELF-EXPRESSION **5 Hours**

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking Group discussion/Peer discussion - Effective Communication Types of communication - Written vs Spoken - Contractions Intonation Stress Active voice - Question tags - Confidence and body language Guided writing- Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent.

UNIT – II - CREATIVE EXPRESSION **5 Hours**

JAM, Debate, Review writing, social media posts, Synonyms - Antonyms , Cloze test, Phrasal verbs, spotting errors, Collocation - Commonly mispronounced.

UNIT – III - FORMAL EXPRESSION **5 Hours**

Writing: Giving written feedback, Review writing, and Letter of complaint. Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases - Giving written feedback, Review writing, and Letter of complaint. Critical reasoning - Modal verbs - Polite ways to express negatives

Total: 15 Hours

Reference(s)

1. Lewis N, Word Power Made Easy by Norman Lewis, Goyal Publishers & Distributors Pvt. Ltd, 2020.
2. Sasikumar, V. A Course In Listening And Speaking - I With Cd General Ed. India, Cambridge University Press, 2009.
3. Murphy, Raymond. English Grammar in Use: A Reference and Practice Book for Intermediate Learners of English; Without Answers. Germany, Cambridge University Press, 2012.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, McGraw-Hill Education (India) Pvt Limited, 2010.
5. Mitra, Barun. Personality Development and Soft Skills. India, Oxford University Press, 2012.
6. Taylor, Ken. Fifty Ways to Improve Your Business English. India, Orient Blackswan, 2011.

22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

Course Objectives

- Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
- Investigate the building materials and the historical context of Hero stones during the Sangam Age by analysing the details of stage constructions in Silappathikaram and their cultural significance.
- Examine ancient knowledge of oceans and its impact on Tamil society

Programme Outcomes (POs)

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Access the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Access the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the Chola Period.
3. Analyze the architectural designs and structural construction methods used in household materials during the Sangam Age.
4. Breakdown the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Evaluate the development of scientific terminology and vocabulary in Tamil language.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				

UNITI **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Templesof Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel - Copper and gold - Coinsas source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V **3 Hours**

SCIENTIFIC TAMIL & TAMIL COMPUTING

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Total: 15 Hours

Reference(s)

1. Dr.K.K.Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr.S.Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

22HS003 **தமிழர் மரபு** **1 0 0 1**

பாடத்திட்டத்தின் ந ◌ாக்கம்

1. இந்திய தமொழிக்குடும்பதFள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன் மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளரச் ◌்சிமய இயம்புதல்.
3. சங்கொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.

கற்றலின் விளைவு

1. இந்திய தமொழிக்குடும்பதFள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன் மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளரச் ◌்சிமய இயம்புதல்.
3. சங்கொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.
4. தமிழ் தமொழியின் சிறப்புகமள அதன் பமடப்பிலக்கியங்கள் மூலம் அறிந்F தகொள்ளுதல்.
5. கற்கொலம் ததொடங்கி, இக்கொலம் வ ம ரசிற்பக்கமல அமடந்த வளரச் ◌்சிமய கண் டுதகொள்ளல்.
6. தமிழர் தம் வொழ்வில் எங்கனம் இயற்மகமய வணங்கி பபொற்றினர் என் ப ம ததிமண பகொட்பொட்டின் வழி ததளிதல்.
7. இந்திய விடுதமல பபொரில் தமிழர் ஆற்றிய பங்கிமன ததரிந்F தகொள்ளுதல்.

அலகு I மொழி மற்றும் இலக்கியம்: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22FD401 **SENSORY EVALUATION OF FOOD** **3 0 0 3**

Course Objectives

- Understand the influence of taste, odour and colour perception on sensory quality
- Apply the principles of sensory evaluation methodologies.
- Evaluate the sensory quality of foods using instruments

Programme Outcomes (POs)

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. To assess the perception of senses by human sensory organs
2. To demonstrate the sensory principles and practices to establish sensory panel and facilities
3. To integrate the appropriate sensory evaluation tests related to the quality of foods
4. To analyze the sensory quality of foods using instruments
5. To evaluate the sensory evaluation by applying basic statistical concepts.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					1	1				1		3		
2					3			2	3	3	2			
3			1	3	3				2	3	3			
4			3	1	3			1						
5				3	1	3		1			1			

UNIT I **9 Hours**

HUMAN SENSES - ANATOMY, PHYSIOLOGY AND PERCEPTION

Aim of sensory evaluation and Applications. Sensory properties and human senses. Importance of Taste, odour, Colour and Texture. Structure and physiology of taste organs - tongue, papillae, taste buds, salivary glands. Mechanism of taste perception- Chemical dimensions of basic tastes- sweet, salt, sour, bitter and umami. olfactory organs and receptors - physiology of odour perception and colour perception Texture classification and texture perception.

UNIT II **9 Hours**

SENSORY PANELS AND TESTING FACILITIES

Establishing sensory panels - Types of panels (Trained panel, discriminative and communicative panel). Selection, training and performance monitoring. Factors influencing sensory verdicts. Response Errors -Types and Steps to reduce the errors. Designing Sensory Testing Facilities. Sampling, preparation and presentation of samples. Panel Measurement scales.

UNIT III **9 Hours**

METHODS OF SENSORY EVALUATION

Methodology for sensory evaluation: Consumer oriented tests and Product Oriented tests. Consumer oriented tests- Preference test, Acceptance test, Hedonic test. Product Oriented tests - Threshold tests; Discriminative test - paired comparison, Duo-trio, triangle; Ranking, Sensitivity Test, Descriptive test - flavor profiling, texture profiling, ratio scaling, quantitative descriptive analysis.

UNIT IV **9 Hours**

INSTRUMENTATION IN SENSORY EVALUATION

Need for Instrumentation in sensory evaluation. Colour Measurement -spectrophotometry, colorimetry, Munsell colour system, CIE colour system, Hunter colour system, Electronic eye (IRIS). Texture measurement - Basic rheological instruments, Texture analyzer. Taste measurement- E-tongue. Odour measurement- E nose, GC - olfactory.

UNIT V **9 Hours**

STATISTICAL ANALYSIS OF SENSORY EVALUATION

Conducting a sensory study. Sensory evaluation of foods and statistical analysis: Hypothesis testing and sensory inference, variation of T Test, Nonparametric and binomial based Statistical methods, Chi square test, analysis of variation, Correlation regression.

Total: 45 Hours

Reference(s)

1. Lyon, D.H., Francombe, M.A., Hasdell, T.A., Lawson, K. (eds), Guidelines for Sensory Analysis in Food Product Development and Quality Control. Chapman and Hall, London, 1992.
2. Amerine, M.A.; Pangborn, R.M.; Roessler, E.B., Principles of Sensory Evaluation. Academic Press, New York, 1965.
3. Martens, M.; Dalen, G.A.; Russwurm, H. (eds): Flavour Science and Technology. John Wiley and Sons, Chichester, 1987.
4. Moskowitz, H.R. (eds), Food Texture: Instrumental and Sensory Measurement. Marcel Dekker Inc. New York, 1987
5. Rao E. S.. Food Quality Evaluation, Variety Books. 2013.
6. B. M. Watts, G. L. Ylimaki, L. E. Jeffery, L. G. Elias, Basic Sensory Methods For Food Evaluation, 1989

22FD402 **HEAT AND MASS TRANSFER** **3 0 2 4**

Course Objectives

- To familiarize conduction heat transfer mechanisms
- To expose the mechanisms of free and forced convection
- To develop the shape factor algebra for black body radiation and grey body radiation
- To demonstrate the phase change heat transfer and determine the performance of heat exchanging devices
- To infer diffusion and convective mass transfer

Programme Outcomes (POs)

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. To select the heat conduction equation to compute the rate of heat transfer in one and two - dimensional systems and composite systems.
2. To assess the convection phenomena and determine the heat transfer rate in free and forced convection.
3. To breakdown the heat transfer rate in radiation and compare the thermal performance of heat exchangers using LMTD or NTU approach.
4. To integrate mass transfer rate in diffusion mass transfer applications.
5. To evaluate convective mass transfer process and apply mass transfer principles in food and bioprocessing.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	1		2							3
2	2	3	2	2	1		2							3
3	3	3	2	2			2							3
4	2	3	2	2			2							3
5	2	3	2	2			2							3

UNIT I **8 Hours**

CONDUCTION

Introduction - Steady State Conduction in one and two -dimensional systems - Composite systems - Extended surfaces.

UNIT II **8 Hours**

CONVECTION

Basic concepts - Heat transfer coefficients - Boundary layers - Forced convection - External and Internal flows -correlations - Natural convection

UNIT III **11 Hours**

RADIATION AND HEAT EXCHANGERS

Radiation heat transfer – concept of black and grey body - monochromatic Total emissive power– Kirchhoff’s law – Planck’s law - Stefan-Boltzmann’s law –Heat exchangers – parallel, counter and cross flow- Logarithmic Mean Temperature Difference – overall coefficient of heat transfer in shell and tube heat exchanger for food products.

UNIT IV **10 Hours**

INTRODUCTION TO MASS TRANSFER

Basics of mass transfer- Fick's laws of diffusion- mechanisms of mass transfer-Molecular diffusion, Fick's first and second laws, steady-state and non-steady-state diffusion, diffusion in solids and liquids, diffusion coefficients.

UNIT V **8 Hours**

CONVECTIVE MASS TRANSFER

Fundamentals of convective mass transfer, boundary layer theory, mass transfer coefficients in laminar and turbulent flow, dimensionless numbers, applications of mass transfer in bio and food industries.

EXPERIMENT 1 **3 Hours**

Determination of thermal conductivity for one dimensional steady state conduction

EXPERIMENT 2 **3 Hours**

Determination of heat transfer co-efficient by unsteady heat transfer

EXPERIMENT 3 **3 Hours**

Determination of heat transfer co-efficient by natural convection

EXPERIMENT 4 **3 Hours**

Determination of heat transfer co-efficient by forced convection

EXPERIMENT 5 **3 Hours**

Determination of Stefan-Boltzmann constant

EXPERIMENT 6 **3 Hours**

Determination of emissivity using emissivity apparatus

EXPERIMENT 7 **3 Hours**

Determination of overall heat transfer for film wise and drop wise condensation

EXPERIMENT 8 **3 Hours**

Determination of overall heat transfer co-efficient for a parallel and counterflow heat exchange

EXPERIMENT 9 **3 Hours**

Experimentation on mass transfer

EXPERIMENT 10 **3 Hours**

Determination of overall heat transfer co-efficient for a fluidized bed heat transfer

Total: 75 Hours

Reference(s)

1. Yunus A. Cengel, Heat and Mass Transfer: Fundamentals and Application, Tata McGraw Hill publishing Company private limited, New Delhi, 6th edition, 2020
2. J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, New Delhi, 10th edition, 2010
3. C. P. Kothandaraman and S. Subramanyan, Fundamentals of Heat and Mass Transfer, New Age International private limited, New Delhi, Rev.3rd edition, 2006
4. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Principles of Heat and Mass Transfer, ISBN: 978-1-119-38291-1 October 2017
5. R. K. Rajput, Heat and Mass Transfer, S Chand and Company, New Delhi, 2018

22FD403 REFRIGERATION AND COLD CHAIN MANAGEMENT 3 1 0 3

Course Objectives

- Learn the principles and the components involved in domestic and commercial refrigeration systems.
- Impart knowledge on application of Refrigeration & Air conditioning systems in food industries.
- Provide knowledge on handling and transport of food materials by ensuring the superior quality.

Programme Outcomes (POs)

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. To select appropriate components of the refrigeration unit and analyze the effect of different refrigerants on environment
2. To demonstrate various refrigeration cycles and its applicability
3. To integrate the knowledge of psychrometry for air conditioning & various food processing operations
4. To parse the knowledge of refrigeration and air conditioning in persevering foods using domestic and industrial refrigeration systems
5. To choose the appropriate refrigerated transport facilities for ensuring the product quality

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3		2			1							
2	3						1	1						
3	2		2	1			1							
4	2	1	1	1		1		1						
5	3	1	3			1			1					

UNIT I **10 Hours**

REFRIGERATION PRINCIPLES AND COMPONENTS

Refrigeration-principles- refrigeration effect-coefficient of performance-units of refrigeration- Refrigeration components-compressor-classification-principle and working - Condensers-types- construction, principle and working. Evaporators-types-principle and working. Expansion device-types construction, principle and working. Refrigerants-properies-classification comparison and advantages- chloroform carbon (CFC) refrigerants-effect on environmental pollution- alternates refrigerants.

UNIT II **9 Hours**

VAPOUR COMPRESSION AND VAPOUR ABSORPTION CYCLE

Simple vapour compression cycle-T-S diagram-p-h chart- vapour compression system-different types-vapour absorption cycle-simple and practical vapour absorption system-advantages-ideal vapour absorption system- Electrolux Refrigerator-Lithium bromide refrigeration-construction and principles

UNIT III **9 Hours**

PSYCHROMETRY

Psychrometry-terms-psychrometric chart-sensible heating-sensible cooling process-by-pass factor-humidification-dehumidification-sensible heat factor-evaporative cooling-cooling and dehumidification-cooling and humidification process-heating and dehumidification- heating and humidification-adiabatic mixing of air streams

UNIT IV **9 Hours**

AIR CONDITIONING SYSTEM

Air conditioning systems-equipment used-classification-comfort and Industrial air conditioning system-winter, summer and year- round air conditioning system- unitary and central air conditioning system-application of refrigeration and air conditioning-domestic refrigerator and freezer-refrigerated trucks-ice manufacture-cold storage-freeze drying.

UNIT V **8 Hours**

COLD CHAIN MANAGEMENT

Cold chain, Refrigerated Transport-Refrigerated Container trucks, Handling and Distribution, Traceability and barcode. Product Temperature and Moisture monitoring

Tutorial : 15 Hours
Total: 60 Hours

Reference(s)

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill, New Delhi, 2002
2. R.S. Khurmi and J. K. Gupta, A textbook of Refrigeration and Air Conditioning, Eurasia Publishing housing (P) Ltd, New Delhi, 2002
3. Manohar Prasad, Refrigeration and Air conditioning, New Age International (P) Ltd, New Delhi, 1999
4. W. F. Stoecker, and J. W. Jones, Refrigeration and Air Conditioning, Tata McGraw Hill, New Delhi, 1986
5. Roy J. Dossat, Principles of Refrigeration, Pearson Education Asia, 4th edition, 2001
6. S. C. Arora and S. Domkundwar, A course in Refrigeration and Air conditioning, DhanpatRai (P) Ltd., New Delhi, 1997

22FD404 **FOOD PROCESSING AND PRESERVATION** **3 0 2 4**

Course Objectives

- Understand the principles of food processing and their impact on the shelf life and quality of food materials and products
- Learn various methods of food processing viz., drying, milling, freezing, thermal treatments etc.
- Introduce novel food processing techniques

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technologyby applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. To demonstrate different methods of high and low temperature processing techniques over raw foods
2. To predict the suitable dryers to different food to increase the shelf life
3. To analyze the shelf life of foods processed and preserved by natural and chemical agents
4. To breakdown the operations and features of different non-thermal processing techniques
5. To choose the principle of advanced novel techniques in food processing industries

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	2					1				2	1
2	2	2	1	2					1				1	2
3	2	2	1	1					1				1	2
4	2	2	1	1									2	1
5	2	2	2	1					2				2	1

UNIT 1 **8 Hours**

HIGH AND LOW TEMPERATURE PROCESSING OF FOODS

Methods of applying heat to food -: Pasteurization (Definition, Time-Temperature Combination, Equipment), Sterilization (Definition, Time-Temperature Combination, Equipment), Blanching (Definition, Time-Temperature Combination, Equipment, Adequacy in blanching). Methods of low temperature preservation- Chilling. Freezing, Freeze Drying, Freeze Concentration - Theory and Principles.

UNIT II **10 Hours**

DRYING, DEHYDRATION AND EXTRUSION

Definition, free and bound moisture, Water activity - sorption behavior of foods - water activity and food stability - Relationship between water activity and moisture - Equilibrium moisture content; Drying - types of dryers. Dehydration - Osmotic dehydration (theory and principles); Extrusion cooking – principles and types of extruders - single and double screw extruder- construction and working; Effect of different parameters - quality of the extruded products.

UNIT III **10 Hours**

PROCESSING AND PRESERVATION OF FOODS BY CHEMICALS

Food preservation by the application of sugar, salt, acid (Principles - mechanism- antimicrobial activity); Preservation by chemicals- type of chemical preservatives- Sulphur dioxide, benzoic acid, etc.; use of other chemicals like acidulant, antioxidants, mold inhibitors, antibodies, etc. Factors affecting antimicrobial activity of preservatives.

UNIT IV **8 Hours**

NON THERMAL PROCESSING

Food Irradiation - High Pressure Processing- Cold plasma- Supercritical-Pulsed electric field processing- UV treatment and Ultrasound - Theory and Principles - effect on microorganisms- Application in Processing of foods.

UNIT V **9 Hours**

NOVEL METHODS OF FOOD PROCESSING

High hydrostatic pressure; Hydrodynamic cavitation Ozone treatment, dielectric heating-microwave, radio frequency, ohmics and infrared heating theory, equipment, applications and effect on foods. Hurdle technology and Nano-technology-principle - application in food processing.

EXPERIMENT 1 **2 Hours**

Determination of textural characteristics of foods

EXPERIMENT 2 **4 Hours**

Determination of flow behavior of Newtonian and Non-Newtonian fluids

EXPERIMENT 3 **4 Hours**

Determination of Thermal Death Time

EXPERIMENT 4 **2 Hours**

Determination of Water activity of processed food products

EXPERIMENT 5 **2 Hours**

Determination of drying rate of fruits and vegetables in Tray dryer

EXPERIMENT 6 **2 Hours**

Determination of color characteristics of curry leaves during Fluidized bed dryer

EXPERIMENT 7 **4 Hours**
Determination of textural characteristics by Extrusion cooking

EXPERIMENT 8 **2 Hours**
Retention of ascorbic acid during Microwave drying of leafy vegetable

EXPERIMENT 9 **2 Hours**
Dehydration and rehydration of vegetables in rotary dryer

EXPERIMENT 10 **2 Hours**
Determination of freezing point of food materials

EXPERIMENT 11 **2 Hours**
Effect of UV treatment on microbial quality of liquid foods

EXPERIMENT 11 **2 Hours**
Effect of ohmic heating on microbial quality of liquid foods

Total: 75 Hours

Reference(s)

1. P.J. Fellows, Food processing Technology: Principles and practice, Second edition, Wood head publishing limited, Cambridge, 2009.
2. Da-Wen Sun, Emerging Technologies for food processing, 2nd Edition, Academic Press, 2014.
3. 3.R.L. Earle, Unit Operations in Food Processing, Pergamon Press, New York, 1989.
4. Dennis R. Heldman and R. Paul Singh, Introduction to food engineering, Fourth edition, CRC Press, 2006.
5. Howard Q. Zhang, Gustavo V. Barbosa-Canovas, V.M.Balasubramaniam, C. Patrick Dunne, Daniel F.Farkas and James T.C.Yuan. Nonthermal processing Technologies for food, IFT Press, 2011.
6. Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Pilar Cano, Novel Food Processing Technologies, CRC Press,1stEdition,2004.

22FD405 UNIT OPERATIONS IN FOOD PROCESSING 3 0 2 4

Course Objectives

- Impart knowledge on different unit operations and its significance in the food Industry.
- Understand problems related to food processing and ability to solve.
- Familiarize with operational skill of equipment and imparting knowledge on entrepreneurship.

Programme Outcomes (POs)

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 Design/development of solutions: Design solutions for complex engineering problemsand design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO12 Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. To assess the principle and operation of different types of evaporators and explain the drying of principles.
2. To assess the suitable process technology such as sedimentation, filtration, cyclone and membrane for separation of different kind of particles present in foods.
3. To outline the operation of different kind of mixing and size reduction equipment
4. To outline the leaching and extraction techniques to transform raw materials into value added products
5. To choose the mechanism of crystallization and distillation process in food industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2		1	1	1					1	1	1
2	1		2			1	2					1	1	1
3	2		1			1	1					1	1	1
4	2				1	2	1					1	1	2
5	2				2	1	1					1	1	1

UNIT 1 **8 Hours**

DRYING AND EVAPORATION

Unit operations in food processing - Drying - principles, theory of drying, equilibrium moisture content, methods of moisture determination and source of heat. Evaporation - definition - single and multiple effect evaporation-types, application and performances of evaporators and total mass balance and common mass balance, types of Feed

UNIT II **12 Hours**

MECHANICAL AND MEMBRANE SEPARATION

Velocity of particles moving in a fluid- terminal velocity, drag coefficient. Sedimentation, Stokes"" law, sedimentation equipment, flotation, sedimentation of particles in a gas, settling under combined forces. Centrifugal Separation, centrifuge equipment. Filtration, filter cake resistance, constant - rate filtration, constant - pressure filtration, filtration graph. Filtration equipment, plate and frame filter press, rotary filters, centrifugal filters, air filters. Air Separators and Sieving: Cyclones - optimum shape efficiency, impingement separators, classifiers, rates of throughput, standard sieve sizes, cumulative analysis, particle size analysis, industrial sieves. Membrane Separation: osmotic pressure, ultra filtration, reverse osmosis, rate of flow through membranes.

UNIT III **8 Hours**

MIXING AND SIZE REDUCTION

Mixing - theory of solid and liquid mixing- equipment - effect on foods. Size reduction - grinding and cutting - principles of comminuting - characteristics of comminuted products - particle size distribution in comminuted products - energy and power requirements in comminuting - crushing efficiency - Rittinger's, Bond"s and Kick's laws for crushing-size reduction equipment - crushers - jaw crusher, gyratory crusher-crushing rolls - grinders -hammer mills - rolling compression mills - attrition, rod, ball and tube mills - construction and operation.

UNIT IV **8 Hours**

EXTRACTION AND LEACHING

Extraction process, rate of extraction, stage-equilibrium extraction, solvent extraction, supercritical fluid extraction, extraction equipment. Leaching: Principles of continuous leaching, counter-current leaching, and leaching equipment,Steady state operations - thickeners,continuous Countercurrent decantation. Leaching of vegetable seeds - Rotocel extractor, Kennedy Extractor

UNIT V **9 Hours**

CRYSTALLIZATION, DISTILLATION

Crystallization - rate of crystal growth - equilibrium crystallization-crystallization equipment - classification - construction and operation-tank, agitated batch, Swenson-Walker vacuum crystallizers-Distillation: Distillation process - binary mixtures - flash and differential distillation-steam distillation - theory - consumption - continuous distillation with rectification - vacuum distillation - batch and fractional distillation - operation and process - advantages and limitations-distillation equipment - construction and operation - factors influencing the operation.

EXPERIMENT 1 **2 Hours**

Determination of economy and thermal efficiency of evaporator

EXPERIMENT 2 **3 Hours**

Solving problems on single effect evaporator

EXPERIMENT 3 **2 Hours**

Solving problems on multiple effect evaporators

EXPERIMENT 4 **2 Hours**

Determination of separation efficiency of centrifugal separator

EXPERIMENT 5 **3 Hours**
Determination of collection efficiency in cyclone separator

EXPERIMENT 6 **2 Hours**
Determination of efficiency of liquid solid separation by filtration

EXPERIMENT 7 **2 Hours**
Determination of particle size of granular foods by sieve analysis

EXPERIMENT 8 **2 Hours**
Performance evaluation of a sieve

EXPERIMENT 9 **2 Hours**
Determination of performance characteristics in size reduction using the burr mill

EXPERIMENT 10 **2 Hours**
Determination of energy requirement in size reduction using ball mill

EXPERIMENT 11 **2 Hours**
Determination of energy requirement in size reduction using hammer mill

EXPERIMENT 12 **2 Hours**
Performance evaluation of pin mill

EXPERIMENT 13 **2 Hours**
Performance evaluation of a hammer mill

EXPERIMENT 14 **2 Hours**
Performance evaluation of a steam distillation process

Total: 75 Hours

Reference(s)

1. R.L. Earle, Unit Operations in Food Processing, Butterworth-Heinemann Ltd; 2nd Revised edition, Pergamon Press, 1983.
2. C.J.Geankoplis, Transport Process and Unit Operations, 3rd edition, Prentice-Hall of India Private Limited, New Delhi, 1993.
3. J.M. Coulson and J.F. Richardson, Chemical Engineering, Volume I to V, The Pergamon Press, New York, 1999.
4. W.L. McCabe, J.C. Smith and P.Harriot, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill. Inc, Kosaido Printing Ltd. Tokyo, Japan, 2005

22HS007 **ENVIRONMENTAL SCIENCE** **2 0 0 0**

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. To find the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. To analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. To resolve the existing environmental challenges related to pollution and its management
4. To justify the suitable strategies for sustainable management of components of environmental science
5. To criticize the impacts of population and human activities on environment

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
1	1	2						1	1			2	1	1
2	1	1						1				2	1	1
3	2	2					1	1	1			1	1	
4	1							1	1				1	1
5	2								1			1		1

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - overexploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods - earthquake

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation- rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION 0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing
- Effectively use the language to persuade others
- Appreciate the nuances of the language and engage an audience
- Use advanced tools of language to improve communicative competence
- Prepare for professional demands at the workplace
- Give concrete expression to the plans and goals

Programme Outcomes (POs)

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

1. To assess the clarity in articulating the objectives and aims and improved proficiency in using the English language
2. To demonstrate the communication effectively and with good interpersonal skills; speak in public, engage the audience, and lead a group discussion
3. To analyze a specific piece of information; take in what is read, and use good writing techniques with proper grammar and syntax in all formal situations
4. To outline the awareness and empathy to emotional signals in communication.
5. To critically evaluate the ethics of persuasive appeals and confidence to influence opinion

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			1	1				1	2	3		1		
2			1	1				1	2	3		1	1	1
3			1	1				1	2	3		1	1	
4			1	1				1	2	3		1	1	1
5			1	1					2	3		1		1

UNIT – 1 - CREATIVE EXPRESSION **15 Hours**

Proposals & Grant applications, Argumentative essays & editorials, Sales Pitches, Campaigning, Commercials/advertisements, effectively answering the famous interview question: 'Why should we hire you?' Sentence and paragraph formation - Rhetorical questions - Emphasis & effective repetition - Empathetic expression, knowing the audience, capturing attention - Creating Memes, Comic Strips, Stand-up comedy, Caption writing, and Limericks, Vocabulary and slang words for comedy - Similes & Metaphors - Homophones, homonyms, alliteration, wordplay.

UNIT 2 - FORMAL EXPRESSION **15 Hours**

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning- SVA - Advanced level - Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbs- Tenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions - Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research Objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct experiments Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - Prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats - Note taking - Active verbs

Total: 30 Hours

Reference(s)

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & KrishnaMohan, Tata McGraw Hill & Co. Ltd., 2001
4. Personality Development, Harold R. Wallace &L.Ann Masters, Cengage Learning, New Delhi
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi
6. English Grammar, Composition and Usage by N.K.Agrawal & F.T.Wood, Macmillan IndiaLtd., New Delhi.

22HS006 தமிழரும் தொழில்நுட்பம் **1 0 0 1**

பாடத்திட்டத்தின் ந ாக்கம்

1. சங்க கொலத்தில் வரலொறு மற்றும் கலொச்சொர ஆவணங் களின் ஒரு வடிவமொக, மட்பொண் டங் கள் மீதொன கிரொஃபிட்டிமய பகுப்பொய் வு தசய் தல் .
2. சிலப்பதிகொரத்தில் கட்டப்பட்ட பமமட கட்டுமொனங் களின் விவரங் கமளயும் அவற்றின் கலொச்சொர முக்கியத்Fவத்மதயும் பகுப்பொய் வு தசய் வதன் மூலம் , சங் க கொலத்தில் மொவீரர் கற்களின் கட்டுமொனப் தபொருட்கள் மற்றும் வரலொற்று சூழமல ஆரொய் தல் .
3. சமுத்திரங் கள் பற்றிய பண் மடய அறிமவயும் , தமிழ் சமூகத்தில் அதன் தொக்கத்மதயும் ஆரொய் வF ஆகியமவ இப்பொடத்திட்டத்தின் பநொக்கம் ஆகும் .

கற்றலின் விளைவு

1. சங் க கொலத்தில் தநசவுத் ததொழிலின் முக்கியத்Fவத்மதயும் அதன் கலொச்சொர முக்கியத்Fவத்மதயும் புரிந்தகொள்ளல் .
2. பசொழர் கொல விவசொய மற்றும் நீர்ப்பொசன நமடமுமறகளில் அமணகள் , குளங் கள் மற்றும் மதகுகளின் முக்கியத்Fவத்மதப் புரிந்F தகொள்ளல் .
3. சங் க கொலத்தில் வீட்டுப் தபொருட்களில் பயன் படுத்தப்பட்ட கட்டடக்கமல வடிவமமப்புகள் மற்றும் கட்டமமப்பு கட்டுமொன முமறகமள ஆரொய் தல் .
4. பண் மடய தமிழ் கலொச்சொரத்தில் , கப்பல் கட்டும் கமல, கடல் வரத்தகம் மற்றும் பபொக்குவரத்தில் அதன் பங் மக ஆரொய் தல் .
5. தமிழ் தமொழியில் அறிவியல் தசொற்களஞ்சியம் மற்றும் தசொல் லகரொதியின் வளரச் ்சிமயக் கண் டறிதல்.

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **உற்பத்தித் தொழில் நுட்பம்**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22FD501 BAKING AND CONFECTIONERY TECHNOLOGY 3 0 2 4

Course Objectives

- Impart knowledge of the principles of the baking process
- Introduce baking techniques to produce bread, biscuits and cakes
- Familiarize with standards and regulations applied in the food industry

Program Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the principles of baking and analyze the role of ingredients in baking.
2. Apply the production process for different types of confectionery products.
3. Assess the standards and quality control for bakery and confectionery product.
4. Compare the processing method for the production of biscuits and cookies.
5. Analyze and illustrate the processing parameters of baking machinery.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1			3		1				2		2	3
2		2		1	2	1					1	1	1	2
3	1		2	2	2	1					1	1	2	
4	2	2		1	3				1		2	2	2	2
5		2		3		2	3	2	1			3		

UNIT I **9 Hours**
BAKING PRINCIPLES AND BREAD
Introduction to wheat- Structure, types, quality evaluation. Dough rheology. Baking principles, Bread-role of ingredients and its chemistry, additives, varieties of bread. Methods of bread preparation-advantages and disadvantages, bread spoilage and remedies. Cake- types of cakes, role of ingredients, cake mixing methods, Preparation, faults and remedies.

UNIT II **9 Hours**
BISCUIT AND COOKIES
Biscuits and cookies - role of ingredients. Types of biscuit dough - Developed/ Hard dough- semi-sweet, fermented and puff; Soft dough, short dough biscuits. Classification and Production of biscuits and cookies. Quality tests for biscuits and cookies. Faults and remedies.

UNIT III **9 Hours**
CONFECTIONERY PRODUCTS
Introduction - Role of ingredients and additives used in confectionery. Cocoa products and its uses in confectionery. Stages of Sugar cookery. Types of confectionery products and manufacturing process - chocolate, caramels, toffees, fondants, fudges and flour confectionery.

UNIT IV **9 Hours**
BAKERY EQUIPMENT
Equipment and machineries for a bakery unit - Light Equipment, Heavy/ Bulk handling Equipment - Dough mixers, Dividers, rounding, sheeting and laminating machines. Ovens and Slicers. Packaging equipment.

UNIT V **9 Hours**
PACKAGING AND QUALITY CONTROL FOR BAKERY AND CONFECTIONERY PRODUCT
Packaging requirements and materials. FSSAI Standards and regulations for bakery and confectionery products. Quality control and Good Manufacturing Practices (GMP). Layout for Baking and Confectionery plant.

EXPERIMENT 1 **3 Hours**
Estimation of gluten content in wheat and refined flour

EXPERIMENT 2 **3 Hours**
Quality analysis of wheat and Maida flour

EXPERIMENT 3 **3 Hours**
Determination of protein quality in wheat and maida flour

EXPERIMENT 4 **3 Hours**
Experiment on the preparation of Cookies

EXPERIMENT 5 **3 Hours**
Experiment on the preparation of Muffins

EXPERIMENT 6 **3 Hours**
Determination of Dough characteristics using farinographic and extensographic

EXPERIMENT 7 **3 Hours**
Experiment on preparation of Bun and bread rolls

EXPERIMENT 8 **3 Hours**
Preparation and analysis of baking and quality parameters in plain and fancy cakes

EXPERIMENT 9 **3 Hours**
Experiment on Preparation of candies

EXPERIMENT 10 **3 Hours**
Experiment on preparation of Fudge and Fondant

Total: 75 Hours

Text Book(s)

1. Bernard, W. Minifie, Chocolate, cocoa and confectionery: CBS Publishers and Distributors, New Delhi, 1997.
2. Iain Davidson, Biscuit, Cookie, and Cracker Production: Process, Production, and Packaging Equipment,Academic Press, Elsevier, 2018

Reference(s)

1. Manley, Duncan., Technology of Biscuits, Crackers and Cookies, Woodhead Publishing Ltd., England, third edition, 2000.
2. Ashokkumar Y, Textbook of Bakery and Confectionery, Prentice Hall India Learning Private Limited; 2 edition (2012).
3. Paula Figoni, How baking works (Exploring the fundamentals of baking science), John Wiley & sons, 2007.

22FD502 FRUITS AND VEGETABLE TECHNOLOGY 3 0 2 4

Course Objectives

- Implement specific post-harvest handling techniques for storage and transport of fruits and vegetables.
- Apply preservation techniques to produce value-added fruits and vegetable products.
- Learn the industrial-scale processing and preservation methods to extend the shelf life of fruit and vegetable commodities.

Program Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply minimal processing and fermentation methods to produce value-added products from fruits and vegetables.
2. Construct and implement low-temperature, modified atmosphere, and controlled atmospheric storage methods for the storage of fruits and vegetables.
3. Interpolate Produce value-added products from fruits and vegetables by using a suitable preservation method (sugar, salt, or dehydration).
4. Evaluate and produce dehydrated fruits and vegetables.
5. Create and evaluate canned and bottled fruits and vegetables.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	1	3	1						1	2	3
2	1	3	3	2	2		1					2	3	3
3	1	2	3	2	2	1	1					2	3	3
4			2	1	3		1					3	1	2
5	1	1	2	2	2	1		1				2	1	2

UNIT I **9 Hours**

HARVESTING, HANDLING AND STORAGE OF FRUITS AND VEGETABLES

Fruits and vegetables: classification, nutritional profile - Harvesting of fruits and vegetables - maturity indices - post harvest physiology - handling - precooling and storage - Storage under ambient condition, low temperature storage - chilling, frozen storage- chilling injury, freeze burn. Controlled atmosphere storage, Modified atmosphere storage - concepts and methods - gas composition - Changes during storage.

UNIT II **9 Hours**

PRESERVATION OF FRUITS BY VALUE ADDITION

Methods of fruit and vegetable preservation - Processing using sugar- Preparation of jam, jelly, marmalade, squash, RTS, crush, nectar, cordial, fruit bar, preserves, candies and carbonated, fruit beverages. Processing using salt - Brining - Preparation of pickles, chutney and sauces, ketchup. Machinery involved in processing of fruits and vegetables products.

UNIT III **9 Hours**

PRESERVATION BY DRYING AND DEHYDRATION

Drying and dehydration - Types of driers - Solar, cabinet, fluidized bed drier, spouted bed drier, heat pump drier, vacuum drier and freeze drier - Applications. Preparation of product. Changes during drying and dehydration. Problems related to storage of dried and dehydrated products.

UNIT IV **9 Hours**

MINIMAL PROCESSING AND FERMENTATION

Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables, Minimal Processing of Fruits and Vegetables. Preservation by fermentation - wine, vinegar, cider and sauerkraut.

UNIT V **9 Hours**

CANNING AND BOTTLING

Canning - principles, types of cans - preparation of canned products - packing of canned products - spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations. General considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit.

EXPERIMENT 1 — 3 Hours

Preparation of Ready to Serve (RTS) beverages

EXPERIMENT 2 — 3 Hours

Preparation of plain / mixed fruit jam

EXPERIMENT 3 — 3 Hours

Preparation of fruit jelly and orange marmalade

EXPERIMENT 4 **3 Hours**
Preparation of fruit preserve and candy

EXPERIMENT 5 **3 Hours**
Preparation of pickles

EXPERIMENT 6 **3 Hours**
Minimal processing of fruits and vegetables

EXPERIMENT 7 **3 Hours**
Osmotic dehydration of fruits

EXPERIMENT 8 **3 Hours**
Osmotic dehydration of vegetables

EXPERIMENT 9 **3 Hours**
Dehydration of vegetables

EXPERIMENT 10 **3 Hours**
Sauerkraut fermentation

Total: 75 Hours

Reference(s)

1. Norman W. Desrosier, and James N. Desrosier. The Technology of Food Preservation 4th Edition, CBS Publisher & Distributions, New Delhi, 2004.
2. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Third Edition, CBS Publishers & Distributors-New Delhi, 2002.
3. A. Chakraverty, A.S. Mujumdar, G.S.Vijaya Raghavan and H.S. Ramaswamy, Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press, USA, 2003.
4. Girdhari Lal, G. S.Siddappa and G.L. Tandon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 2009.
5. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.
6. K.Sharma, Stevan J.Mulvaney and Syed S.H. Rizvi, Food Process Engineering-Theory and Laboratory equipments, John Wiley & Sons, New York, 2000.

22FD503 MEAT, POULTRY AND FISH TECHNOLOGY 3 0 0 3

Course Objectives

- Impart the processing technologies and equipment used for meat, fish and Poultry
- Understand the preservation and value addition of meat, egg and poultry products
- Assess the quality assurance, sanitation and packaging techniques for meat, fish and poultry products.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the appropriate processing and preservation methods for fish and its products.
2. Apply the effective processing methods for waste/By-product utilization from meat and poultry.
3. Assess the nutritive value, processing and quality parameters of Poultry, egg, and its products.
4. Analyze the scope, challenges, nutritive value and processing techniques of meat and its products.
5. Evaluate the quality and suitable packaging for meat, fish and poultry products industry.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	3	1	1	1	1			1	2	1
2	1	2	1	2	3	2						2	2	3
3		1	1	2	3	2	1					1	3	1
4	1	2	2	2	3	3	2					1	2	1
5		2	3	1	3	3	1					1	2	3

UNIT I **12 Hours**

MEAT PROCESSING

Meat processing industries- status and scope- Structure, composition and nutritive value of meat, Common and commercially important meats, pre -slaughter care-stunning methods-slaughtering method- evisceration and dressing of carcasses-refrigeration and transport, Meat tenderization and Meat quality evaluation. Rigor mortis - changes of meat, carcass chilling, ageing; storage of fresh meat. Processing and preservation of meat- aging, pickling, smoking. Dried and Cured meat. Canned meat, frozen meat, Cooked and Refrigerated meat, Sausages.

UNIT II **12 Hours**

POULTRY AND EGG PROCESSING

Composition and nutritive value of poultry meat, Types of poultry, production, classification & grading. Slaughtering, bleeding, scalding, defeathering, evisceration, chilling, packaging; storage. Egg structure, composition, nutritive value and functional properties of eggs and its preservation by different methods. Factor affecting egg quality and measures of egg quality. Preservation of egg by different methods. Egg powder processing. Egg quality assessment

UNIT III **9 Hours**

FISH AND FISH PROCESSING

Fish-composition and nutrition value, commercially important fish and shell fish, Processing and Preservation-chilling, freezing, canning, smoking, curing, salting and drying, fish meal and fish oils; ready-to-eat fish and other sea food products, spoilage factors, ship board operations, storage and transport.

UNIT IV **5 Hours**

PACKAGING AND QUALITY STANDARDS

Modified atmosphere packaging, packaging of retail cuts, Indian regulation and quality standards, Kosher and Halal certification, HACCP, Good Manufacturing Practices, meat plant sanitation and safety.

UNIT V **7 Hours**

EQUIPMENTS AND BY-PRODUCT UTILIZATION

Meat processing equipment - Meat grinder, Sausage stuffer, Hand crank meat tenderizer, meat mixer, meat mincer and meat slicer. Poultry processing equipment - Chicken feather plucking machine, cutter, Slaughter machine, Bone and meat cutter. Fish processing equipment - Fish slicing machine, Fish gutting machine, fish grader, fish de-scaling machine, Solid waste, Liquid waste, Chicken rendering unit-Dry rendering, wet rendering, Effluent Treatment Plant, By product utilization.

Total: 45 Hours

Reference(s)

1. A.M Pearson and T.A. Gillett, Processed Meats, CBS Publishers & Distributors, Third Edition, New Delhi, 1997.
2. P.C. Panda, Text Book on Egg and Poultry Technology, Vikas Publishing House Pvt. Ltd., New Delhi, 1998.
3. K.K. Balachandran, Post harvest Technology of fish and fish products, Daya publiching house, Delhi, 2001.
4. G.M. Hall, Fish processing Technology, Blackie Academic and Professional, London, 1997.
5. W.J. Stadelman and O. J. Cotterill, Egg science and Technology, AVI Publishing Co., Connecticut, 1995.
6. V.P. Singh and Neelam Sachan, Principles of meat technology, New India publishing agency, New Delhi, 2012

22FD504 **DAIRY TECHNOLOGY** **3 0 2 4**

Course Objectives

- Analyse the physico-chemical and functional properties of milk constituents.
- Understand the steps involved in the processing of milk and milk products.
- Apply the technologies for the production of different dairy products.

Program Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Understand the composition of milk and the physical and chemical properties of milk.
2. Apply the principles of different thermal processing of milk.
3. Apply the principles and process of Homogenization and cream separation in milk processing.
4. Analyse the process flow for the preparation of different dairy products.
5. Analyse the process and equipment used for the manufacturing of ice cream and milk powder production.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
1	2	2	2	1	3	1	1					2	2	1
2	2	2	1	1	3		2					3	1	3
3	2	1	2	2	1	1						1	2	2
4	1	2		2	3		1	1			1	3	2	1
5	2	2		3	1	1					1	2	2	3

UNIT I **9 Hours**

MILK PROPERTIES AND PRESERVATION

Milk- Composition and Nutritional value- physio chemical properties, Macro components - Micro components. Milk reception- Platform test - Cooling and storage of raw milk -principles and methods transfer of milk -transport and storage tanks - Standardization-cleaning and sanitization of Dairy equipment- CIP systems - Can washers - types - working principle and maintenance.

UNIT II **9 Hours**

PASTEURIZATION AND FILLING OF MILK

Pasteurization - principles and objectives - methods- batch / LTLT method - equipments - HTST method- process and equipment- plate heat exchanger - regeneration efficiency - milk flow diagram - UHT pasteurization- principles and methods - vacreation - form fill seal machines- aseptic filling.

UNIT III **9 Hours**

HOMOGENIZATION AND CREAM SEPARATION

Homogenization - theory - effect on milk properties - working principle of homogenizers – valves pumps-homogenization efficiency - cream separation - principles - gravity and centrifugal separation - clarifiers and separators - centrifugal separator- parts -construction and working principle - separation efficiency - fat loss in skim milk - bactofugation.

UNIT IV **9 Hours**

BUTTER AND CHEESE PROCESSING

Butter - composition- method of manufacture- churning of cream - theory of churning - operation of butter churn- over run -batch and continuous methods of butter making- cheese - composition classification - cheddar and cottage cheese - equipment- cheese vats and press- construction details.

UNIT V **9 Hours**

ICE CREAM AND MILK POWDER PRODUCTION

Ice cream - ingredients - preparation of ice cream mix - overrun- freezing - calculation of freezing point and refrigeration requirements of mixes- ice cream freezers -batch and continuous freezers - drying of milk - drying equipment - drum drier and spray drier - components - construction and working principles.

EXPERIMENT 1 **3 Hours**

Estimation of specific gravity of milk

EXPERIMENT 2 **3 Hours**

Determination of fat content of milk by Gerber's method

EXPERIMENT 3 **3 Hours**

Standardization of milk by Pearson square method

EXPERIMENT 4	**3 Hours**

Study on (Low temperature low time) LTLT process vat

EXPERIMENT 5	**3 Hours**

Study on construction details and milk flow pattern in Plate heat exchanger.

EXPERIMENT 6	**3 Hours**

Construction of parts and working of cream separator

EXPERIMENT 7	**3 Hours**

Problem solving - Skimming efficiency of cream separator

EXPERIMENT 8	**3 Hours**

Construction and operation of butter churning and butter working accessories

EXPERIMENT 9	**3 Hours**

Construction and working of homogenizer for reduction of fat globules

EXPERIMENT 10	**3 Hours**

Construction and operation of Spray dryer for the production of milk powder

Total: 75 Hours

Reference(s)

1. R.K. Robinson, Modern dairy technology Vol. I Advances in Milk processing. Elsevier Applied Science Publishes, London, 1986.
2. Gerrit Smit, Dairy processing Improving quality, Published by Woodhead Publishing Limited, CCR PRESS, 2000.
3. H.G. Kessler, Food engineering and dairy technology, Verlag A. Kessler, Freising, (F.R.Germany.) 1981.
4. A.W. Farrall, Engineering for dairy and food products, John Wiley and Sons, New York, 1963.

22FD507 **MINI PROJECT I** **0 0 2 1**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analyzing capability of the students.
- Increase the exuberance in finding the solution to various problems

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Formulate a real-world problem, identify the requirements, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies
3. Design the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Create and evaluate the report and present oral demonstrations.

Articulation Matrix

CO No	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO12	PSO 1	PSO 2
1	1	2	1	1	2	2	1	2	1				3	3
2	1	1	2	3	3	1		1	3	3	3		3	2
3	3	3	2	2	3	3	1	1			3		3	3
4	1	2	1	2	1	2	2	1		2	3		3	2
5	1	3	2	1	2	2		1			1	1	3	2

Total: 15 Hours

22FD601 FOOD PROCESSING PLANT DESIGN AND LAYOUT 3 1 0 4

Course Objectives

- Impart basic knowledge in selecting a location as well as plant layout concerning material handling, space utilization, future expansion, etc.
- Understand the importance of the availability of raw materials and facilities for the production of goods.
- Integrate man, materials, and machinery for optimum production.

Program Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply different methods for production planning.
2. Design layout for various types of food processing industries.
3. Design water storage systems and prepare electrical layout.
4. Demonstrate the repair and maintenance of equipment.
5. Evaluate and construct a project profile analysis and prepare a project report.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	2	2	1	2					1	1
2	1	1	2	3	3	1		1			3		2	1
3	3	3	2	2	3	3	1	1			3		1	1
4	1	2	1	2	1	2	2	1			3		1	1
5	1	3	2	1	2	2		1			1	1	2	1

UNIT I **12 Hours**

PLANT LOCATION AND LAYOUTS

Introduction to food plant design - special features of food and agricultural process industry - plant location - location factors, site selection, location theory and models - layout - objectives, classical and practical layout - preparation of process chart and machinery layout - product layout and process layout - plant layout for size reduction machinery, evaporation plant, drying plant, heat exchanger plant, refrigeration and packaging plant.

UNIT II **12 Hours**

PROJECT PROFILE ANALYSIS

Project profile, key aspects to consider in preparing a project profile and DPR (Detailed Project Report), Describing Project Operations, Categorizing Costs, Environmental Sustainability, completing and interpreting the profile, Project Profile Formats, Preparing model project report on fruit and vegetable processing unit.

UNIT III **12 Hours**

ELECTRICAL AND WATER SUPPLY

Estimation of services - peak and critical load - preparation of electrical layout - selection of fittings and accessories for electrical and water supply - provision of water supply - design of water storage system - selection of pipe, valves and safety devices - drainage - systems, pipeline, traps, safety devices - illumination and ventilation - materials, mounting, operation and maintenance - layout for effluent treatment plant - safe disposal of effluent.

UNIT IV **12 Hours**

PRODUCTION PLANNING AND CONTROL

Production planning and control - continuous and intermittent production - scheduling - routing and dispatching - activity chart and Gantt chart - network planning methods - PERT and CPM - applications - method study - work study - methods - man-machine chart - time study - standard time of a job - inventory control - economic ordering quantity - inventory models.

UNIT V **12 Hours**

REPAIR AND MAINTENANCE OF EQUIPMENT

Repair and maintenance of equipment - preventive maintenance and breakdown maintenance - replacement of equipment - alternative methods and analysis - method of annual equivalence, present worth method and internal rate of returns.

Total: 60 Hours

Reference(s)

1. O.P.Kanna, Industrial Engineering and Management, DhanpatRai Publication (P) Ltd., New Delhi, 2003.
2. S.P. Arora and S.P. Bindra, A Text Book of Building Construction, 5th edition, Dhanpat Rai Publications (p) Ltd., New Delhi, 2014.
3. Zacharias B. Maroulis and George D. Saravacos, Food Process Design, Marcel Dekker, Inc. U.S.A., 2003.

4. Antonio Lopez-Gomez and Gustavo V. Barbosa-Canovas, Food Plant Design, CRC, London, 2005.
5. C.S.Rao, Environmental Pollution Control Engineering, New age International (P) Ltd., New Delhi, 1999.
6. G.K. Agarwal, Plant layout and materials handling, Jain brothers, New Delhi, 2008.

22FD602 **FOOD EQUIPMENT DESIGN** **3 1 0 4**

Course Objectives

- Impart knowledge of basic principles of designing equipment for food processing
- Become familiar with the design and manufacture of storage tanks, pulpers, heat exchangers, driers, etc
- Provide an idea about devising cold storage units, freezers, etc.

Program Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Select the suitable products and materials for designing heat exchangers and evaporator
2. Design and analyze the performance of dryers and extruders.
3. Analyze the process parameters of equipment and design pressure vessels storage tanks, and pulper
4. Analyze and determine the parameters for designing size reduction and conveying equipment.
5. Evaluate the cooling load of cold storage and design cold storage for fruits and vegetables

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	1		1	1	1	1			1	1	1
2	3	2	2	2	2	3	1	1			1	1	2	
3	3	2	2	1	2	2	1	1			2	1	2	1
4	2	1	2	1	2	1	1	1			2	1	2	1
5	2	1	2	1		2						1	2	1

UNIT I **9 Hours**

DESIGN OF PRESSURE VESSELS, STORAGE TANKS AND PULPER

Introduction to design - principles and selection of food processing equipment - design of pressure vessels - design aspects of storage tanks, design of sterilizers and process vats - design of pulper - design considerations - materials of construction - installation and operation.

UNIT II **9 Hours**

DESIGN OF HEAT EXCHANGERS AND EVAPORATORS

Design of heat exchangers - plate heat exchanger, shell and tube heat exchangers - materials of construction - installation and operation - design of single effect evaporators - applications -multiple effect evaporators- entrainment separators-installation and maintenance

UNIT III **9 Hours**

DESIGN OF DRYERS AND EXTRUDERS

Design of dryers - cabinet dryer, fluidized bed dryer, heat pump dryer, foam mat dryer - freeze dryer - Spray dryer - design considerations, installation, operation and maintenance - design considerations of food extruders - single and twin screw extruders - installation, operation and maintenance of food extruders

UNIT IV **9 Hours**

DESIGN OF COLD STORAGE AND FREEZERS

Design of cold storage - estimation of cooling load - construction, operation and maintenance of cold storage -design consideration for controlled atmospheric storage and modified atmospheric storage of perishables - design of freezers - types of freezers - design considerations - construction and operation-design of frozen storage

UNIT V **9 Hours**

DESIGN OF SIZE REDUCTION AND CONVEYING EQUIPMENTS

Design consideration of size reduction equipment- installation and maintenance-design consideration of material conveying equipment- belt conveyor- screw conveyor - bucket elevator- pneumatic conveyor

Total: 45 Hours

Tutorial: 15 Hours

Reference(s)

1. P.S. Phirke, Processing and conveying equipment design, Jain Brothers, New Delhi, 2004
2. M.V. Joshi and V.V. Mahajani, Process Equipment Design (3rd edition), New India Publishing Agency, New Delhi, 2004
3. Jasim Ahmed and Mohammad Shafiur Rahman (Editors), Handbook of Food Process Design, John Wiley and Sons, Ltd., U.K., 2012
4. Kennath. J. Valentas and R.Paul Singh (Editors), Handbook of Food Engineering Practice, CRC Press, London, 1997
5. Zacharias B. Maroulis and George D. Saravacos, Food Process Design, Marcel Dekker, Inc. U.S.A, 2003

22FD603 FOOD INSTRUMENTATION AND ANALYSIS 3 0 2 4

Course Objectives

- Expose the principles of chemical and instrumental methods of food analysis
- Expose the methods of chemical and instrumental methods of food analysis
- Expose the techniques of chemical and instrumental methods of food analysis

Program Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the principles behind analytical techniques in food analysis.
2. Analyze the methods of selecting appropriate techniques in the analysis of food products.
3. Demonstrate the role of food analysis in food standards and regulations for the manufacture and sale of food products
4. Determine food quality control in food industries
5. Relate the current state of knowledge in food analysis

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	2	1	1		1	1			2	2	1
2	2	1	1	2	1	1	1		1			1	2	2
3	2	3	3	2	1	1	1	2	1			2	2	2
4	3	3	3	2	1	1	1	2				2	2	2
5	3	2	2	1	2	1	1	1	1			2	1	2

UNIT I **9 Hours**

INTRODUCTION

Introduction, food regulations and standards; sampling methods, and sample preparation for analysis; statistical evaluation of analytical data. General methods of food analysis- Moisture determination by different methods; ash analysis-different methods; titratable acidity in foods; determination of crude fiber and dietary fiber.

UNIT II **9 Hours**

LIPIDS, PROTEINS AND CARBOHYDRATE ANALYSIS

Analysis of oils and fats for physical and chemical parameters and quality standards, protein analysis by different techniques; analysis of carbohydrates by different techniques.

UNIT III **9 Hours**

SPECTROSCOPIC TECHNIQUES

Basic principles; application of UV-Visible spectrophotometer in the analysis of food additives; IR Spectroscopy in online determination of components of food- FT-IR tintometer in color intensity determination; application of Atomic Absorption Spectrophotometer, Atomic emission spectrophotometer and applications.

UNIT IV **9 Hours**

CHROMATOGRAPHIC TECHNIQUES

Basic principles; application of paper chromatography and TLC in food analysis; detection of adulterants in foods; Column chromatography for purification analysis- Ion exchange and affinity chromatography; HPLC and GC in food analysis; Significance of MS detectors in HPLC and GC; FAME analysis in oils and fats

UNIT V **9 Hours**

ELECTROPHORESIS, REFRACTOMETRY AND POLARIMETRY

Basic principles; application of the electrophoresis in food analysis; Brixs value of fruit juices; total soluble solids in fruit products; Refractive indices of oils and fats; specific rotations of sugars; Estimation of simple sugars and disaccharides by polarimeter.

3 Hours

EXPERIMENT 1

Estimation of pH and Titratable acidity

EXPERIMENT 2 **3 Hours**

Determination of moisture content and water activity

EXPERIMENT 3

Estimation of total sugars by titrimetric method **3 Hours**

EXPERIMENT 4 **3 Hours**
Estimation of starch by (a) titrimetric method (b) calorimetric method.

EXPERIMENT 5 **3 Hours**
Estimation of total polyphenols

EXPERIMENT 6 **3 Hours**
Determination of Free Fatty Acids

EXPERIMENT 7 **3 Hours**
Estimation of oil in oil seeds

EXPERIMENT 8 **3 Hours**
Estimation of protein by Kjeldahl method

EXPERIMENT 9 **3 Hours**
Estimation of crude fiber.

EXPERIMENT 10 **3 Hours**
Determination of antioxidant activity by the DPPH Method

Total: 75 Hours

Reference(s)

1. Pomeranz, Yeshajahu. Food Analysis: Theory and Practice 3rd Edition. Aspen Publishers / Springer, 2000.
2. Nielsen, S. Suzanne. Food Analysis 3rd Edition. Springer, 2003.
3. Otles, Semih. Methods of Analysis of Food Components and Additives, CRC Press, 2005.

22FD607 **MINI PROJECT II** **0 0 2 1**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analyzing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Program Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the real-world problem, identify the requirements, and develop the design solutions.
2. Resolve technical ideas, strategies, and methodologies
3. Construct the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Evaluate and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Generate the report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	2	2	1	2	1				1	2
2	1	1	2	3	3	1		1	3	3	3		2	2
3	3	3	2	2	3	3	1	1			3		2	3
4	1	2	1	2	1	2	2	1		2	3		1	2
5	1	3	2	1	2	2		1			1	1	2	2

Total: 15 Hours

22FD701 FOOD LAWS AND SAFETY STANDARDS 3 0 0 3

Course Objectives

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of foodborne illness - viz. physical, chemical and biological.- and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the sources of food spoilage and food toxicants.
2. Predict the food quality evaluation methods.
3. Outline the food inspection procedures to evaluate the food quality
4. Conclude the National and International Food laws and regulations.
5. Evaluate the quality control measures in food processing industry and marketing center.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1			2	1						1	1	2
2		3	1		1	3	1		2			1	1	2
3		3						1	1	1		1	2	1
4	3				2							1	1	
5	2	2	2			1			1			3		1

UNIT I **9 Hours**

FOOD SAFETY

Food safety - General principles of food safety. Characterization of food Hazards - physical, chemical and biological. Food spoilage and food borne infection hazards-sources of food spoilage and microorganisms- microbial problems in food safety-food toxicants and food poisoning - prevention. Cross contamination, Limits for pesticide and metal contamination of food. Adulteration, Food additives- types- usage, permissible limits, concept of safe food.

UNIT II **9 Hours**

FOOD QUALITY AND QUALITY EVALUATION OF FOODS

Food Quality - its need and its role in Food Industry. Food Quality and Quality Attributes Classification of Quality Attributes and their role in food Quality. Quality Assessment of Food materials-Fruits, vegetables, cereals, legumes, dairy products, meat, poultry, egg and processed food. Sensory Evaluation of Food Quality. Requirements for conducting Sensory Evaluation, Methods of Sensory Evaluation and Evaluation cards, Different methods of Quantitative descriptive analysis.

UNIT III **9 Hours**

QUALITY CONTROL

Objectives, Importance and Functions of Quality Control, Quality control specifications, training of food technologists for quality control, implementation of standards and specifications. Quality control, principles of quality control - raw material control, process control, finished product inspection, process control, quality problems and quality improvement techniques mechanization, future of quality control, Total quality management. Objective/Instrumental analysis of Quality Control.

UNIT IV **12 Hours**

NATIONAL AND INTERNATIONAL FOOD LAWS AND STANDARDS

Standards for food packaging and labeling - FSSAI, Bureau of Indian Standards (BIS), Agricultural Grading and Marketing (AGMARK), The Agricultural and Processed Food Product Export Development Authority (APEDA), MPEDA. Food and Drug Administration Act (FDA), International Organization for Standards (ISO) and its implication, Generally recognized as safe(GRAS), European Council (EU) , Codex Alimentarius Commission (CAC), Total Quality Management (TQM), Good Manufacturing Practices (GMP), Good Agricultural Practices(GAP), and Good Hygienic Practices (GHP) , GMP, Hazard Analysis Critical Control Point (HACCP), FSMA, Legal Metrology Rules, Food Safety Standards for Organic foods, GFSi, HALAL and KOSHER

UNIT V **6 Hours**

QUALITY CONTROL MEASURES IN INDUSTRIAL AND MARKETING CENTRES

Quality control system in storage, Quality control aspects in food industries, Importance of quality control in marketing of Food products - domestic and export markets. International standards for export and quarantine requirements for export of Agricultural and Horticultural produce.

Total: 45 Hours

Reference(s)

1. Manoranjan Kalia, Food analysis and Quality control, Kalyani Publishers, Ludhiana, 2002.
2. Mehta, Rajesh and J. George, Food Safety Regulation Concerns and Trade: The Developing Country Perspective, Macmillan, 2005.
3. P.A. Luning, F. Devlieghere and R. Verhe, Safety in the agri - food chain, Wageningen Academic Publishers, Netherland, 2006.
4. Leo and M.L. Nollet, Handbook of food analysis - Methods and Instruments in applied food analysis, Marcel Dekker Inc., 2004.
5. J. Andres Vasconcellos, Quality Assurance for the Food Industry: A Practical Approach, 1st Edition, 2003.
6. V Ravishankar Rai, Jamuna A Bai, Food Safety and Protection 1st Edition, CRC Press, 2017.

22FD702 **FOOD WASTE MANAGEMENT** **3 0 2 4**

Course Objectives

- Understand the importance of treating waste product from food industry
- Learn different solid and liquid management techniques
- Impart knowledge on different treatment methods and recycling of waste product from food industry

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Predict the impacts of food wastage and its causes in environment
2. Assess and analyze the different food industry wastes leads to environmental pollution
3. Outline the physical, chemical and biological principles for liquid waste treatment
4. Analyze the solid waste management techniques
5. Evaluate the by-product/waste utilization from different food processing industries

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						3	3	3				1	1	
2	1				2	3	3	1					2	
3	2		1		1	3	3	1		1	3			1
4	2		1		2	3	3	2		2	3		1	
5	2		1		1	2					2			2

UNIT I **9 Hours**

INTRODUCTION TO WASTE MANAGEMENT

Definition-Food wastage- food loss- global scenario- Sources of waste and pollutants, Classification and characterization of wastes - causes and prevention of food waste- impact of food losses and waste- food waste hierarchy-need for minimization of food waste

UNIT II **9 Hours**

FOOD INDUSTRY WASTES AND ENVIRONMENTAL POLLUTION

Food Industries- Environmental Pollution due to Food Industry wastes - characteristics and impact on soil, water, air pollution - Processes for waste utilization from fruit and vegetable industries, meat, fish, dairy, oil processing industries.

UNIT III **9 Hours**

LIQUID WASTE MANAGEMENT IN FOOD INDUSTRIES

Principles of Physical treatment - Screening, Sedimentation, Filtration, back washing, membrane separation. Principles of Chemical treatment- COD, BOD, VLSS, MLSS and ETP. Coagulation, flocculation, Precipitation, flotation, Disinfection and fluoridation. Principles of biological treatment, aerobic process, activated sludge process, trickling filters, anaerobic digestion, UASB reactor.

UNIT IV **9 Hours**

SOLID WASTE MANAGEMENT IN FOOD INDUSTRIES

Solid waste management techniques, Principles and practices, 3R concept, resource recovery. Composting methods of composting, vermicomposting- Incineration, pyrolysis Briquetting - value addition, Pelletizing, SCP, enzymes, pectin.

UNIT V **9 Hours**

BY PRODUCT/WASTE UTILIZATION

Utilization of oil cake and defatted oil cake as cattle feed and industrial uses. Utilization of sugarcane tops, bagasse, molasses and press mud - animal feed from sugarcane tops and bagasse - Utilization of Agro-industries - Utilization of furfural and activated carbon-Environmental Laws and Acts-Regulatory issues with food industry waste

EXPERIMENT 1 **3 Hours**
Preparation of Extruded product from Edible fruit and vegetable wastes

EXPERIMENT 2 **3 Hours**
Formulation of Jelly from Banana peel juice

EXPERIMENT 3 **3 Hours**
Preparation of protein concentrates from sea food waste

EXPERIMENT 4 **3 Hours**
Design and formulation of edible cutlery from fruit peels

EXPERIMENT 5 **3 Hours**
Quantification of Whey from Dairy effluents

EXPERIMENT 6 **3 Hours**
Analysis of BOD in the Food processing industrial effluent

EXPERIMENT 7 **3 Hours**
Analysis of COD in the Food processing industrial effluent

EXPERIMENT 8 **3 Hours**
Formulation of animal feed from unutilized fibre food

EXPERIMENT 9 **3 Hours**
Preparation of Fruit Jam from the Edible parts of Fruit waste

EXPERIMENT 10 **3 Hours**
Disposal methods and management of particular solid and liquid waste

Total: 75 Hours

Reference(s)

1. Ioannis S. Arvanitoyannis, Waste Management for the Food Industries, Academic Press, 2008.
2. Wang, L. K., Lo, H. H., Hung, Y. T., & Yapijakis, C. Waste treatment in the food processing industry, CRC Press,2005
3. Lawrence K.Wang, Yung-Tse Hung, Howard H.Lo and Constantine Yapijakis, Waste Treatment in the Food Processing Industry, CRC press, Taylor and Francis Group, 2006.
4. Sylvan H Wittwer, Food, Climate and Carbon Dioxide: The Global Environment and World Food Production, CRC Press, 1995.
5. S.N. Jogdhand, Environmental Biotechnology: Industrial Pollution Management, (III ed), Himalaya Publishing House, New Delhi, 2010.

22FD707 **PROJECT WORK I** **0 0 4 2**

Course Objectives

- To develop knowledge to formulate a real-world problem and project's goals.
- To identify the various tasks of the project to determine standard procedures.
- To identify and learn new tools, algorithms and techniques.
- To understand the various procedures for validation of the product and analysis the cost effectiveness.
- To understand the guideline to Prepare report for oral demonstrations.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select a real-world problem, identify the requirement and develop the design solutions.
2. Assess the technical ideas, strategies and methodologies.
3. Integrate the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Outline the test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Conclude the report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	1	1	1	2	1	2	1	2	1	1	1
2	2	2	1	2	2	1	1	2	1	1	2	1	2	2
3	3	2	2	2	1	2	2	2	1	2	2	1	2	2
4	3	3	2	3	1	2	2	2	2	2	2	1	1	2
5	3	3	2	2	2	2	1	2	1	2	1	1	2	1

Total: 60 Hours

22FD801 **PROJECT WORK II** **0 0 20 10**

Course Objectives

- Develop knowledge to formulate a real-world problem and project's goals.
- Identify the various tasks of the project to determine standard procedures.
- Identify and learn new tools, algorithms and techniques.
- Understand the various procedures for validation of the product and analysis the cost effectiveness.
- Understand the guideline to Prepare report for oral demonstrations

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select a real-world problem, identify the requirement and develop the design solutions.
2. Assess the technical ideas, strategies and methodologies
3. Integrate the new tools, algorithms, techniques that contribute to obtain the solution of the project.

4. Outline the test and validate through conformance of the developed prototype and analysis the costeffectiveness
5. Conclude the report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	1	1	1	2	1	2	1	2	1	1	1
2	2	2	1	2	2	1	1	2	1	1	2	1	2	2
3	3	2	2	2	1	2	2	2	1	2	2	1	2	2
4	3	3	2	3	1	2	2	2	2	2	2	1	1	2
5	3	3	2	2	2	2	1	2	1	2	1	1	2	1

Total: 300 Hours

22FD001 FOOD PACKAGING TECHNOLOGY 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food packaging for socio-economic needs
2. Analyze the importance of Chemical alteration in Natural macromolecular compounds.
3. Justify the importance of processing Non-renewable materials in traditional packaging.
4. Outline the new innovation in developing advanced packaging material
5. Check the response to the changes in processing foods by modern packaging techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2	1	2	1	1				1			
2	1	2	2	1	2	1								
3	1	1	1	1	3	1	3				1			
4	2	2	2		2	1	2					1	1	2
5	1	2	1								1			1

UNIT I **9 Hours**

INTRODUCTION TO FOOD PACKAGING

Introduction, Definitions, Functions of packaging - Containment, Protection, Convenience, Communication. Packaging Environments - Physical Environment, Ambient Environment, Human Environment. Functions/ Environmental Grid, Socio-Economic Needs. Deterioration reactions in foods - Deteriorative reactions & Factors. Shelf life of Food.

UNIT II **9 Hours**

PLASTIC POLYMERS

Structure and Related Properties of Plastic Polymers-Factors influencing polymers structures and related properties(Molecular structure, Molecular weight , Density , Crystallinity, Physical Transitions in Polymers, Chemical structures , and Additives in plastics).Optical , Mechanical, and Barrier properties of Thermoplastic polymers. Processing and Converting of Thermoplastic Polymers.

UNIT III **9 Hours**

EDIBLE, BIOBASED

Edible Packaging materials- Polysaccharides, Lipids, Proteins, Composite materials, Film additives, Bio-nano composites. Biobased & Biodegradable Packaging materials- Classification, Degradability, Degradability of Biobased polymers, OBD Polymers, Category 1,2,3,4,Properties of Biobased packaging materials (Barrier & Mechanical),Current Limitations, Methods to improve Functionality, Bio-nano composites, Applications. Environmental Aspects & Future trends.

UNIT IV **9 Hours**

ASEPTIC PACKAGING

Aseptic packaging- Introduction (History & Principles of Sterilization),Sterilization of packaging material food contact surface (Irradiation, Heat, Chemical Treatments, Verification of Sterilization process),Aseptic packaging systems(Carton systems, Bottle systems, Sachey & Pouch systems , Cup systems) Integrity Testing of Aseptic Packages. Packaging of Microwavable Foods- Introduction, Basic principles, Effect of food Product, Packaging (Transparent, Absorbent, Shielding & Field modification,Doneness Indicators, Testing methods & Safety)

UNIT V **9 Hours**

ACTIVE AND INTELLIGENT PACKAGING

Active and Intelligent Packaging- Definitions, Active packaging systems (Sachets and Pads, Active packaging materials, Self- Heating and Self- Cooling Packages, changing gas permeability, Wedges), Intelligent Packaging (Indicating Product Quality, Convenience, Theft, counterfeiting & Tampering, safety& regulations). Modified atmospheric packaging- Introduction, Principles, Gas used in MAP, Methods of creating MA conditions, Equipment involved, Applications, Microbiology of MAP, Safety, Refrigerated & Pasteurized Foods with Extended durability and sous vide.

Total: 45 Hours

Reference(s)

1. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, Blackwell Publishers, 2003.
2. Gordon L. Robertson, Food Packaging: Principles and Practice, Third Edition (Food Science and Technology), Taylor & Francis, CRC Press, 2013
3. NIIR Board, Food Packaging Technology Handbook (2nd Revised Edition), NIIR Project Consultancy Services, 2012.
4. Richard Coles and Mark J. Kirwan, Food and Beverage Packaging Technology, Second Edition, Wiley & Blackwell, 2011.
5. K.L. Yam and D.S. Lee, Emerging Food Packaging Technologies, Principles and Practice, A volume in Woodhead Publishing series in Food Science, Technology and Nutrition, 2012.
6. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni, Food Packaging Science and Technology, CRC Press, 2

22FD002 FOOD PACKAGING DESIGN AND DEVELOPMENT 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery ofgoods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the functions of food packaging for food processing industries
2. Demonstrate the importance of 2D & 3D sketching of Packaging Design
3. Outline the importance of fabrication techniques for food packaging materials
4. Justify the importance of printing techniques in food packaging
5. Determine the new innovation in developing advanced packaging material

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2							1
2	2	1	1	1	2	1							2	3
3	2	2	2	1	2	1	3				1			
4	1	2	2	1	2	1	2							
5	1	2	1								1		2	1

UNIT I **9 Hours**

INTRODUCTION

History-Past Innovations-Outline of traditional and modern food packaging system, Residual migration of food packaging system, Dyes- synthetic and non-synthetic. Types of Packaging materials used in foodprocessing industry.

UNIT II **9 Hours**

PACKAGING DESIGN AND PATTERN MAKING

Principles-2D and 3D sketching, Preparation of key line diagram- Primary, Secondary and Tertiary packaging materials , Basics of Computer Aided Engineering and Design. Food packaging design and simulation, CAD and CAM application in Food Industry. Food packaging design as per FSSAI guidelines.

UNIT III **9 Hours**

PACKAGING MOULDING TECHNIQUES

Introduction-Paper & Paper Board, Cartons, Glass, Metals and plastic materials for food packaging system. Types of Molding Techniques- Paper Pulping, Fabrication of corrugated Fiber board. Glass forming techniques, Thermostat & Thermopiles packaging materials. Processing of metal tin/can.

UNIT IV **9 Hours**

PRINTING TECHNIQUES IN PACKAGING MATERIALS

Introduction-Types of printing techniques involved in food packaging materials- Offset, Screen, Flexographic and Digital Printing

UNIT V **9 Hours**

NOVEL FOOD PACKAGING DESIGN

Introduction- Emerging packaging techniques, Design and principles of smart packaging system Design, Recent Innovation- Intelligent packaging, Application of Active packaging system-Anti-microbial, Anti-Oxidant, Anti- Freeze and Fortification in packed food via active materials, Development of packaging materials using novel biomaterials.

Total: 45 Hours

Reference(s)

1. W.Soroka, Fundamentals of packaging Technology, IoPP
2. Plastics: Materials and processing, pearson-prentice Hall
3. Paper and paperboard Packaging Technology, Mark J. Kirwan, Blackwell Publishing
4. Harald Johnson, Understanding Digital Printing, Thomson Publisher, Boston
5. Barnard & peacock, Hand book of print and production
6. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, Blackwell Publishers, 2003.

22FD003 DIVERSE MATERIALS IN FOOD PACKAGING 3 0 0 3

Course Objectives

- Understand the properties and characteristics of glass, wood, metal, and cardboard as packaging materials.
- Analyze the advantages and disadvantages of each material for different packaging applications.
- Evaluate the sustainability issues related to packaging, including recyclability, biodegradability, and environmental impact.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Show an awareness of the historical and strategic dimensions of food packaging, understanding its protective function, logistic implications, and impact on shelf life in food marketing systems.
2. Predict the environmental impact of paper and paperboard packaging solutions by analyzing and designing based on considerations such as fiber sources, manufacturing processes, and functional properties.
3. Justify the diverse facets of plastics in food packaging, encompassing manufacturing, and types, printing, sealing, and addressing environmental concerns.

4. Analyze the market trends, container designs, raw materials, manufacturing processes, and corrosion challenges in metal packaging, gaining a deep understanding of its role in the food industry.
5. Evaluate the knowledge in glass container packaging, recognizing glass as a marketing tool, by understanding its composition, manufacturing, closure techniques, thermal processing, and environmental considerations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	2	1	2	1							1
2	1	2	2	2	1	3	1							
3	1	1	2	1	3	1	3							
4	2	1	2			3	1							
5	1	1	2	1	1	1	3	1					1	

UNIT I **8 Hours**

FUNDAMENTALS OF FOOD

Introduction, Packaging developments-an historic perspective, Food supply and the protective role of packaging, basic functions of packaging, packaging strategy, packaging design and development, food bio deterioration and methods of preservation, packaged product quality and shelf life, Logistic packaging for food marketing systems.

UNIT II **8 Hours**

PAPER AND PAPERBOARD PACKAGING

Introduction, Paper and Paperboard- fibre source and fibre separation, Paper and paperboard manufacture-methods and process involved. Packaging papers and paperboards, properties of paper and paperboard, Additional functional properties of paper and paperboard, Design for paper and paperboardpackaging, package types, systems, environmental profile.

UNIT III **10 Hours**

PLASTICS IN FOOD PACKAGING

Introduction, Manufacture of plastics packaging, types of plastic used in packaging, coating of plastic films-types and properties, secondary conversion techniques, printing, printing and labelling of rigid plastic containers, food contact and barrier properties, sealabilty and closure, cold seal, plastic closures for bottles, jar and tubs, adhesive systems used with plastics, retort pouch, environmental and waste management issue, plastic manufacturing and life cycle assessment (CLA), plastic waste management.

UNIT IV **9 Hours**

METAL IN FOOD PACKAGING

Overview of market for metal cans, container performance requirements, container designs, raw materials for can making-steel, aluminum, recycling of packaging metal, can-making processes, end making processes, coatings, film laminates and inks, processing of food and drinks in metal packages, shelf life of canned foods, internal corrosion, stress corrosion cracking, environmental stress cracking corrosion of aluminum alloy beverage can ends, Sulphur staining, external corrosion.

UNIT V **10 Hours**

PACKAGING OF FOOD IN GLASS CONTAINERS

Definition of glass, brief history, glass packaging, glass containers market sectors for foods and drinks, glass composition, attributes of food packaged in glass containers, glass and glass container manufacture, closure section, thermal processing of glass packaged foods, plastic sleeving and

decorating possibilities, strength in theory and practice, glass pack design and specification, packaging-due diligence in the use of glass containers, environmental profile, glass as a marketing tool.

Total: 45 Hours

Reference(s)

1. Food packaging technology by Richar coles, Derek MsDowelll and Mark J. Kirwan. Blackwell publishing, CRC press, 2003.
2. Food Packaging by Takashi Kadoya, Kanagawa University, Hiratsuka, Japan. Academic press,1990
3. Glass Packaging Technology" by Walter Sperling and Werner Holleis, Wiley-VCH, 2012.
4. Corrugated Packaging: The Essential Guide" by Neil McGuire, DEStech Publications, Inc., 2013.
5. Metal Packaging: Materials, Markets and Applications" by D.R. Gabe, Smithers Rapra Technology, 2010.
6. Cardboard in Architecture: Volume 7 of the Research in Architectural Engineering Series" edited by Reza Mokhtarian and Ali Araghi, CRC Press, 2018.

22FD004 **EMERGING TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY** **3 0 0 3**

Course Objectives

- Analyze and critically evaluate current trends and innovations in food packaging technology, including emerging materials, design concepts, and sustainability practices.
- Apply theoretical knowledge to assess the impact of technological advancements on food packaging, considering factors such as shelf-life extension, preservation methods, and consumer preferences.
- Explore and synthesize information on cutting-edge developments in food packaging, fostering the ability to adapt and implement innovative technologies to address challenges in the ever-evolving food industry.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the fundamentals of quality preservation in food through new technologies in packaging
2. Show the active packaging technologies and evaluate their applications in food packaging.
3. Outline the packaging properties for various fresh foods and comprehend their significance.
4. Determine a deep understanding of edible and biodegradable coatings.
5. Relate the knowledge of new packaging technologies and anticipating future trends in the dynamicfield of food packaging.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2		1					
2	2	1	1	2	1									1
3	2	2	2	1	2	1	3		1					2
4	1	2	2			1	2		2					
5	1	2	1										2	

8 Hours

UNIT I

FUNDAMENTALS OF QUALITY PRESERVATION OF FOOD

New technologies in food packaging: overview, Mass transfer of gas and solute through packaging materials, quality of packaged foods, surface chemistry of food, packaging and biopolymer materials.

UNIT II **8 Hours**

ACTIVE PACKAGING

Introduction to active packaging technologies, antimicrobial packaging systems, packaging containing natural antimicrobial or antioxidative agents, oxygen-scavenging packaging, intelligent packaging

UNIT III **10 Hours**

MODIFIED ATMOSPHERIC PACKAGING

Introduction of Modified Atmospheric Packaging (MAP), internal modified atmospheres of coated fresh fruits and vegetables: relative humidity effects, MAP of ready to eat foods, preservative packaging for fresh meats, poultry and fin fish. Centralized packaging systems for meats.

UNIT IV **10 Hours**

EDIBLE AND BIODEGRADABLE COATINGS AND FILMS

Introduction to edible films and coatings, agro-polymers for edible and biodegradable films, edible films and coatings from plant origin proteins; animal origin proteins; starches; non-starch polysaccharides, lipid-based edible films and coatings, emulsion and bi-layer edible films, plasticizers in edible films and coatings, sensory quality of foods associated with edible films and coating systems and shelf-life extension.

UNIT V **9 Hours**

COMMERICAL ASPECTS OF NEW PACKAGING TECHNOLOGIES

Commercial uses of active food packaging and MAP systems, US Food and Drug Administration regulations - The food additive petition process, Food contact substance notifications, special considerations for antimicrobial food additives, packaging from non-thermal food processing, Future trends.

Total: 45 Hours

Reference(s)

1. Innovations in Food Packaging by Jung H. Han. Elsevier academic press, Food science and Technology, International series, 2005.
2. Food Packaging by Takashi Kadoya, Kanagawa University, Hiratsuka, Japan. Academic press,1990
3. Food packaging technology by Richar coles, Derek Ms Dowelll and Mark J. Kirwan. Blackwellpublishing, CRC press, 2003.

4. Corrugated Packaging: The Essential Guide" by Neil McGuire, DE Stech Publications, Inc.,2013.
5. Metal Packaging: Materials, Markets and Applications" by D.R. Gabe, Smithers Rapra Technology, 2010.
6. Food Packaging: Principles and Practice" by Gordon L. Robertson, CRC Press, 2012.

22FD005 PACKAGING PERFORMANCE TESTING AND MACHINERY 3 0 0 3

Course Objectives

- To provide an overview of the laws and regulations governing food packaging
- Impart knowledge about the regulatory framework for food packaging in different countries and regions, including the United States, the European Union, and other global markets.
- Learn about food safety, packaging materials and properties, labeling and claims, and emerging issues in food packaging regulations.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the regulatory framework for food packaging in different countries and regions
2. Predict the different types of food packaging materials and their properties
3. Conclude the role of packaging in ensuring food safety
4. Outline labeling and claims on food packaging
5. Evaluate emerging issues in food packaging regulations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		1	2			1	2	1						
2	1	2	2			1	2	1					2	2
3		2	2	1		1	3							1
4		1		1	1	1		1						2
5	2	2		2		1						-	2	1

UNIT I **8 Hours**
FOOD PACKAGING LAWS AND REGUALATIONS
History of Food Packaging regulations, Overview of global regulatory framework for food packaging, Types of food packaging materials and their properties. Food safety & packaging- Microbial hazards, Physical hazards & Chemical hazards associated with food packaging. Packaging as a control measurein HACCP.

UNIT II **8 Hours**
FOOD PACKAGING STANDARDS AND GUIDELINES
Overview of food packaging standards and guidelines, Food contact materials regulations, Standards for specific food packaging materials (Plastic, glass, metal, paper, etc.). Regulatory agencies and their roles in food packaging - FDA regulations & guidelines, USDA regulations & guidelines, EU regulations & guidelines and other global regulatory agencies & their roles.

UNIT III **11 Hours**
LABELING AND CLAIMS
Overview of global regulatory framework for labelling claims, Types of labeling claims and their definitions. Overview of food labeling requirements, Nutrition labeling requirements, Health and wellness claims, Environmental claims. The role of labelling claims in consumer behavior. Emerging issues in labelling claims-Novel foods & labelling claims, health claims for functional food & supplements, allergen labelling & claims, Sustainable packaging claims.

UNIT IV **10 Hours**
HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP) IN FOOD PACKAGING
Introduction to HACCP in Food packaging - Historic development of HACCP, Overview of global regulatory framework for HACCP, principles of HACCP in food packaging. HACCP plan development& implementation - Overview of HACCP plan development, Hazard analysis & identification, Critical control points and critical limits, Monitoring, corrective actions & verification. Risk assessment in Food Packaging - Overview, Types of hazards in food packaging, Risk assessment methods for foodpackaging materials and processes.

UNIT V **8 Hours**
TESTING AND QUALITY ASSURANCE
Food packaging materials, shelf life of packed food & packaging functionality, testing of physical, optical, electrical, thermal, and rheological properties for plastic packaging materials, permeation testing of synthetic polymers, testing glass as a food packaging material, metal packaging: testing and quality assurance, testing of paper as packaging material for food industry, testing and quality assurance of bioplastics, shock and vibration testing, testing migration, food package testing authorities & regulations.

Total: 45 Hours

Reference(s)

1. Food Packaging: Principles and Practice" by Gordon L. Robertson, 3rd Edition, 2012.
2. Food Packaging and Shelf Life: A Practical Guide" by Gordon L. Robertson, 2nd Edition, 2011.
3. The Certified HACCP Auditor Handbook" by ASQ Quality Press, 3rd Edition, 2016.
4. Hazard Analysis and Critical Control Point (HACCP) - A Systematic Approach to Food Safety" by Sara E. Mortimore and Carol Wallace, 3rd Edition, 2013.
5. Nutrition Labeling Handbook" by Marion Greaser and Geraldine June, 2nd Edition, 2013.
6. Consumer Behavior in Action: Real-Life Applications for Marketing Managers" by Geoffrey P. Lantos, 4th Edition, 2016.

22FD006 NEXT GENERATION PACKAGING 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on developing high barrier packaging materials to safe guard the quality offood products
- Learn about modern techniques in food packaging system.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food packaging for food processing industries
2. Find the importance of active and intelligent packaging materials in food preservation.
3. Outline the importance of edible coating and film formation.
4. Analyse the importance of Nano technology in food packaging industry.
5. Evaluate the new innovation in developing advanced packaging material

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2							
2	2	1	1	1	2	1							1	
3	2	2	2	1	2	1	3				1			
4	1	2	2	1	2	1	2							
5	1	2	1								1		1	2

UNIT I **9 Hours**

INTRODUCTION

History-Past Innovations in food packaging materials: Outline of recent techniques involved in the development of food packaging system: Active packaging, Intelligent Packaging - Freshness indicator, Sensor based - Temperature, Gas Scavengers. Traditional practice in the development of edible packaging matrix- Barrier enhancement via blends and multi-layer.

UNIT II **9 Hours**

ACTIVE PACKAGING

Introduction-Active Packaging: Types of active compounds migration studies from the packaging materials to food. Intelligent Packaging - mechanism and application in food industry. Application of RFID and Barcode in novel packaging materials.

UNIT III **9 Hours**

INTELLIGENT PACKAGING

Introduction-Intelligent Packaging: mechanism and application in food industry. Application of RFID and Barcode in novel packaging materials. Authentication using smart technologies, and Non-invasive biometric sensory tools.

UNIT IV **9 Hours**

EDIBLE COATING FILMS

Introduction- Molecular interaction of Edible source (polysaccharides, protein and lipids) during film matrix formation. Application of Nano materials in edible film and coatings. Biochemical aspects of edible packaging. Current research progress in the development of edible film coating.

UNIT V **9 Hours**

RECENT ADVANCEMENTS IN MULTI-LAYER PACKAGING

Introduction - multi-layer packaging. Emerging packaging techniques - Microwavable food packaging, Functional packaging materials - Fortification of active ingredients like flavour and color. Application of Nano techniques and Nano composite in food packaging materials.

Total: 45 Hours

Reference(s)

1. Innovations in Food Packaging. (2013). Netherlands: Elsevier Science.
2. Food Packaging: Advanced Materials, Technologies, and Innovations (2020). UnitedKingdom: CRC Press.
3. Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods (FMCG):Markets, Materials and Technologies. (2013). United Kingdom: Elsevier Science.
4. Food Packaging: The Smarter Way. (2022). Singapore: Springer Nature Singapore.
5. Ghosh, T., Katiyar, V. (2021). Nanotechnology in Edible Food Packaging: Food PreservationPractices for a Sustainable Future. Germany: Springer Nature Singapore.

6. Edible Food Packaging: Materials and Processing Technologies. (2017). United States: CRCPress.

22FD007 RADIATION PRESERVATION AND PROCESSING OF FOOD PRODUCTS 3 0 0 3

Course Objectives

- Identify the importance of non-thermal methods like irradiation as an alternative to the conventional methods of processing.
- Understand the effect of radiation as a processing and preservation method.
- Learn the importance and safety issues of the irradiated foods.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the concept of Radiation chemistry on food preservation.
2. Predict the effect of dosage of radiation on plant and animal foods.
3. Exemplify and analyze the effect of microwave in food processing.
4. Outline the effect of Infra-red radiation in food processing.
5. Evaluate the effect of radio frequency on foods.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	1	2	2			1				1	1
2	2	1	2	1	1	2			1					2
3	2	3	1	2		3			1					
4	3	2	2	1	1	2			1				3	3
5	3	2	3	2	2	2			1				2	2

UNIT I **9 Hours**

BASICS OF RADIATION CHEMISTRY

Electromagnetic energy, ionizing radiation, Concept of radiation, dielectric properties, ionization and excitation, Radiation chemistry basics - primary chemical effects and secondary effects on food, G value, irradiation parameters, instruments for measuring radiation, effect of food irradiation and potentialities for radiation processing of foods.

9 Hours

UNIT II

RADIATION CHEMISTRY OF FOOD COMPONENTS

Basics-carbohydrates, proteins, lipids, vitamins etc. Radiation effect on contaminating microorganisms like bacteria, viruses, yeasts and molds - Dosages of radiation for various plant foods and animal foods-meat and poultry, fruits, vegetables, spices, dairy products; Radiation equipment, salient features; Packaging of irradiated foods and safety issues.

UNIT III **9 Hours**

MICROWAVES IN FOOD PROCESSING

Microwave heating, nature of energy, batch and continuous ovens, microwave generators, wave guides, brief description of oven construction, application of microwave radiation and safety measures.

UNIT IV **9 Hours**

INFRA RED RADIATION

Absorption and scattering characteristics of various food materials, Polarization characteristics of IR radiation, Propagation of IR radiation in food stuffs. IR generators, applications, Relative merits and demerits.

UNIT V **9 Hours**

RADIO FREQUENCY HEATING PRINCIPLES

RF heating equipment, Advantages of Radio frequency heating of foods - Ultra violet radiation and its effect on microorganisms in foods - UV treatment application and equipment.

Total: 45 Hours

Reference(s)

1. Welter M. Urbain: Food Irradiation Academic Press, New York, 1986
2. Ohlsson and Bengtson, Microwave Processing Technologies Woodhead Publishing, Cambridge, UK, 2002.
3. Gould G.W., New Methods of Food Preservation, Aspen Publishers Inc., Maryland, 1999.
4. S.G.Llyasor and V.V. Krasnikov, Physical Principles of Infra-Red Irradiation of Food Stuffs: Hemisphere Publishing Corporation, London, 1991.
5. Philip Richardson, Thermal Technologies for Food Processing, Wood head Publishing Limited, CRC Press, 2001.
6. Robert V. Decareau, Microwave Foods, New Product Development Food & Nutrition Press Inc., USA, 1992.

22FD008 NON- THERMAL PROCESSING TECHNIQUES 3 0 0 3

Course Objectives

- Understand and apply the different non-thermal techniques in processing of foods.
- Familiarize about the equipment used for the processing of foods in non-thermal techniques
- Compare the application of alternate non-thermal processing techniques on foods

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

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PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the basic fundamentals and principles of High-pressure processing on foods.
2. Predict the importance of Pulsed electric field processing of solids and liquid foods.
3. Analyze the methodology and equipments in Ultrasound processing methods.
4. Outline the non-thermal technologies for inactivation of microorganisms.
5. Determine the non-thermal techniques by electromagnetic energy for food processing andpreservation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2			1	3			1				1	1
2	1		2	2	2	3			2					
3	1	3			2	3			1				2	2
4	2	1			1	3			1				1	1
5	2		1		2	3			2				2	2

UNIT I **9 Hours**

HIGH PRESSURE PROCESSING

Principles - Mechanism and applications of high-pressure processing to food systems - High pressure processing of salads, meats and seafoods, fruits and fruit products -Effect of high pressure on microorganisms, enzymes, textural and nutritional quality of foods - Other applications of high-pressure processing - High Pressure Freezing: principles and equipment, types of high-pressure freezing process, microbiological and enzymatic inactivation after high pressure freezing.

UNIT II **9 Hours**

PULSED ELECTRIC FIELDS PROCESSING

Principles - Mechanism - PEF treatment systems - Main processing parameters PEF technology - Equipment - Applications - Mechanisms of microbial and enzyme inactivation. PEF processing of solid foods, liquid foods and beverages. Food safety aspects of pulsed electric fields.

UNIT III **9 Hours**

ULTRASOUND PROCESSING

Principle of ultrasound - Fundamentals - Ultrasound as a processing and food preservation tool - Effectof ultrasound on properties of foods - Applications of ultrasound in microbial inactivation, assisted drying, extraction, osmotic dehydration, detection of foreign bodies, filtration and freezing - challenges in ultrasound processing.

UNIT IV **9 Hours**

ALTERNATIVE NON-THERMAL PROCESSING TECHNIQUES

High Intensity pulsed light technology:- principles of PLT technology - Technological aspects of PLT Effects of PLT technology on microorganisms and food quality. Ohmic Heating: Fundamentals of Ohmic Heating, Electrical Conductivity, Generic Configuration, Treatment of Products. Infrared Heating - Fundamentals, Basic laws for blackbody radiation; IR Heater, IR Emitters - Types and Selection Criteria, Applications and Effect on Foods

UNIT V **9 Hours**

PROCESSING TECHNIQUES BY ELECTROMAGNETIC ENERGY

Microwave heating and microwave drying: Microwaves - dielectric heating, dielectric properties of foods - thermal properties of foods - Recent developments in microwave heating - combined microwave-vacuum drying, microwave freeze-drying - applications. Radio frequency electric fields: equipment, applications for heating and drying, effect of radio frequency electrical field on inactivation of microorganisms.

Total: 45 Hours

Reference(s)

1. Emerging Technologies for Food Processing. Da-Wen Sun (Ed), Academic Press, 1 Edition, 2005.
2. Novel Food Processing Technologies. M. P. Cano, M. S. Tapia, and G. V. Barbosa Canovas, CRC Press, 1st Edition, 2004.
3. Novel Food Processing Technologies. M. P. Cano, M. S. Tapia, and G. V. Barbosa Canovas, CRC Press, 1st Edition, 2004.
4. P.J. Fellows, Food processing Technology: Principles and practice, Second edition, Wood head publishing limited, Cambridge, 2009.

22FD009 THERMAL PROCESSING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the basic fundamentals and principles of thermal processing foods.
2. Analyze the importance of various thermal applications using steam/water and their effects on food.
3. Outline the methodology and equipment applied on thermal processing methods using hot air.
4. Choose the alternate thermal techniques to a food and analyze their hygienic and safety aspects.
5. Relate the thermal resistance and its kinetics on micro-organisms and its resistance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2				3							1	1
2	1		2	2		3								
3	1	3			1	3			1				2	2
4	2	1			1	3			1				1	1
5	2		1		1	3							2	2

UNIT I **9 Hours**

INTRODUCTION TO THERMAL PROCESSING TECHNIQUES

Introduction. Thermophysical Properties of Foods - Definition and Measurement. Dielectric Properties. Heat Transfer - Conduction, Convection and Radiation, Basic Heat transfer Modes, Heat Transfer with phase changes, Heat changes with Electromagnetic Waves, Mass Transfer - Molecular Diffusion, Convection Mass Transfer

UNIT II **9 Hours**

THERMAL PROCESSING USING STEAM OR WATER

Blanching - Theory, Methods, Equipment, Effect on Enzyme Inactivation, Testing the Effectiveness of Blanching. Pasteurization - Theory, Methods, Equipment, Effect on Foods. Sterilization - In-container sterilization (Retorting), Ultra High Temperature (UHT), canned foods, Process and Equipment, Effect on foods. Evaporation and Distillation - Theory, Equipment, Effect on Foods, Extrusion - Rheological Properties of food, Equipment, Applications, Effects on foods.

UNIT III **9 Hours**

THERMAL PROCESSING USING HOT AIR

Dehydration or Drying - Fundamental concepts, Drying characteristics, Moisture Sorption Isotherms, Method - Sun drying, Hot air Drying, Fluidized bed drying, Spray drying, Freeze drying, Dielectric drying, Hybrid Drying technology. Baking and Roasting - Theory, Equipments, Effects on Physical properties and nutritional value

UNIT IV **9 Hours**

OTHER THERMAL PROCESSING METHODS

Frying - Shallow frying, Deep Frying, Equipment and design, Effect of Heat on oil, Effect of Heat on fried Foods. Cooking - Theory, Methods, Effect on nutritional value, Quality Retention. Safety Aspects of Thermal Processing - Legislation and codes of Practice, Implementation of GMP aseptic packaging, HACCP Techniques, Process Audit, Aspects of GMP, Thermal process Validation

UNIT V **9 Hours**

HEAT RESISTANCE OF MICROORGANISM

Introduction, Temperature Distribution and Heat Penetration, Kinetic of Reaction, Ball’s Formula, Thermal Death Time, Thermal Death Point, Heat Resistance of Microorganism, Heat Resistance of Enzyme, D value, Z value, F value, TDT curve & 12-D concept.

Total: 45 Hours

Reference(s)

1. P.J. Fellows, Food processing Technology: Principles and practice, second edition, Wood head publishing limited, Cambridge, 2009.
2. Donald Holdsworth & Ricardo Simpson, Thermal Processing of Packaged Foods, Second Edition, Springer, 2015.
3. Da-Wen Sun, Thermal Food Processing, CRC Press, 2006.
4. P Richardson, Thermal Technologies in Food Processing, Woodhead Publishing Limited, Cambridge, 2001.

22FD010 **FOOD SENSORS** **3 0 0 3**

Course Objectives

- Understand the need and scope of sensor- based detection methods in the food processingindustries.
- Impart theoretical knowledge on fundamental or basic sensors used in quantification andqualification of food
- Learn about modern development in the food-based sensors in the industry.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the fundamentals and applications of the sensors in the food industry
2. Implement the different types of basic sensors used in the quantification and qualification of food compounds.
3. Outline the basic circuit and working principle of sensors with its construction
4. Analyze different types of quantification and qualification sensors used in finding the adulteration in food
5. Evaluate and compare modern development and invention carried out in sensor-based industries

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2		2	1							1	1
2	1	2	2		2	1			1					
3	1	2	1		3	2			1				1	
4	2	2	2		2	1			1					
5	1	2	1						2					

UNIT I **9 Hours**

INTRODUCTION TO SESNORS

Introduction. Need of sensors - Sea food Poisoning, Food Poisoning, Adulteration, and Qualification. Research challenges - Development and Troubleshoots. Sensors - Working and Principles. Applications Food Industry, Pharma industry, Chemical Industries. Detection Methods

UNIT II **9 Hours**

BASIC SENSORS USED IN QUANTIFICATION AND QUALIFICATION

Quantification - Weighing Sensor, Measuring Sensor - Construction and working principles and methods used in sensors. Qualification - pH Sensor, Titratable Acidity Sensor, Color Sensor, AutomaticBrix calculating sensor, biosensor, Amperometric Sensor, thermocouple sensor - construction and working principles of each sensor.

UNIT III **9 Hours**

CIRCUIT ANALYSIS OF A SENSOR

Introduction to Planar Interdigital Sensors - Parallel plate capacitors, Planar Interdigital Sensor. Calculation of capacitance using circuit analysis. COSMOL Multiphysics - Modelling using cosmol Multiphysics Sensor Design and Fabrication - Design and Fabrication process, Conventional Interdigital Sensors, Novel planar interdigital Sensors.

UNIT IV **9 Hours**

QUNTIFICATION AND QUALIFICATION METHODS

Titratable Acidity, Brix and consistency, pH calculation, Color Prediction, Texture analysis - effect of sensors in analysis. Calorimetric and electrochemical quantification. Paper Chromatography - Working procedure with sensor region

UNIT V **9 Hours**

MODREN INVENTIONS IN SENSORS

Gas chromatography with mass spectrometer - Construction and working procedure. Plasma Sensors - Plasma polymer film coated sensor, applications. Pattern Recognition in gas sensing - application of gas sensing in ripening process. Electronic Nose and Electronic tongue

Total: 45 Hours

References

1. Mehrnetmutlu,(2010)“Biosensors in food processing, safety, and quality control”-CRC Press
2. Erika Kress-Rogers (2001). Instrumentation and sensors for the food industry, CRC Press Publishers.
3. I.E. Tothill (Editor) (2000.) Rapid and On-Line Instrumentation for Food Quality Assurance (Woodhead Publishing in Food Science and Technology). Woodhead Publishing, England.

22FD011 **3D PRINTING OF FOODS** **3 0 0 3**

Course Objectives

- Understand the culinary potential of 3D food printing for personalized nutrition and creativefood design.
- Analyze the printability of different food materials and optimize their properties for printing.
- Evaluate the current state of 3D food printing technology and its potential for futureapplications.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the basic fundamentals and principles of thermal processing foods.
2. Predict the importance of various thermal applications using steam/water and theireffects on food
3. Outline the methodology and equipment applied on thermal processing methods using hot air.
4. Evaluate the alternate thermal techniques to a food and analyze their hygienic and safety aspects.
5. Check the thermal resistance and its kinetics on micro-organisms and its resistance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2		2	1			1				1	1
2	1	2	2		2	1			1					
3	1	2	1		3	2			2				1	
4	2	2	2		2	1			1					
5	1	2	1						2					

UNIT I **9 Hours**

INTRODUCTION TO 3D FOOD PRINTING

Overview of 3D food printing technology. History and evolution of 3D food printing. Applications of 3D food printing in the food industry, healthcare, and other sectors. Benefits and challenges of 3D food printing

UNIT II **9 Hours**

3D FOOD PRINTING HARDWARE AND SOFTWARE

Types of 3D food printers and their working principles. Key components of a 3D food printer, including extruder, build platform, and print head. Different food materials used in 3D printing and their properties. 3D food printing software for designing and slicing food models.

UNIT III **9 Hours**

3D FOOD PRINTING PROCESS AND DESIGN PRINCIPLES

Workflow of the 3D food printing process, from design to printing. Factors affecting the printability of food materials. Design principles for creating 3D printable food models. Techniques for optimizing food models for printability

UNIT IV **9 Hours**

CULINARY APPLICATIONS OF 3D FOOD PRINTING

Creating visually appealing and personalized food presentations. Customizing food textures and shapes for dietary needs and preferences. Enhancing nutritional value and incorporating functional ingredients. Exploring culinary creativity and developing innovative 3D-printed food products.

UNIT V **9 Hours**

FUTURE DIRECTIONS AND CHALLENGES IN 3D FOOD PRINTING

Advancements in 3D food printing technology and materials. Emerging applications of 3D food printing in personalized nutrition and healthcare. Regulatory and safety considerations for 3D-printed food products. Addressing challenges in scalability, cost-effectiveness, and consumer acceptance.

Total: 45 Hours

Reference(s)

1. C. Anandharamakrishnan, Jeyan A. Moses, T. Anukiruthika, 3D Printing of Foods, John Wiley& Sons Ltd., 2022.
2. Kamalpreet Sandhu, Sunpreet Singh, Food Printing: 3D Printing in Food Industry, Springer, 2022.
3. Xie, Y., Liu, Q., Zhang, W., Yang, F., Zhao, K., Dong, X., ... & Yuan, Y. (2023). Advances inthe Potential Application of 3D Food Printing to Enhance Elderly Nutritional Dietary Intake. Foods, 12(9), 1842.
4. Ghilan, A., Chiriac, A. P., Nita, L. E., Rusu, A. G., Neamtu, I., & Chiriac, V. M. (2020). Trendsin 3D printing processes for biomedical field: opportunities and challenges. Journal of Polymersand the Environment, 28, 1345-1367.
5. Belda-Perez, R., Heras, S., Cimini, C., Romero-Aguirregomezcorta, J., Valbonetti, L., Colosimo, A., ... & Coy, P. (2023). Advancing bovine in vitro fertilization through 3D printing: the effect of the 3D printed materials. Frontiers in Bioengineering and Biotechnology, 11.

22FD012 **APPLICATION OF NANOTECHNOLOGYAND CRYOGENICS IN FOOD PROCESSING** **3 0 0 3**

Course Objectives

- Understanding of nanotechnology applications in food, covering Nano encapsulation, cryogenic methods, and their integration.
- Explore safety considerations, regulatory compliance, and ethical aspects associated with nanotechnology and cryogenics in food processing.
- Investigate emerging trends in sustainable food technologies, including the use of eco-friendly nanomaterials and cryogenic practices.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select the basic principles of Nano Technology in enhancing the food quality and standard

2. Apply the principles of cryogenics food processing and different techniques used incryogenic food processing

3. Analyze and integrating nanotechnology and cryogenics in food processing to design and implementsynergistic approaches.

4. Outline the different types of applications including the ability to assess toxicological risks in food processing

5. Evaluate the advancements in sustainable nanomaterials, eco-friendly cryogenic technologies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2		2	1							1	
2	1	2	2		2	1								
3					3	2		1	2	1			1	
4					2	1		2	1	1				1
5								1	2	1				

UNIT I **9 Hours**

NANOTECHNOLOGY IN FOOD PROCESSING

Introduction, Nano technology - application, needs and scope, different methods. Encapsulation - Need of Encapsulation, Advantages. Nanoencapsulation Techniques - Core Shell Nano encapsules for controlled release, Lipid-based nanostructures. Nano Structured food ingredients - Nano emulsions and nanoscale delivery system. Nanomaterials for food packaging - Antimicrobial nanoparticle, Nano composite films.

UNIT II **9 Hours**

CRYOGENICS IN FOOD PROCESSING

Introduction, applications, advantages and disadvantages. Different techniques - Flash freezing - Rapid Freezing, cryogenic freezing, Cryogenic grinding technique - application and working principles, cryopreservation of flash procedure - applications in food processing

UNIT III **9 Hours**

NANOTECHNOLOGY-CRYOGENICS INTEGRATION

Nanoparticle Assisted Cryopreservation - impact of nanomaterials and preservation efficiency. Nano Carriers - design, cellular integrity, nanoscale delivery. Smart Cryogenic packaging - Real time monitoring, intelligent packaging system. Synergistic effects on food quality - overall quality, interaction between two methods

UNIT IV **9 Hours**

SAFETY AND REGULATORY CONSIDERATIONS

Toxicology of nanoparticles in food - potential risks, safe exposure levels. FSSAI - standards and regulation for normal foods. Regulatory framework - Nanotechnology - food safety regulations, Labelling and consumer awareness

UNIT V **9 Hours**

FUTURE TRENDS AND CHALLENGES

Innovations in Nanomaterials - Development of novel nanoparticles - Extraction and isolation of nano particles. Biodegradable nanomaterials for sustainability. Advancements in Cryogenic Technologies - Integration and Energy Efficient cryogenic process. Addressing Ethical Concerns - Public Perception, Ethical considerations

Total: 45 Hours

Reference(s)

1. McClements, D. J.(2015). "Nanotechnology in the Food Industry: A Review" Comprehensive Reviews in Food Science and Food Safety, 14(4), 438-456.
2. Nanotechnology in the Food, Beverage, and Nutraceutical Industries by Qingrong Huang andQin Wang
3. Sun, D. W. (2016). "Emerging Technologies for Food Processing." Academic Press.
4. Handbook of Frozen Food Processing and Packaging by Da-Wen Sun.
5. Nanoscience in Food and Agriculture 4 by Shivendu Ranjan, Nandita Dasgupta, and EricLichtfouse.

22FD013 TRADITIONAL CONFECTIONARIES 3 0 0 3

Course Objectives

- Understand the influence of sugar in confectionery
- Apply the principles of ingredients chemistry.
- Troubleshoot the problems faced during processing of various traditional confectioneries

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the significance of bulk sweeteners used in confectionery
2. Apply the functional properties of confectionery ingredients.
3. Outline the production and quality parameters of sugar based confections
4. Analyse the ingredients and processing of aerated confections
5. Evaluate the stability of cocoa based products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2		2			2	1			2		1
2	2	2							1			2		1
3	2	2	2	2					1			2		1
4	2	2	2						2			2		1
5	2			2					1				2	1

UNIT I **7 Hours**

BULK SWEETENERS

Significance of bulk sweeteners and application- Types of bulk sweeteners- Monosaccharides, Disaccharides, Invert sugar, Glucose syrup- Natural and alternative sweeteners- High-intensity sweeteners- Physicochemical properties and applications.

UNIT II **11 Hours**

INGREDIENTS CHEMISTRY AND FUNCTIONALITY

Fats and Oils-chemical properties, lipid oxidation, polymorphism, phase behaviour- Crystallization of fats; Modification technologies- hydrogenation, fractionation, inter-esterification; Emulsifier-uses, types, and applications; Starches - separation of starches, property of starches and modified starches; Protein-chemistry, functional properties, application in confections; Pectin - chemistry and analyses; Gums - agar agar, alginates, carrageenan, gum arabica, gum tragacanth, guar gum; Other ingredients.

UNIT III **9 Hours**

SUGAR BASED CONFECTIONS

Compressed tablets and Lozenges-introduction, formulation and ingredients, processing, product characteristics, problem and trouble-shooting; Hard candy- formulations and ingredients, processing, product characteristics, trouble-shooting; Fondants and Creams- introduction, formulation, ingredients, manufacturing, product characteristics and potential problems; Caramel, Fudge and Toffee - ingredients, mixing, emulsification, cooking and browning, cooling and forming, colour and flavor generation, microstructure, shelf-life, trouble shooting.

UNIT IV **9 Hours**

AERATED CONFECTIONS

Introduction, Ingredients - sweeteners, stabilizers, humectants, emulsifiers, organic acids, gelation aids, active ingredients - processing, physical properties and shelf-life, problems and trouble-shooting; Jellies, Gummies, Licorices, Chewing and Bubble gums - ingredients, processing, product features. Sugar and Sugar free panned confections- pre-coat materials, colours, flavors, glaze and polish, Sugar shell application, special decoration, multicomponent layering, micro-stricture, soft panned and hard panned candies.

UNIT V **9 Hours**

CHOCOLATE AND COMPOUND COATINGS

Introduction, Cocoa bean production, composition and quality aspects; Chocolate processing- Tempering, Forming; Chocolate characteristics; Stability and shelf-life; Compound coatings- formulation, manufacturing, applications, coating characteristics, shelf-life; Chocolate panning- operation, types, finishing, storage and handling.

Total: 45 Hours

Reference(s)

1. Richard W. Hartel, Joachim H. von Elbe Randy Hofberger. (eds), Confectionery Science and Technology, Springer, 2017.
2. Amerine, M.A.; Pangborn, R.M.; Roessler, E.B., Principles of Sensory Evaluation. Academic Press, New York, 1965.
3. Martens, M.; Dalen, G.A.; Russwurm, H. (eds): Flavour Science and Technology. John Wiley and Sons, Chichester, 1987.

22FD014 RHEOLOGICAL PROPERTIES OF BAKERY AND CONFECTIONERY PRODUCTS 3 0 0 3

Course Objectives

- Understand the concepts of Food Rheology and various methods to measure rheological & textural properties of Food
- Exemplify the concepts of dough rheology and effects of various factors on rheological and textural properties of dough.
- Grasp knowledge regarding various instruments used in determination of food rheology.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select the food rheology and role of ingredients in rheology of bakery products.
2. Apply and interpret rheological properties of bakery products.
3. Analyze the appropriate techniques in assessing rheological properties of bakery products.
4. Outline the various factors and working of equipment in rheological properties of bakery products.
5. Evaluate the concepts of various testing methods to estimate the rheological properties of bakery products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1		1				1		2		2	2
2	2	2			1				1		2		2	2
3	2	2	1		1				1		2		2	2
4	2	2	1		1				1		2		2	2
5	2	2	1		1				1		2		2	2

UNIT I **9 Hours**

INTRODUCTION TO FOOD RHEOLOGY

Food rheology concept, scope of food rheology, texture of foods-types of stress, types of strain, types of viscosity, modulus (young, shear, bulk), poisson"s ratio, definition and importance of texture, texture-related concepts. Determination of rheological properties and measuring methods: destructive and non-destructive measurements, creep recovery and stress relaxation, dynamic mechanical tests, Modeling food texture: introduction, factor affecting texture, models to predict texture.

UNIT II **9 Hours**

RHEOLOGICAL PROPERTIES OF SOLID FOOD

Rheological properties of solid food: deformation of material, viscoelastic behavior, Failure and glass transition in solid foods: failure in solid foods, glass transition of solid foods (measurement, factor affecting, importance), Texture of foods: compression, snapping-bending, cutting shear, puncture, penetration, texture profile analysis.

UNIT III **9 Hours**

BASIC APPROACHES TO RHEOLOGY OF DOUGH AND GLUTEN

Dough structure and basics of rheology. Creep and recovery, viscometry, stress relaxation, oscillatory measurements. Empirical and fundamental testing. Rheological behavior of dough and gluten. Rheological properties of dough from high extraction, whole wheat and composite flours. Importance of dough and gluten viscoelasticity in gas retention and bread making.

UNIT IV **9 Hours**

BAKERY INGREDIENTS, PROCESSING PARAMETERS AND DOUGH RHEOLOGY

Effects of water, yeast, oxidation and compounds with disulfide and thiol groups, sugar and emulsifiers on rheological properties of dough. Influence of proteins, gluten, starch, and enzymes on rheological properties of dough. Effects of mechanical work, mixing time and temperature on dough rheology.

UNIT V **9 Hours**

RHEOLOGICAL TESTING

Rheological methods- Fundamental testing and empirical methods, Rheological testing equipment, compression, penetration, modified penetrometers, transient tests, dynamic tests, extensional viscosity, dough testing instruments- farinograph, mixograph, extensograph, alveograph, amylograph.

Total: 45 Hours

Reference(s)

1. Rao, M. A., Rizvi, S. S. H. and Datta A. K. 2005. Engineering Properties of Foods: CRC Press.
2. Heldman, D. R. (2007). Food Process Engineering:AVI Publications.
3. Faridi, H. and Faubion, J. M. (1997). Dough Rheology and Baked Products: CBS Publications, New Delhi.

22FD015 DESIGN OF BAKERY AND CONFECTIONERY EQUIPMENT 3 0 0 3

Course Objectives

- Understand the working of Food Processing equipment and various parameters for designing Food processing equipment
- Analyze and evaluate the design concepts of both baking and confectionery equipment
- Simulating novel techniques and concepts to design an efficient baking and confectionery equipment.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select food process equipment based on constructional and operational characteristics
2. Assess the sizing, construction and costing of food process equipment
3. Apply the criteria for design of food process equipment
4. Outline the various factors and working of equipment in bakery and confectionery products.
5. Evaluate the concepts to design the equipment for bakery and confectionery products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1		1				1		2		2	2
2	2	2	1		1				1		2		2	2
3	2	2	1		1				1		2		2	2
4	2	2	1		1				1		2		2	2
5	2	2	1		1				1		2		2	2

UNIT I **9 Hours**

BASICS ABOUT FOOD PROCESSING EQUIPMENT

Construction characteristics. Operational characteristics- reliability, convenience, safety, instrumentation, ergonomics, efficiency, accuracy, environmental impact. Testing of equipment. Equipment specifications. Sizing and costing of Equipment, materials of construction, Fabrication of equipment- Strength of Construction, Fabrication and Installation of Equipment, Hygienic Design of Food Processing Equipment.

UNIT II **9 Hours**

DESIGN OF FOOD PROCESS EQUIPMENT

Heat exchangers- heat transfer factor. Baking oven - load of baking chamber, load by products, load by heat loss, total thermal load, types of heating source. Types of agitators. Power requirements for agitation. Design of agitation system components-shaft design and agitator design. Challenges faced during design of equipment

UNIT III **9 Hours**

EQUIPMENT USED FOR BAKING

Measuring tools- dry measuring cup and liquid measuring cup, measuring spoon, scale thermometers- oven thermometers, candy thermometers, timer; Hand tools - rolling pin, whisk, cookie cutter; Baking pans-aluminum pan, insulated pan, disposable pan, muffin pan, loaf pan; Mixers - vertical mixers, spiral mixers, horizontal mixers, electric mixers - electric handheld mixers, electric stand up or table top mixer, dough sheeter, proofer, retarder, ovens- deck oven, rack oven, mechanical oven, convection oven; Kettles, fryers.

UNIT IV **9 Hours**

EQUIPMENT USED FOR CONFECTIONERY

Extruder, temper, enrober, pastry blender, pastry cutter, cooling simulator, chip depositor, rollers, frozen cone unit, feeder mixer, aeration and aroma system, filling and weighing station, melting tank, wafer & biscuit feeder, chocolate stringer, packaging equipment.

UNIT V **9 Hours**

ANALYSER FOR BAKING AND CONFECTIONERY PRODUCTS

Moisture test, grain hardness testing, viscograph, amylograph, farinograph, dough mixers, dividers, rounders, proofing, moulding, ovens, slicers, packaging materials and equipment, chocometer, chocoanalyser

Total: 45 Hours

Reference(s)

1. George D, Saravacos. Handbook of food processing equipment, 2nd Ed, Springer Science and Business Media, 2016.
2. Ed Bausbacher and Roger Hunt, Process plant layout and piping design, 1st Ed, New Jersey, 1993
3. Manley, Duncan., Technology of Biscuits, Crackers and Cookies, Woodhead Publishing Ltd., England, third edition, 2000.

22FD016 INDUSTRIAL PRODUCTION OF BAKED GOODS 3 0 0 3

Course Objectives

- Impart knowledge on the principles of baking process
- Introduce baking techniques to produce bread, biscuits and crackers
- Familiarize with standards and regulations applied in food industry

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select the principles of baking and analyze the role of ingredients in baking
2. Apply the processing methods for the production of biscuits and cookies
3. Assess the production process for different types of puffs and crackers
4. Analyze the processing parameters of breads and buns
5. Evaluate the standards and quality control for bakery products

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1						1		2		1	2
2	1	1	2						1	2	1		1	2
3	1	1	2	2					1		1		2	1
4	2	1	1		2				1		2		1	2
5	1	2	2						1		1		2	1

UNIT I **9 Hours**

INTRODUCTION TO INDUSTRIAL BAKING

Overview of Baking processes - Principles of Baking - Ingredients and Formulation : role of flour, yeast, fats, sugars and additives - Equipment and Machinery - Industrial scale baking equipment, ovens, mixers, proofers and their functions.

UNIT II **9 Hours**

BISCUITS AND COOKIES

Biscuits and cookies - role of ingredients. Industrial Production of biscuits - Hard biscuits, Soft biscuits. Types of biscuit dough - Developed/ Hard dough- semi-sweet, fermented and puff; Soft dough, short dough biscuits. Quality tests for biscuits and cookies. Faults and remedies.

UNIT III **9 Hours**

CRACKERS AND PUFFS

Introduction - Types of crackers. Manufacturing process of Cream crackers, Soda crackers and Water Biscuits, Puff pastries - Methods, types: Vol-au-vent, palmiers, Napolean pastry. Quality test for Crackers and Puffs. Faults and remedies

UNIT IV **9 Hours**

BREADS AND BUNS

Bread and Bun - origin, varieties, characteristics, regional variations - Ingredient functionality - Dough mixing techniques. Baking Process and Technology - Fermentation and proofing, shaping and forming. Quality control and assurance - Quality parameters, Quality assurance practices, Troubleshooting in production.

UNIT V **9 Hours**

PACKAGING AND QUALITY CONTROL FOR BAKERY PRODUCTS

Packaging equipment, requirements and materials. FSSAI Standards and regulations for bakery products. Regulatory compliance and market trends. Operations management in baking industry - supply chain management, cost control and efficiency. Layout for Baking and Confectionery plant.

Total: 45 Hours

Reference(s)

1. Manley, Duncan., Technology of Biscuits, Crackers and Cookies, Woodhead Publishing Ltd., England, third edition, 2000.
2. Ashokkumar Y, Textbook of Bakery and Confectionery, Prentice Hall India Learning Private Limited; 2 edition (2012)
3. Iain Davidson, Biscuit, Cookie, and Cracker Production: Process, Production, and Packaging Equipment, Academic Press, Elsevier, 2018

22FD017 **SUGAR TECHNOLOGY** **3 0 0 3**

Course Objectives

- Understand important unit operations involved in sugarcane processing
- Know the production of sugar from sugarcane, beet and palm
- Explore the large scale processing of sugar from sugarcane

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Select the suitable machineries for pre-processing and transportation of sugarcane
2. Assess the appropriate crushers for cane juice extraction and determine its efficiency
3. Apply the cane juice clarification using different clarifying agents
4. Analyze and apply the filtration and evaporation in sugarcane processing
5. Evaluate crystallization for the large scale production of sugar

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2		2					1				1	1
2	2	2		2	2	2			1				1	1
3	2	2		2	2	2			1				2	1
4	2	2		2	2	2			1				2	1
5	2	2		2					1				1	1

UNIT I **7 Hours**
PRE-PROCESSING OPERATIONS
Sugarcane - Constituents - Harvesting indices - Cane cutting - Manual, Mechanical - Transportation - loading - Unloading - Cane conveyor - Washing - Shredders - Types.

UNIT II **7 Hours**
JUICE EXTRACTION
Crushing - Crushers - Types, Crushing efficiency - Extraction of juice - methods, Accumulators - types - Maceration - Theory of cane diffusivity - different diffuser - ring diffuser - weighing of juice.

UNIT III **7 Hours**

CANE JUICE CLARIFICATION
Clarification - methods - clarifying agent - bleaching agent - Role of pH, non-sugars, colloids and gums in cane juice clarification. Liming of cane juice - CO2 P2O5 and its importance.

UNIT IV **12 Hours**
FILTRATION AND EVAPORATION PROCESS IN CANE INDUSTRY
Filtration of mud - Filter types - filter press, rotary vacuum filter - Rapi - Floc process. Filter cake washing. Evaporation - Evaporation rate - types of evaporators used in cane sugar industry - Cleaning of evaporators Entrainment separator - methods - Boiling in Vacuum pan - Footing magma - Massecuite. A,B,C - Mother liquor, Molasses A,B,C Molasses exhaustibility.

UNIT V **12 Hours**
SUGAR PRODUCTION
Crystallization - Super saturation - Crystallizers type - batch and continuous. Centrifuge - types. Drying of sugar - conveyors for sugar - by-product from sugar mills - utilization. sugar production from beet, palm and coconut. Physical & chemical properties of sugars, Manufacture of sugar-free, sugarless carbonated beverages, Sugars and sweetening agents, Sugar alcohols.

Total: 45 Hours

Reference(s)
1. Meade and Chen, Hand of book of cane sugar, 11th Ed , Wiley Interscience, New York, 2001
2. John H. Payne, Unit operation in cane sugar production, Sugar series book 4, Elsevier Pub. Co., New York, 1982.
3. Baikow, V.E. 1967. Manufacturing and refining of raw cane sugar. Elsevier Publishing Company, New York
4. McCabe, W.L. and J.e. Smith 1976. Unit operations in chemical engineering. McGraw Hill Kogakusha Ltd., Tokyo.
5. R B L Mathur, Hand Book of Cane Sugar Technology, 2 nd Ed, Oxford & IBH, 1978

22FD018 BAKERY SCIENCE AND INGREDIENT TECHNOLOGY 3 0 0 3

Course Objectives

- Impart knowledge on the principles of baking process
- Introduce ingredients for the manufacturing of various bakery products
- Familiarize with advances and sustainability in the baking technology

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the bakery science principles and ingredient roles
2. Predict the impact of ingredient selection and functionalities
3. Analyze the technical competence in executing baking process, trouble shooting and ensuring quality
4. Outline the innovative approaches to create specialty bakery products
5. Evaluate the critical analysis and problem solving skills in promoting sustainability practices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1								2		1	2
2	1	1	2		1					2	2		1	2
3	1	1	2	2	1						2		2	1
4	2	1	1		2					2	2		1	2
5	1	2	2		2					2	2		2	1

UNIT I **9 Hours**
INTRODUCTION TO BAKERY SCIENCE
Introduction to fundamentals of bakery science; Historical overview and evolution of baking techniques; role of bakery science in modern food production; basic principles of baking: heat transfer, mixing and fermentation.

UNIT II **9 Hours**
INGREDIENTS IN BAKING
Flour - types, properties and gluten formation. Yeast - functions, fermentation and types. Sugars and Sweeteners - effects on texture and taste; Fats and Oils: role in structure and flavour development; Leavening agents and their impact on baked goods

UNIT III **9 Hours**
BAKING TECHNIQUES AND PROCESSES
Dough development and handling techniques; Fermentation and Proofing; Baking equipment and their functions; Temperature control and its impact on baking; Troubleshooting common baking issues.

UNIT IV **9 Hours**
SPECIALITY BAKING AND PRODUCT DEVELOPMENT
Gluten-free and alternative ingredient baking; Artisanal and traditional baking techniques; Innovation and recipe development; Quality control and sensory evaluation in baking; Marketing and consumer trends in bakery products.

UNIT V **9 Hours**
ADVANCEMENT IN BAKING SCIENCE
Preservation techniques in baking; Enzymes and their role in baked goods; Nutritional aspects and health considerations; Food safety and hygiene in bakery operations; Sustainable practices in bakery.

Total: 45 Hours

Reference(s)

1. Ashokkumar Y, Textbook of Bakery and Confectionery, Prentice Hall India Learning Private Limited; 2 edition (2012)
2. Paula Figoni, How baking works (Exploring the fundamentals of baking science), John Wiley & sons, 2007
3. Iain Davidson, Biscuit, Cookie, and Cracker Production: Process, Production, and Packaging Equipment, Academic Press, Elsevier, 2018
4. Geoff Talbot, Science and technology of enrobed and filled chocolate, confectionery and bakery products, Woodhead Publishing, 2009
5. Hui, Y.H., De Leyn, I., Pagani, M.A., Rosell, C.M., Selman, J.D., Therdthai, N. Bakery Products Science and Technology, Wiley Blackwell, 2nd Edition, 2014

22FD019 **TEA AND COFFEE PROCESSING** **3 0 0 3**

Course Objectives

- Introduce to tea & coffee cultivation, harvesting, production, processing and packaging.
- Learn to assess the classification of tea & coffee and tea - coffee pharmacology.
- Understand to characterize quality assurance and quality control of tea & coffee processing.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the importance of tea & coffee as a beverage in India.
2. Predict the different tea & coffee processing and production methods.
3. Outline the role of tea & coffee in pharmacology.
4. Conclude the health effects of tea and coffee.
5. Evaluate the quality assurance and quality control of tea and coffee.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1				
3	1		1	2	3	2		1		1			1	
4	2		2	2	2	1		1		1				
5	1		1	2				1		1				

UNIT I **9 Hours**

INTRODUCTION OF TEA & COFFEE

Introduction - History of the tea & coffee trade and its origin - Chemical composition - Climates of tea & coffee cultivation and harvesting process - Geographical distribution of tea plantations. Production - Morphology and anatomy - Classification - Health effects - By Products utilization of tea & coffee - Economics.

UNIT II **9 Hours**

PRODUCTION AND PROCESSING OF TEA LEAVES

Black tea - green tea - Oolong tea. Chemistry of tea manufacturing and tea quality - Tea processing - Picking - Withering - Rolling/ Bruising - Fermentation - Fixation - Drying - Packaging. Equipment used in tea processing - CTC machine - Orthodox Machine. Biochemical changes during fermentation. Instant tea - Tea concentrates - Decaffeinated tea - flavored tea - Herbal tea. Storage of tea - Sorting and Grading of Tea.

UNIT III **9 Hours**

PROCESSING OF COFFEE

Introduction - Coffee fruit and morphology – Chemical composition and Nutritional value of coffee – Green coffee processing - Harvesting the cherries - Types of coffee - Processing the cherries - Wet and dry processing - Sorting - Pulping - Fermentation - Drying - Milling – Storage. Physiochemical changes during drying – Decaffeination. Instant coffee – Extraction and aroma recovery – Evaporation – Freeze drying – Spray drying and agglomeration.

UNIT IV **9 Hours**

TEA & COFFEE PHARMACOLOGY

Chemical composition of tea leaf & coffee - Inorganic constituents - Enzymes - Polyphenols - Aromatic compounds. Pharmacology of tea and coffee. Biochemical changes during chemical withering – volatile flavor compounds – Chlorophyll – Caffeine – Lipids – Catechins and enzyme activity – Carotenoids. Bioavailability of antioxidants in tea & coffee. Focus on international works regarding health values on tea & coffee.

UNIT V **9 Hours**

TEA & COFFEE QUALITY TESTING, INSPECTION AND CERTIFICATION

Introduction of tea & coffee quality testing and analysis - Quality testing of tea & coffee - Physical appearance - Color - Size - Flavor - Taste. Chemical - Microbial - Sensory analysis - Other analysis includes testing for presence of chemicals - heavy metals - toxins. Quality assurance in tea & coffee industry - Importance of tea & coffee quality testing and analysis - Tea & coffee import and export - National and international bodies of tea & coffee quality testing and analysis.

FURTHER READING

Tea garden management - Land preparation - Planning - Terracing - Uprooting - Layout and style of planting - Spacing - Planting materials - Planting techniques -Water management in tea and coffee - Soil management - Bio-fertilizer - Vermiculture - Irrigation - Different methods of irrigation.

Total: 45 Hours

Reference(s)

1. K.C. Willson. 1999.Crop production science in horticulture. CABl publishing, UK, 231p.
2. Hongping Chen. 2013.Degradation pattern of gibberellic acid during the whole process of tea production. Food chemistry .138: 976-981.
3. Ramaswamy Ravichandran.2000. Lipid Occurrence, distribution and degradation to flavor volatiles during tea processing. Food chemistry.68:7-13.
4. Dr. Balasubramaniam. 1995.Tea processing. Academic press, New York.
5. Tea, In Health and Disease Prevention Edited by V. R. Preddy, Elsevier.

22FD020 AROMATIC SPICES PROCESSING 3 0 0 3

Course Objectives

- Understand to the fundamentals of aromatic spices and herbs.
- Analyze to the methods of processing for different aromatic spices.
- Evaluate to the processing and extraction techniques of Major and Minor spices.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Predict the scope, uses and functional properties of aromatic spices.
2. Assess the post-harvest handling and standards of aromatic crops.
3. Analyze the processing techniques and active compounds of the value-added products.
4. Conclude the processing methods and extraction techniques of major spices.
5. Evaluate the extraction of flavor components from minor spices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	2	1	1		1		1			1	1
2	1		2	2	2	1		2		1				
3	2		2	1	3	2		1		1				
4	3		1	1	1	1		1		1			1	
5	3		1	2	2			1		1			1	1

UNIT I **9 Hours**

INTRODUCTION TO AROMATIC SPICES

Aromatic Spice Crops – Introduction – Importance of spice crops – present status and future prospects - classification- Production, consumption and processing – Under- utilized herbs and spices - Active plant constituents – Functional properties – Use of aromatic herbs and spices – Role of commodity boards and developmental institutions in plantation crops.

UNIT II **9 Hours**

MAJOR AROMATIC SPICE PROCESSING

Importance for aromatic spices - production and export status - stages and methods of harvest of important spices- equipment used for threshing, shelling, decortications of spices – Processing and classification of cardamom-stages of harvest- Industrial processing of pepper, chemical composition, functional properties - harvesting - packaging-processing of white pepper - wet and dry pulping and retting methods – drying; Processing of turmeric, active compounds, value added products, applications - Processing of chilly – harvesting, drying - packaging and grinding – Culinary applications.

UNIT III **9 Hours**

MINOR AROMATIC SPICE PROCESSING

Minor Spices - Cumin, Coriander, Cinnamon, fenugreek, Garlic and Clove- Processing, Functional properties – Chemical composition – Quality issues - applications of minor spices - Processing of ginger - harvesting, washing, drying, and packaging - quality aspects - processing and toxicology of clove, nutmeg and other minor spices- Packaging and storage of aromatic spices.

UNIT IV **9 Hours**

PRODUCTION TECHNOLOGY OF AROMATIC CROPS

Production technology, post-harvest handling – Drying, Processing, Grading, Packing and storage – Processing of value addition – Major chemical constituents of spice essential oils - Oleoresins and essential oils- Method of manufacture - Chemistry of the volatiles- Enzymatic synthesis of flavor identical - Cryogenic grinding - advantages - refrigerant used - construction and working. Phytochemical extraction techniques – production technology – Distillation methods, advanced methods – Solvent extraction process of aromatic spices and herbs

UNIT V **9 Hours**

QUALITY INDICES OF AROMATIC SPICES

Introduction – Defining Quality – Major international quality specifications - Quality standards in aromatic spice products. GAP and GMP certification of organic products - Quality analysis- AGMARK and ASTA standards.

FURTHER READING

Value addition of spices, turmeric, areca nut, oil palm processing, chemistry of different spice flavors, adulteration in spices.

Total: 45 Hours

Reference(s)

1. Spices: Morphology, History, Chemistry, J W Parry, Chemical Publishing Co., New York (1969)
2. Kumar, N., Abdul Khader, Rangaswami, P. and Irvadappan, 1993, Introduction to spices, plantation crops, Medicinal and Aromatic plants, Rajalakshmi Publication.
3. Peter, Kuruppacharil V., ed. Handbook of herbs and spices: volume 3. Woodhead publishing, 2006.
4. Panda, H. Handbook on spices and condiments (cultivation, processing and extraction). ASIA PACIFIC BUSINESS PRESS Inc., 2010.
5. Pruthi, J. S. "Spices and condiments National Bank Trust." New Delhi, India 226 (1976).

22FD021 PROCESSING OF CHOCOLATE AND ITS PRODUCTS 3 0 0 3

Course Objectives

- Learn about the chocolate and its products.
- Understand about processing, storage and packaging of different types of chocolate and its products.
- Characterize the production and manufacturing process of cocoa and chocolate.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the scope, processing and production of cocoa and chocolate
2. Apply the processing methods of chocolate and its products.
3. Analyze different types of cocoa and chocolate.
4. Conclude the chocolate base products and its manufacturing process.
5. Evaluate the various chocolate based confectionery products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2			2	1	1		1		1			1	1
2	1			2	2	1		2					1	
3	2			1	3	2		1		1			1	1
4	3		1	1	1	1		1		1			1	1
5	3		1	2	2	2							1	1

UNIT I **9 Hours**

INTRODUCTION TO COCOA

Introduction of chocolate – History and development– Sources – cocoa beans, types of cocoa – Morphological and varietal characteristics of cocoa – Pests and diseases of cocoa – Cocoa crop protection. Post- Harvest Treatments – Cocoa bean quality. Flowering and pod development – Environmental aspects of cocoa cultivation.

UNIT II **9 Hours**

POST – HARVEST TREATMENTS OF COCOA

Introduction - Techniques for improving cocoa bean quality – Varieties of cocoa – Harvesting – Fermenting and drying. Fermentation techniques – Changes during fermentation of cocoa beans – Biochemical changes – Microbial succession during fermentation – Changes in enzymatic activities. Quality assessment of cocoa – contaminants and residues – cocoa butter hardness. Cocoa bean quality and selection – Steps in cocoa processing – cocoa powder production.

UNIT III **9 Hours**

CHOCOLATE MANUFACTURING AND ITS TYPES

Introduction to chocolate manufacture – Chocolate manufacturing process – Mixing – Refining – Conching, Principles, phases, Conching machines – Tempering and Lipid crystallization, polymorphism of cocoa butter, Measurement of temper, Tempering machines –Molding and enrobing, – Cooling – Demoulding – Wrapping/ Packaging. Chocolate quality and defects – Fat bloom – Sugar bloom.

UNIT IV **9 Hours**

PROCESSING TECHNOLOGY OF CHOCOLATES

Particle size reduction – Principles, equipment, cocoa nib grinding. Particle size reduction and chocolate flow properties. Flavor development in cocoa and chocolates – Fermentation - Roasting – Drying- Conching. Chocolate flow properties – Non –Newtonian flow – sample preparation and measurement procedures. Chocolate panning- Methods – Process. Packaging in confectionery industry – metal cans – paper and associated materials, types of paper – metal foil – transparent films- flow wrap machinery and sealing.

UNIT V **9 Hours**

CHOCOLATE AND ITS PRODUCTS

Types of chocolates and its manufacturing processes - Milk chocolate – White chocolate – Dark chocolate– Semisweet chocolate – Bittersweet chocolate – Unsweetened chocolate –Sweet Garman chocolate –

Couverture chocolate – Ruby chocolate - Cocoa powder – Cocoa butter – Application, advantages, disadvantages of different varieties of chocolate. Nutritional and health aspects of chocolate – Uses and applications of chocolate.

FURTHER READING

Regulations and standards of chocolate manufacturing – Safety and hygiene of chocolate production house and equipment design of chocolate manufacturing process.

Total: 45 Hours

Reference(s)

1. Flavour Development in Cocoa and Chocolate (Pages: 169-191) by Dr., Dr.-Ing. G. Ziegleder.
2. Beckett, Steve T., ed. Industrial chocolate manufacture and use. John Wiley & Sons, 2011.
3. Afoakwa, Emmanuel Ohene. Cocoa production and processing technology. CRC Press, 2014.
4. Production and Quality Standards of Cocoa Mass, Cocoa Butter and Cocoa Powder (Pages: 121-141) by H. J. Kamphuis M.Sc., Ph.D.
5. Chocolate Science and Technology by Afoakwa, Emmanuel Ohene.

22FD022 **VALUE ADDED SPICE PRODUCTS** **3 0 0 3**

Course Objectives

- Understand about the different spice processing techniques.
- Learn about processing techniques, value added techniques, marketing and commercialization of different types of spice and value-added spice products.
- Introduce the quality control, appearance and industrial trends of value-added spice products.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the scope, processing and production of spices and plantation crops.
2. Assess the processing methods for value addition of spices.
3. Analyze the value-added techniques, marketing and commercialization of value-added spice products.
4. Conclude about different value-added spice products.
5. Evaluate the quality control, appearance and industrial trends of value-added spice product.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	2	1	1		1		1			1	1
2	1		2	2	2	1		2					1	
3	2		3	1	3	2		1		1				1
4	3		1	1	1	1		1		1				1
5	3		1							2			1	

UNIT I **9 Hours**

INTRODUCTION TO THE SPICE INDUSTRY

Overview of the Spice Industry - Global and regional perspectives and Economic significance, Historical Overview of the Spice Trade - Exploration of the historical significance of spices, Impact on cultural and economic development, Spice Cultivation and Harvesting - Basics of cultivation practices and Harvesting techniques, Post-Harvest Handling and Processing - Cleaning, sorting, and grading, Techniques to maintain spice quality. Global and Regional Spice Varieties - Examination of key spice varieties from around the world, understanding regional preferences and uses.

UNIT II **9 Hours**

SPICE PROCESSING TECHNIQUES

Drying and Dehydration - Methods and equipment and Impact on spice properties, Grinding and Milling Processes - Techniques and different machinery - Particle size considerations, Extraction Methods - Essential oils extraction - Oleoresins and solvent extraction.

UNIT III **9 Hours**

VALUE ADDED TECHNIQUES, MARKETING AND COMMERCIALIZATION

Enhancing Flavor and Aroma - Techniques for intensifying sensory properties, Blending and mixing approaches, Product Development with Spices - Formulation principles, Incorporating spices into various products, Market Analysis and Consumer Trends - Identifying target markets, Understanding consumer preferences - Branding and Packaging - Strategies for effective branding, Packaging considerations for spice products - Marketing Strategies - Traditional and digital marketing approaches, Creating a marketing plan for spice products.

UNIT IV **9 Hours**

VALUE ADDED SPICE PRODUCTS

Introduction to spices - Cinnamon, black pepper, turmeric, cumin, cardamom, clove, chili powder, paprika, salt, coriander, oregano, bay leaves. Introduction to value added spice products - Spice blends and seasonings - Spice infused chocolates - Infused olive oils - Ready to use curry sauces - Spiced nut mixes - Spice infused beverages - Spiced honey and syrups - Herb and spice infused sea salts.

UNIT V **9 Hours**

QUALITY CONTROL, APPEARANCE AND INDUSTRY TRENDS

Importance of Quality in Spice Products - Factors affecting spice quality, Regulatory standards - Testing Methods and Standards, Quality control procedures - Laboratory testing techniques - Industry Trends and

Case Studies, Analyzing successful value-added spice products - Emerging trends in the spice industry.

FURTHER READING

Sustainability of spice products - Functional properties of spice compounds - Innovative packaging solutions - Impacts of spice products on culinary - Technological innovations in spice processing.

Total: 45 Hours

Reference(s)

1. Spices: Morphology, History, Chemistry, J W Parry, Chemical Publishing Co., New York (1969).
2. D. K. Salunkhe and S. S. Kadam, “Handbook of Fruit Science and Technology: Production, Composition, Storage, and Processing”, 1st edition, CRC Press, 1995.
3. N. K. Jain, “Global Advances in Tea Science”, 1st edition, Aravali Books International, 1999.
4. M. N. Clifford and K. C. Willson, “Coffee: Botany, Biochemistry and Production of Beans and Beverage”, 1st edition, AVI publishing Co.,1985.

22FD023 PROCESSING OF COCONUTS AND ITS PRODUCTS 3 0 0 3

Course Objectives

- To gain knowledge in coconut and its products.
- To know about harvesting, processing and development of coconut and its products.
- To characterize quality control and marketing of coconut and its products.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the characteristics, processing and production of coconut.
2. Apply the harvesting and post harvesting management of coconut.
3. Outline about different coconut processing techniques.
4. Conclude the value-added coconut products.
5. Evaluate the quality control and marketing of coconut products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1				
3	1		1	2	3	2		1		1			1	
4	2		2	2	2	1		1		1				
5	1		1	2				1		1				1

UNIT I **9 Hours**

INTRODUCTION TO COCONUT AND ITS IMPORTANCE

Definition and Botanical Characteristics - Classification and types of coconut palms, Anatomy of a coconut fruit, Overview of coconut cultivation - Cultivation Practices, Soil and climate requirements, Propagation methods, Pest and disease management in coconut plantations - Economic and cultural significance of coconuts - Historical and cultural uses of coconuts, Economic impact on local and global economies, Global Coconut Production and Trade - Major coconut-producing regions, Trade dynamics and market trends.

UNIT II **9 Hours**

HARVESTING AND POST HARVEST MANAGEMENT

Techniques for harvesting coconuts - Timing of harvesting, Manual and mechanized harvesting methods, Tools and equipment used in harvesting, Handling and transportation of coconuts - Best practices for handling coconuts post-harvest, Transportation logistics and considerations, Post-harvest losses and mitigation strategies - Causes of post-harvest losses, Storage conditions to minimize losses, Technologies for reducing post-harvest losses, Storage and preservation methods - Storage facilities and conditions, Techniques for preserving coconuts and coconut products, Shelf-life considerations.

UNIT III **9 Hours**

COCONUT PROCESSING TECHNIQUES

Coconut husking and dehusking methods - Traditional vs. modern husking methods, Dehusking machines and equipment - Coconut water extraction and processing - Extraction methods, Processing technologies for coconut water, Coconut Oil Extraction Processes - Traditional methods - cold-pressing, expeller pressing, Modern methods - solvent extraction, cold extraction, Refining and fractionation processes - Coconut Milk and Cream Production - Grating and extracting coconut milk, Concentration and formulation of coconut cream, Copra Production and Drying Techniques - Traditional sun drying vs. mechanical drying, Copra quality standards.

UNIT IV **9 Hours**

VALUE ADDED COCONUT PRODUCTS

Introduction to value addition in coconut processing - Definition and importance of value-added products, Market demand for value-added coconut products, Desiccated Coconut Production - Grading and processing of desiccated coconut, Quality standards and packaging, Coconut Flour and Coconut Sugar Processing - Milling and production processes, Nutritional aspects and health benefits, Coconut-Based Snacks and Confectioneries - Recipe development and production techniques, Marketing strategies for coconut snacks.

UNIT V **9 Hours**

QUALITY CONTROL AND MARKETING OF COCONUT PRODUCTS

Quality standards for coconut and coconut products - International and national quality certifications, Adherence to food safety standards, Quality Control Measures in Processing Units - Process monitoring and control, Testing methods for coconut products, Packaging and Labeling - Sustainable packaging options, Importance of clear and informative labeling, Market Trends and Opportunities - Emerging trends in the coconut industry, Identifying and capitalizing on market opportunities, Export/Import Regulations and Certifications - Compliance with international trade regulations, Certification processes for exporting coconut products.

FURTHER READING

Different coconut cultivation techniques - Soil management - Coconut based products production - Different storage and packaging techniques for coconut and its products - Quality management system.

Total: 45 Hours

Reference(s)

1. "Coconut Handbook" by Asian and Pacific Coconut Community (APCC).
2. "Coconut Production and Marketing" by R. Sreedharan.
3. "Coconut: The Complete Guide to the World's Most Versatile Superfood" by Bruce Fife.
4. "Coconut Processing for Value Addition" by N. G. Ravishankar and P. K. Gopalakrishna Pillai.

22FD024 AROMATIC HERBS PROCESSING 3 0 0 3

Course Objectives

- Learn about different aromatic herbs processing techniques.
- Understand about processing techniques, quality control and safety, different types of aromatic herbs products.
- Analyze the advanced processing techniques and innovations of aromatic herbs.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the scope, processing and production of aromatic herbs.
2. Find the processing methods for aromatic herbs.
3. Outline about the quality control and safety of aromatic herbs.
4. Analyze about the different aromatic herbs' products.
5. Evaluate about advanced processing techniques and innovations of aromatic herbs.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1				
3	1		1	2	3	2		1		1			1	
4	2		2	2	2	1		1		1				
5	1		1	2	2	2		1		1				

UNIT I **9 Hours**

INTRODUCTION TO AROMATIC HERBS

Overview of Aromatic Herbs - Definition and classification of aromatic herbs, Historical and cultural significance, Importance in various industries - culinary, medicinal, Common Aromatic Herbs - Identification and characteristics of popular aromatic herbs, Growing conditions and cultivation practices, Harvesting and post-harvest handling.

UNIT II **9 Hours**

PROCESSING TECHNIQUES

Drying and Preservation Methods - Sun drying, air drying, and commercial drying techniques, Preservation methods: freeze-drying, dehydration, and extraction, Factors affecting the quality of dried herbs, Distillation and Extraction - Essential oil extraction methods, Distillation processes for aromatic herbs, Applications and uses of essential oils.

UNIT III **9 Hours**

QUALITY CONTROL AND SAFETY

Quality Assessment - Factors affecting herb quality, Sensory evaluation and grading, Quality control standards, Safety Measures in Processing - Hygiene and sanitation practices, Pesticide and contaminant control, Regulatory standards and certifications.

UNIT IV **9 Hours**

AROMATIC HERBS PRODUCTS

Culinary Applications - Using aromatic herbs in cooking, Herb blends and flavor profiles, culinary product development, Medicinal Products - Herbal remedies and formulations, Aromatic herbs in different medicinal products, Marketing and branding considerations.

UNIT V **9 Hours**

ADVANCED PROCESSING TECHNIQUES AND INNOVATIONS

Sustainable Processing Practices - Sustainable agriculture and processing, green processing techniques, Environmental impact assessment, Research and Development in Herb Processing - Current research in aromatic herbs, Innovations in herb cultivation and processing, Case studies of successful R&D projects, Emerging Trends and Future Prospects - Market trends and forecasting, Future prospects in the herb processing industry. Adapting to consumer preferences.

FURTHER READING

Research and Development in Herb Processing - Current research in aromatic herbs, Innovations in herb cultivation and processing, Case studies of successful R&D projects.

Total: 45 Hours

Reference(s)

1. "The Complete Book of Herbs: A Practical Guide to Growing and Using Herbs" by Lesley Bremness.
2. "The Essential Oils Handbook: All the Oils You Will Ever Need for Health, Vitality, and Well-Being" by Jennie Harding.
3. "The Complete Guide to Growing Healing and Medicinal Herbs: A Complete Step-by-Step Guide" by Wendy Vincent.

22FD025 NATIONAL AND INTERNATIONAL FOOD LAWS 3 0 0 3

Course Objectives

- Learn about food safety laws and regulations.
- To be aware of the regulatory and statutory bodies in national and international level.
- Understand about different type of food hazards, physical, chemical and biological in the industry and food service establishments.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

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PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the importance of the food laws and regulations in India and aboard.
2. Assess the regulations followed by the food safety and standards act followed in India.
3. Outline the role of food authority and rules of FDA in USA.
4. Analyze the federal systems followed in Canadian system.
5. Evaluate the legislative process opted by European Union.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1				1
3	1		1	2	3	2		1		1			1	1
4	2		2	2	2	1		1		1			1	
5	1		1	2	2	2							1	

UNIT I **9 Hours**

INTRODUCTION TO FOOD LAW AND REGULATIONS

Historical perspectives, Reason and need for food law and regulations, methods of evaluation & labelling - food composition tables, World Trade order – Functioning and responsibilities of the WTO, World Health Organization – Operations and responsibilities. Concept of Six Sigma, International organization of standardization (ISO), Food safety and quality management system, essentials of ISO 9001 and ISO 22000, accreditation and certification.

UNIT II **9 Hours**

FOOD AUTHORITY IN INDIA

Food safety and Standards Act – organizational chart – role of individual authority –principles to be followed – –Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers –Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Offences and penalties – Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS.

UNIT III **9 Hours**

FOOD LAW AND REGULATION IN USA

History of Food and Drug Administration (FDA); Role of the US federal government; Legislation process; Code of federal regulations; US Department of Agriculture food acts and responsibilities; Standard of identity for food products Substances and additives used in foods; Basic labeling of food products; Allergen and organic food declaration; GMO foods regulations; Nutrition Labeling and Education Act, US FDA Modernization Act, Dietary Supplement Health and Education Act.

UNIT IV **9 Hours**

CANADIAN FOOD LAWS AND REGULATIONS

Introduction - Food Inspection Agency – responsibilities and authorities; Agriculture and Agri-Food Canada – responsibilities and authorities; Acts and regulations- Food and Drugs Act and Regulations, Canada Agriculture Products Act and Regulations, Meat and Fish Inspection Acts and Regulations, Consumer Packaging and Labelling Act and Regulations, Safety Food for Canadians Act; Health claims- Function and nutrient function claims, Disease risk reduction claims, Therapeutic claims.

UNIT V **9 Hours**

FOOD LAW AND REGULATIONS IN EUROPEAN UNION

European treaties, Member states of the EU, EU regulatory institutions- European Commission, Council of the EU, European food safety authority, Legislative process, Forms of legislations, Official journal of the European Communities, Food additives, Flavoring’s, labelling requirements for additives, 2% rule and QUID, Allergen, organic, and GMO food declaration, Nutrition labeling, Nutrition claims, Current health claims.

FURTHER READING

HACCP, Codex Alimenteris, BIS, GMP, GHP, GLP, difference between labeling regulations among different countries, Safety regulations in food products that are treated with novel technologies.

Total: 45 Hours

Reference(s)

1. Mehta R. and George J., "Food Safety Regulation Concerns and Trade- The Developing Country Perspective", Macmillan India Ltd., New Delhi. 2005.
2. Kees A. van der Heijden, Sanford Miller (1999). International Food Safety Handbook: Science, International Regulation, and Control, CRC Press.
3. Mehta, R and George, J. "Food Safety Regulations Concerns and Trade": The Developing Country Perspective", Macmillan, 2005.
4. Vetter, J.L. 1996. "Food Laws and Regulations" American Institute of Baking, Manhattan, Kansas.
5. Vetter, J.L. 1993. "Food Labeling – Requirements for FDA Regulated Products" American Institute of Baking, Manhattan, Kansas.
6. Graham, J., Babinski, M., Collard, C., Loh, A., Patry, M., Prince, V. and Wise, J. 2007. "Canadian Food and Drug Legislation and Commentary" Lexis Nexis Canada (available in September 2007).
7. Goodburn, K (Ed.) 2005. "EU Food Law: A Practical Guide" CRC Press. Boca Raton, Boston, New York, Washington D.C., Woodhead Publishing Limited, Cambridge, England.

22FD026 **RISK ANALYSIS** **3 0 0 3**

Course Objectives

- Introduce to the knowledge in hazard identification.
- Understand to the regulatory aspect of risk analysis.
- Characterize to the different aspects of risk analysis, risk management, risk assessment and risk communication.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

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PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the importance of the risk analysis in relation with food safety hazards.
2. Predict the principles of risk analysis in decision making.
3. Analyze the role of risk management in managing food safety.
4. Outline the concept of risk assessment.
5. Evaluate the priority of risk communication and its principle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1			1	
3	1		1	2	3	2		1		2			1	
4	2		2	2	2	1		1		2			1	1
5	1		1	2						1			1	1

UNIT I **9 Hours**

RISK ANALYSIS IN RELATION TO FOOD SAFETY HAZARDS

Definitions, Risk assessment (Hazard identification, Hazard characterization, Exposure assessment (deterministic and probabilistic approach), Risk characterization), Chemical risk assessment in foods (including aggregated and cumulative assessment), Microbial risk assessment in foods.

UNIT II **9 Hours**

FOOD SAFETY RISK ANALYSIS IN THE REGULATORY PROCESS

Introduction to risk analysis, Principles of risk management decision-making, General principles of food law, how risk analysis fits into food safety law systems.

UNIT III **9 Hours**

RISK MANAGEMENT

Risk manager's role and how we think about things, Risk management frameworks and models, Principles of decision-making and the constraints, Dealing with uncertainty of risk assessment, Risk management options and decision, Interactions between risk manager and risk assessor.

UNIT IV **9 Hours**

RISK ASSESSMENT

Context of food safety risk assessment, Risk assessor's toolbox, Application to food-borne and related hazards, Components of risk assessment.

UNIT V **9 Hours**

RISK COMMUNICATION

Principles of risk communication, establishing your goal, Risk perception and understanding your audience, Creating your message, Communication in action.

FURTHER READING

Deterministic microbiological risk assessment, Deterministic and probabilistic chemical risk assessment, risk management in practice (EU, WHO/FAO).

Total: 45 Hours

Reference(s)

1. Hoboken, N.J. (2011) Risk assessment: theory, methods, and applications.
2. Hoboken, N.J. (2011) Risk and crisis communications methods and messages.

22FD027 FOOD ADULTERATION AND ITS CONTROL 3 0 0 3

Course Objectives

- To understand about adulteration in food.
- Learn to be aware of adulterants and its impact on health.
- To ensure the safety, quality and authenticity of food products.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the types of adulterants in food.
2. Predict the detection methods of adulterant in different food products.
3. Outline the food laws and procedures on adulteration.
4. Analyze the strategies to control food adulteration.
5. Evaluate the consumer by providing appropriate education and public awareness.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	
2	1		2	2	2	1		2		1			1	
3	1		1	2	3	2		1		2			1	
4	2		2	2	2	1		1		2				1
5	1		1	2	2	1		2						1

UNIT I **9 Hours**

INTRODUCTION TO ADULTERATION

Common Foods subjected to Adulteration-Adulteration-Definition –Types; Poisonous substances, foreign matter, cheap substitutes, Spoiled parts. Adulteration through Food Additives –Intentional and incidental. General Impact on Human Health.

UNIT II **9 Hours**

ADULTERATION OF COMMON FOODS AND METHODS OF DETECTION

Means of Adulteration Methods of Detection Adulterants in the following Foods; Milk, Oil, Grain, Sugar, Spices and Condiments, Processed Food, Fruits and Vegetables. Additives and Sweetening agents (at least three methods of detection for each food item).

UNIT III **9 Hours**

PRESENT LAWS AND PROCEDURES ON ADULTERATION

Highlights of Food Safety and Standards Act 2006 (FSSA) –Food Safety and Standards Authority of India- Rules and Procedures of Local Authorities. Role of Voluntary Agencies Such as, Agmark, I.S.I.

UNIT IV **9 Hours**

QUALITY CONTROL ROLE ON FOOD ADULTERANT

Quality control laboratories of Companies, Private testing laboratories, Quality control laboratories of Consumer co-operatives.

UNIT V **9 Hours**

CONSUMER EDUCATION

Consumer Education, Consumer’s problems, rights and responsibilities, COPRA 2019- Offenses and Penalties - Procedures to Complain – Compensation to Victims.

FURTHER READING

Case study on food adulteration.

Total: 45 Hours

Reference(s)

1. A first course in Food Analysis – A.Y. Sathe, New Age International (p) Ltd, 1999.
2. Food Safety, case studies –Ramesh.V. Bhat, NIN,1992.
3. Rapid Detection of Food Adulterants and Contaminants- Theory and Practice, Shyam Narayan Jha and Pranay, 2016.

22FD028 FOOD SAFETY MANAGEMENT SYSTEMS 3 0 0 3

Course Objectives

- To describe the importance of food safety management systems (FSMS).
- To apply the HACCP principles to develop and implement a HACCP plan.
- To implement GMPs in food production facilities.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

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PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the benefits of implementing an FSMS.
2. Assess the hazards in food production processes.
3. Outline GMPs and explain their importance in food safety.
4. Analyze the steps involved in a food recall.
5. Evaluate the requirements of these regulations and standards.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	
2	1		2	2	2	1		2		1			1	
3	1		1	2	3	2		1		2				
4	2		2	3	2	1		1		2				
5	2		2			2								1

UNIT I **9 Hours**

INTRODUCTION TO FOOD SAFETY MANAGEMENT SYSTEMS

Importance of food safety in the food industry, History of foodborne illness outbreaks, Economic and public health impact of foodborne illness, Principles of food safety management, Introduction to FSMS standards and regulations.

UNIT II **9 Hours**

HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP)

Introduction to HACCP, the seven principles of HACCP, developing a HACCP plan, Identifying and assessing hazards, determining critical control points (CCPs), Establishing monitoring procedures for CCPs, implementing corrective actions, Maintaining HACCP documentation

UNIT III **9 Hours**

GOOD MANUFACTURING PRACTICES (GMPs)

Introduction to GMPs, Basic requirements of GMPs, Personal hygiene, Sanitation, Pest control, Equipment and utensils, Quality control, GMP audits

UNIT IV **9 Hours**

FOOD RECALL AND CRISIS MANAGEMENT

Introduction to food recalls, Steps involved in a food recall, Developing a food recall plan, Crisis communication

UNIT V **9 Hours**

FOOD SAFETY REGULATIOND AND STANDARDS

Introduction to food safety regulations and standards, Key food safety regulations and standards, Implementing food safety regulations and standards

FURTHER READING

FSSAI regulations, Legislation for different food products, international laws for food safety.

Total: 45 Hours

Reference(s)

1. "Food Safety Management Systems: A Practical Guide for the Food Industry" by Bryan Bedford and Richard Walls
2. "HACCP: A Practical Guide" by Frank Busta, Michael Davidson, and John Lake
3. "Good Manufacturing Practices for Food Industries" by C.L. Lawrie and A.L. Griffiths
4. "Food Recall: A Practical Guide" by Bill Marler and David S. Acheson
5. "Food Safety Regulations: A Guidebook for the Food Industry" by Richard H. Linton and MichaelJ.Sofos.

22FD029 FOOD SUPPLY CHAIN MANAGEMENT AND LOGISTICS 3 0 0 3

Course Objectives

- To define food supply chain management and logistics.
- To identify the key components of a food supply chain.
- To Explain the role of logistics in food supply chain management.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

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Course Outcomes (COs)

1. Apply food supply chain management principles to real-world scenarios.
2. Assess strategies for improving food supply chain efficiency and effectiveness.
3. Analyze the impact of logistics on food safety and quality.
4. Outline the sustainability of food supply chain practices.
5. Evaluate the food supply chain and its components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1			1	
3	2		1	2	3	2		1		2				
4	1			3	2	1		1		2				1
5	1			1	1			2		2				1

UNIT I **9 Hours**

INTRODUCTION

Logistics and supply chain management - Scope, Significance and Drivers; Basic Model - Primary and Secondary Activities; Role and Challenges of Logistics and supply chain management in food industry.

UNIT II **9 Hours**

DEMAND FORECASTING AND WAREHOUSING

Demand and supply management, Forecasting techniques, Strategic planning for material sourcing, Outsourcing strategies, Warehouse strategies, Inventory models and control techniques.

UNIT III **9 Hours**

DISTRIBUTION AND TRANSPORTATION

Various sources of distribution channels, Distribution models, Third Party Logistics and Fourth Party Logistics, Distribution network planning, Modes of transportation, Design of transshipment, Containerization.

UNIT IV **9 Hours**

PACKAGING AND INFORMATION TECHNOLOGY

Applications of Packaging in logistics, Types of packaging and packaging materials, Export & import packaging and labeling details, Reverse Supply Chain, Information Technology and the Supply Chain (ERP, Bar-coding, RFID, GPS, E-Procurement).

UNIT V **9 Hours**

GLOBAL LSCM AND PERFORMANCE ANALYSIS

Export and import procedure and Documentation, Customer relationship management in LSCM, Performance metrics in Supply Chain, Challenges in SCM.

FURTHER READING

Case study on logistics and food supply chain management.

Total: 45 Hours

Reference(s)

1. D K Agarwal, Logistics and supply chain management, Macmillan Publishers India Ltd. (2003), Eighth Impressions, 2010.
2. Sunil Chopra and Peter Meindi, Supply chain management Pearson Education publishers, 2010.
3. David Taylor and David Brunt, Manufacturing Operations and Supply chain Management, Vikas Thomson Learning publishers, 2009.

4. Amit Sinha and Herbert Kotzab, Supply Chain Management, Tata McGraw Hill, 2011.
5. Surendra M. Gupta, Reverse Supply Chains: Issues and Analysis, CRC Press, 2013.
6. David Blanchard, Supply Chain Management Best Practices, Wiley Publications, 2010.

22FD030 **QUALITY ASSURANCE AND QUALITY CONTROL IN FOOD INDUSTRIES** **3 0 0 3**

Course Objectives

- To identify the different types of QA/QC systems used in food processing operations.
- To implement QA/QC procedures to ensure the safety and quality of food products.
- To troubleshoot and resolve QA/QC problems in food processing operations.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply quality management systems (QMS) and their importance in food industries
2. Predict the different types of QMS and their applications
3. Outline the principles of ISO 22000, HACCP, and SQF
4. Analyze and maintain a QMS in a food processing facility
5. Evaluate statistical models and to study the several characteristics of data structures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	
2	1		2	2	2	1		2		1			1	
3	2		1	2	3	2		1		2			1	
4	1			3	2	1		1		2			1	1
5	1			1	1								1	1

UNIT I **9 Hours**

CONCEPT OF QUALITY CONTROL AND QUALITY ASSURANCE

Definition and scope of quality control and quality assurance in food processing; Importance of quality control and quality assurance in the food industry; Relationship between quality control, quality assurance, and food safety.

UNIT II **9 Hours**

QUALITY CONTROL TECHNIQUES IN FOOD PROCESSING

Physical, chemical, and microbiological methods for food quality control; Sensory evaluation methods for food quality control; Sampling techniques for food quality control; Statistical process control for food quality control.

UNIT III **9 Hours**

QUALITY ASSURANCE FOR MEAT INDUSTRY

Characteristics of meat-Microorganisms associated with meat - spoilage of animal food - control of microbial food borne pathogens in meat chain - meat safety at pre-harvest, harvest and post- harvest level - nutritive value of meat-Structure of muscle, methods of slaughtering, Ante mortem and post mortem inspection of meat, Biochemical changes in meat-Rigor mortis-Aging of meat, meat cut and grade, MPL for Meat and Meat products. Maximum Permissible Limit of additives for meat and meat products.

UNIT IV **9 Hours**

QUALITY ASSURANCE FOR BAKERY AND CONFECTIONARY INDUSTRIES Quality of raw materials, quality checks on flours, building inspection and routine cleaning programs, process control- microbial and fungal contaminants. Ingredients, equipment, bakery quality assurance, ingredient inspection, process control, assessing products for quality.

UNIT V **9 Hours**

ADVANCED INSTRUMENTATION FOR FOOD SAFETY AND QUALITY ASSURANCE

Basic chromatographic technique; spectrophotometric techniques; high pressure liquid chromatography and gas chromatography; advanced analytical techniques; advanced analytical instrumentation in trace analysis.

FURTHER READING

Case study on Quality assurance and quality control in other food industries.

Total: 45 Hours

Reference(s)

1. International Food Standards Organization (IFS). (2022). IFS Food Standard.
2. Codex Alimentarius Commission. (2023). Food Hygiene Basic Principles.
3. World Health Organization. (2016). Five keys to safer food manual.
4. British Standards Institution. (2018). BS EN ISO 22000:2018 Food safety management systems - Requirements for organizations involved in the food chain.
5. American Society for Quality (ASQ). (2023). Body of Knowledge (BoK) for Certified QualityAuditor(CQA).

22FD031 MICROBIAL PRESERVATION AND PROCESSING 3 0 0 3

Course Objectives

- Understand and identify the important pathogens and spoilage microorganisms in foods and the conditions under which they will grow (covered in detail).
- Impart knowledge on role and significance of microorganism in development of fermented food products.
- Learn about the general characteristics of bacteria, fungi, virus, protozoa and algae also Morphological characteristics important in Food bacteriology.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food microbes for manufacturing fermented foods.
2. Find the importance of as food safety to act as a mode of transmission of various infectious agents.
3. Outline the importance of microbes in producing pro and prebiotic food products.
4. Analyze the new innovation in developing new preservative techniques.
5. Evaluate the response to the changes in processing foods by modern preservation techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1			1	1
3	1		1	2	3	2		1		1			1	1
4	2		2	2	2	1		1		1			1	1
5	1		1	2	2	2		2		2			1	1

UNIT I **9 Hours**

INTRODUCTION AND SCOPE OF FOOD MICROBIOLOGY

Introduction of microbiology - General characteristics of microbiomes including bacteria, fungi, virus, protozoa and algae. - Importance of microorganisms in food - Food as a substrate for microorganism - Classification of nomenclature of microorganism - Factors affecting the growth of microorganisms in food, feed and fodder - Normal micro flora of some common foods.

UNIT II **9 Hours**

MICROBIAL GROWTH RESPONSE IN THE FOOD ENVIRONMENT

Microbial growth characteristics - Factors influencing microbial growth in food - Microbial metabolism of food components - Microbial sporulation and germination - Microbial stress response in the food environment.

UNIT III **9 Hours**

BENEFICIAL USES OF MICROORGANISMS IN FOOD

Basic of food fermentation process and role of microorganisms, Microorganisms used in food fermentation - Microbiology of fermented food production - Intestinal beneficial bacteria - Food bio preservatives of microbial origin - Food ingredients and enzymes of microbial origin.

UNIT IV **9 Hours**

MICROBIAL FOODBORNE DISEASES

Important factors in microbial food spoilage - Food spoilage by microbial enzymes- Indicators of microbial food spoilage - Microbial foodborne diseases - Foodborne intoxications - Foodborne infections - Foodborne toxic infections - Opportunistic pathogens, parasites, and algal toxins - Indicators of bacterial pathogens.

UNIT V **9 Hours**

CONTROL OF MICROORGANISMS IN FOODS

Control of access (Cleaning and Sanitation) - Physical removal – heat - low temperature - reduced a_w- low pH and organic acids - modified atmosphere (or reducing O-R potential) - Antimicrobial preservatives - Novel processing technologies - Hurdle concept - Detection of microorganisms in food and food environment.

FURTHER READING

Control of microbial growth and food preservation, Factors affecting microbial behavior in food Importance of microorganism in food, Pathogenic microorganism in food.

Total: 45 Hours

Reference(s)

1. Adams, M. R. and M. O. Moss. 2008. Food Microbiology, 3rd Edition. Cambridge: The Royal Society of Chemistry (RSC Publishing).
2. Benwart, G. J. 1987. Basic Food Microbiology. New Delhi: CBS Publishers & Distributors.
3. Blackburn, Clive de W. 2006. Food Spoilage Microorganisms. Cambridge: Woodhead Publishing.
4. Deak, T. and L. R. Beuchat. 1996. Handbook of Food Spoilage Yeasts. US: CRC Press.
5. Frazier, William C. and Dennis C. Westhoff. 1988. Food Microbiology. New York: McGraw-Hill.
6. Garbutt, John. 1997. Essentials of Food Microbiology. London: Arnold – International Students Edition.
7. Jay, J. M. 2000. Modern Food Microbiology, 6th Edition. New York: Chapman & Hall.
8. Prescott, L. M., J. P. Harley and D. A. Klein. 2014. Microbiology, 9th Edition. New York: McGraw Hill.
9. Ray, Bibek and Arun Bhunia. 2013. Fundamental Food Microbiology, 5th Edition. . New York: CRC Press.
10. Robinson, Richard K. 2002. Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products, 3rd Edition. New York: Wiley Interscienc.

22FD032 BIOPROCESS TECHNOLOGY 3 0 0 3

Course Objectives

- To understand the fundamentals of bioreactor design for efficient production of biomolecules andmonitoring of bioprocesses in industry.
- To plan a research career or to work in the biotechnology industry with a strong foundation aboutbioreactor design and scale-up.
- To apply modelling and simulation of bioprocesses to reduce costs and to enhance the quality ofproducts and systems.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12 **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Find the bioprocess and sterilization kinetics.
2. Apply stoichiometric calculations to predict bioprocess efficacy.
3. Analyze the productivity in a bioreactor for the given metabolite.
4. Evaluate the structured models and metabolic pathways in product formation.
5. Evaluate simulated bioprocesses for automatic control with reduced costs and enhanced productquality.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	3	1	2			1		2		1		
2	2	1	3	2	2			1		2		2		
3	2	2	3	2	3			2		2		1		
4	1	2	3	2	2			2		2		2		
5	1			2	2							1		

UNIT I **9 Hours**

MEDIA DESIGN AND STERILIZATION

Basic configuration of bioreactor and ancillaries, Medium requirements for bioprocesses, Medium formulation of optimal growth and product formation, Medium optimization methods, Thermal death kinetics of microorganisms, Heat and filter sterilization of liquid media, Air sterilization, Design of sterilization equipment.

UNIT II **9 Hours**

METABOLIC STOICHIOMETRY AND ENERGETICS

Stoichiometry of cell growth and product formation, Elemental balances, Degrees of reduction of substrate and biomass, Available electron balances, Yield coefficients of biomass and product formation, Energetic analysis of microbial growth and product formation, Thermodynamic efficiency of growth.

UNIT III **9 Hours**

BIOREACTOR DESIGN AND SCALE UP

Batch, fed batch and continuous cultivation. Feeding Strategies and Microbial Kinetics, Rheology of fermentation fluids, Transport phenomena in bioprocess systems, Oxygen mass transfer rate determination methods, Stirred tank reactor, Plug flow reactor, Fluidized bed reactor, Bubble column, Air lift reactor, Photo bioreactor, Bioreactors on a chip, Scale up criteria for bioreactors.

UNIT IV **9 Hours**

MODELLING OF BIOPROCESSES

Monod model, Multiple substrate models, Models of growth associated product formation kinetics, Compartmental models, Models of cellular energetics and metabolism, Single cell models, Models of gene expression and regulation, Models of plasmid expression and replication.

UNIT V **9 Hours**

BIOPROCESS SIMULATION

Major subsystems of a process simulator, General architecture of on-line simulation system, Dynamic simulation of batch, Fed batch, Steady and transient culture metabolism, Model simulation using MATLAB - SIMULINK and ISIM software packages.

FURTHER READING

Fermentation technology and applications, Downstream processing in bioprocess technology, Bioreactor design and optimization, Metabolic engineering and synthetic biology.

Total: 45 Hours

Reference(s)

1. Michael L. Shuler and FikretKargi, Bioprocess Engineering - Basic Concepts, Pearson NewInternational Edition, 2014.
2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press Limited, 2013.
3. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, Butterworth Heinemann publications, 1995.
4. Harvey W. Blanch, S. Douglas and Clark, Biochemical Engineering, New York: Marcel Dekker Inc.,1997.
5. Shijie Liu, Bioprocess Engineering - Kinetics, Sustainability, and Reactor Design, Elsevier Science,2013.

22FD033 FOOD ALLERGENS AND TOXICOLOGY 3 0 0 3

Course Objectives

- Familiarize with hazards, and toxicity associated with food and their implications for health.
- Know the various kinds of allergens and basis of allergic reactions.
- To understand the protocols of sampling techniques in food toxicology measurements.
- To gain the knowledge on level of processing of food to destroy allergens / toxins.
- Creates an awareness to choose food with highly safe.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the different types of allergens and Natural toxins associated with food.
2. Assess the food toxicology and its hazards.
3. Outline about food sensitivity and allergy.
4. Analyze food toxin in food samples.
5. Evaluate toxin formed during processing and controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1			1	1
3	1		1	2	3	2		1		1			1	1
4	2		2	2	2	1		1		1			1	1
5	1		1	2	2	2		2		2			1	1

UNIT I **9 Hours**

INTRODUCTION OF FOOD TOXICOLOGY AND ALLERGENS

Definition and need for understanding food toxicology; Hazards - Microbiological, nutritional and environmental. Basics of immune resources - Humoral and cell media resources. Allergen and mechanism of allergic resources.

UNIT II **9 Hours**

FOOD ALLERGY AND SENSITIVITY

Chemistry of food allergens, celiac disease, food disorders associated with metabolism, Lactose intolerance, and asthma. Natural toxins in food: Natural toxins of importance in food - Toxins of plant and animal origin; Microbial toxins (e.g., bacterial toxins, fungal toxins and algal toxins), Natural occurrence, Toxicity and significance, Determination of toxicants in foods and their management.

UNIT III **9 Hours**

PRINCIPLES OF TOXICOLOGY

Natural food toxicants - Toxicity of mushroom alkaloids, seafood, vegetables, fruits, pulses, and antinutritional compounds. Biological factors that influence toxicity, Toxin absorption in the G. I. track, Industrial microflora, blood, brain barrier, storage and excretion of toxins.

UNIT IV **9 Hours**

DETERMINATION OF TOXICANTS IN FOOD SAMPLING

Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioral effect, immunotoxicity.

UNIT V **9 Hours**

TOXICANTS FORMED DURING FOOD PROCESSING

Intentional direct additives, preservatives, nitrate, nitrite, and N- nitroso compound flavor enhancers, food colors, indirect additives, residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N - nitrosamines, Acrylamide and their mode of action.

FURTHER READING

Mechanisms of food allergies, Toxicology of food contaminants, Food processing and allergenicity, Risk assessment and management in food toxicology.

Total: 45 Hours

Reference(s)

1. Helferich, W., and Winter, C.K "Food Toxicology",. CRC Press, LLC. Boca Raton, FL. 2007.
2. Shibamoto, T., and Bjeldanes, L. "Introduction to Food Toxicology", 2009, 2ndEdition. Elsevier Inc., Burlington, MA.
3. Watson, D.H. "Natural Toxicants in Food", CRC Press, LLC. Boca Raton, FL1998.
4. Duffus, J.H., and Worth, H.G. J. "FundamentalToxicology", The Royal Society of Chemistry.2006.
5. Stine, K.E., and Brown, T.M. "Principles of Toxicology", 2ndEdition. CRC Press. 2006.
6. Tönu, P. "Principles of Food Toxicology". CRC Press, LLC. Boca Raton, FL. 2007.
7. Alluwalia, Vikas "Food Hygiene and Toxicology" Paragon International Publishers, 2007
8. Maleki, Soheila J. A. Wesley Burks, and Ricki M. Helm "Food Allergy" ASM Press, 2006
9. Labbe, Ronald G. and Santos Garcia "Guide to Food Borne Pathogens" John Wiley & Sons,2001.
10. Cliver, Dean O. and Hans P. Riemann "Food Borne Diseases" 2ndEdition., Academic Press/Elsevier, 2002.

22FD034 ENZYME TECHNOLOGY 3 0 0 3

Course Objectives

- To provide students with a basic understanding of classification, nomenclature, mechanism and purification and characterization of enzymes.
- To understand enzyme immobilization methods, kinetics of free, immobilized and allosteric enzymes.
- To learn the Kinetics, inhibition study of enzyme and also its application in Food Industry.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply the set one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PSO2 Practical and research training imparted to the students will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply and gain knowledge on enzyme, coenzyme and their classification.
2. Find the different methods of Production and Purification of enzymes from various sources.
3. Outline the theoretical and practical aspects of enzyme kinetics to promote research.
4. Analyze the different methods of enzyme inhibition and kinetics.
5. Evaluate the role of enzymes in Food Processing and Preservation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3			2					1				2
2	1	2	3	2	2					2				1
3	3	3	1		3					2				2
4	2	3	1	1	2					1	2			1
5	2	3	3		2					2	2			1

UNIT I **9 Hours**

INTRODUCTION TO ENZYMES

Nomenclature and classification of enzymes. Mechanism and specificity of enzyme action - Units for enzyme activity - Coenzymes-Classification, Coenzymes in metabolic pathways, metal-activated enzyme and metalloenzyme.

UNIT II **9 Hours**

ENZYMES: EXTRACTION, PURIFICATION AND IMMOBILIZATION

Production and purification of crude enzyme extracts from plant, animal, and microbial sources; methods of characterization of enzymes; development of enzymatic assays. Physical and chemical techniques for enzyme immobilization adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding.

UNIT III **9 Hours**

ENZYME INHIBITION

Reversible inhibition - Competitive, non-competitive, uncompetitive, mixed, Substrate, allosteric and product inhibition. Irreversible Inhibition - Suicide inhibition. Examples and mechanism of various inhibitions like Penicillin, Iodoacetamide and DIPF.

UNIT IV **9 Hours**

ENZYME KINETICS

Factors affecting the enzyme activity - Concentration, pH and temperature. Kinetics of a single - Substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes.

UNIT V **9 Hours**

APPLICATION OF ENZYME IN FOOD INDUSTRY

Application of enzymes in food processing and production - Enzymes in baking, brewing, dairy and meat industries. Enzymes used in various fermentation processes, cellulose degrading enzymes, Applications of enzymes in flavor enhancement and modification.

FURTHER READING

Enzyme kinetics and mechanisms, Industrial applications of enzymes, Enzyme engineering and modification, Enzyme production and purification.

Total: 45 Hours

Reference(s)

1. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 1995.
2. Chaplin and Bucke, Enzyme Technology, Cambridge University Press, 1990.
3. Price and Stevens, Fundamentals of Enzymology, Oxford University Press.
4. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997.
5. Branden C. and Tooze J., Introduction to Protein Structured Garland Publishing, 1999.
6. Creighton T.E. Proteins, 2ndEdition. W.H. Freeman, 1993.

22FD035 FOOD FERMENTATION TECHNOLOGY 3 0 0 3

Course Objectives

- Explore how fermentation can be used as a method of food preservation, extending the shelf life of perishable foods.
- Gain insights into developing fermented food products with desirable sensory attributes, nutritional value, and safety.
- Understand how fermentation can enhance the nutritional profile of foods by synthesizing vitamins, increasing bioavailability of nutrients, and reducing anti-nutritional factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the different methods of fermentation technique for the food product formation.
2. Assess the history and properties of the fermented foods.
3. Analyze the production of different types of fermented dairy, fruit and vegetable products.
4. Outline the process of wine processing and preservation by fermentation.
5. Evaluate the concept of producing fermented fish and meat products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1			1	
3	1		1	2	3	2								
4	2		2	2	2	1		1						1
5	1		1					2		2				1

UNIT I **9 Hours**

INTRODUCTION

History of food fermentations; Types of fermented foods and substrates/raw materials used, Traditional fermented foods, Major biotransformation of raw materials during fermentation, Modern fermented foods industry, Properties of fermented foods, Fermented foods in the twenty-first century, Health benefits of fermented foods and beverages**.**

UNIT II **9 Hours**

FERMENTED DIARY PRODUCTS

Fermented Dairy products Introduction, Consumption of cultured dairy products, Cultured dairy products - Yogurt, Cultured buttermilk, Sour cream, Kefir, Other cultured dairy products. Cheese Introduction, Manufacturing principles, General steps in cheese making, Types of cheese, Cheese ripening, Microbial defects, Recent technological advances in cultured dairy products technology.

UNIT III **9 Hours**

FERMENTED FRUITS AND VEGETABLE PRODUCTS

Fermented Vegetable products - Introduction, Production principles, Manufacture of Sauerkraut, Principles of pickle production, fermented olives, Kimchi. Fermented Fruit Products - Manufacture of Canned fruits - Fruit vinegar production- Fermented Fruit juices.

UNIT IV **9 Hours**

ENOLOGY (STUDY OF WINE)

Wine manufacture principles - Harvesting and preparation of grapes, Crushing and maceration, Sulphur dioxide treatment, Separation and pressing, Fermentation, Yeast metabolism, Factors affecting yeast metabolism, Sulphur and nitrogen metabolism, stuck fermentations, Adjustments, blending, and clarification, Aging, Malolactic fermentation, Types of wine, Wine spoilage and defects.

UNIT V **9 Hours**

FERMENTED MEAT AND FISH PRODUCTS

Fermented Meat product Sausages - History and evolution of the fermented meats industry, Meat composition, Fermentation principles, Meat starter cultures, Principles of fermented sausage manufacture, Manufacture of fermented sausage - Cutting and mixing, Stuffing, Casing materials, Fermentation, Cooking, drying, and smoking, Mold-ripening, Flavor of fermented meats, Defects and spoilage of fermented meats. Fermented fish products Fish sauces, Fish paste - Manufacturing steps, Biochemical changes, Storage and Shelf-life of products.

FURTHER READING

Shelf-life study of fermented foods, Packaging aspects involved in the fermented foods.

Total: 45 Hours

Reference(s)

1. Joshi, V. K. "Biotechnology Food Fermentation" Volume 1. Educational Publishers Distributors, 2004.
2. Robert W. Hutkins. "Microbiology and Technology of Fermented Foods", 2nd Edition, Blackwell, 2006
3. Hui Y. H "Handbook of Food and Beverage Fermentation Technology". Marcel Dekker, 2004.
4. Wood, Brian J. B. "Microbiology of Fermented Foods" Volume 1 and 2. II Edition. Blackie Academic and Professional, 1998.
5. Farnworth, Edward R. "Handbook of Fermented Functional Foods" II Edition. CRC Press, 2008.
6. Ramesh C. Ray and Didier Montet, "Fermented Foods, Part- II Technological Interventions", CRC Press, 2017.
7. N.R. Reddy, "Legume based Fermented foods", CRC Press, 2018.

22FD036 **CELLULAR AGRICULTURE** **3 0 0 3**

Course Objectives

- Familiarize with cellular agriculture and its applications.
- Know the various kinds of cellular development in food products.
- To understand the protocols of sampling techniques in cellular agricultural measurements.
- To gain the knowledge on level of tissue culturing.
- Creates an awareness to choose food with highly natural.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply the set one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PSO2 Practical and research training imparted to the students will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the fundamentals of cellular agriculture.
2. Assess the fermentation in cellular agriculture.
3. Outline about the plant-based alternatives and dairy substitutes.
4. Analyze technological platforms and automation.
5. Evaluate knowledge through projects and presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	1	2					1	1			1
2	1	2	2	2	2					1	1			1
3	1	1	1	2	3					2	1			
4	2	2	2	2	2					2	1			
5	1			1	2									

UNIT I **9 Hours**

INTRODUCTION TO CELLULAR AGRICULTURE

Overview of Cellular Agriculture, Historical perspective and development, Definition and scope of cellular agriculture, Basics of cell biology and its relevance to cellular agriculture, Comparison with traditional agriculture, Ethical considerations and sustainability, Evolution of traditional agriculture practices, Challenges and opportunities in developing regulatory frameworks.

UNIT II **9 Hours**

TISSUE ENGINEERING AND BIOPROCESSING

Definition and goals of tissue engineering, Basic principles of tissue engineering design and methodology, Cellular Components in Tissue Engineering-Cell sources and selection for tissue engineering, Role of stem cells in tissue regeneration, Bioprocessing Techniques in Cellular Agriculture-Overview of bioprocessing in cellular agriculture, Scale-up challenges and solutions, Bioreactor design and function, Challenges and innovations in large-scale cultivation.

UNIT III **9 Hours**

CELLULAR AGRICULTURE PRODUCTS

Cultured Meat Productions-In-depth exploration of cultured meat production, Different cell sources and their impact on product characteristics. Plant-Based Alternatives-plant-based cellular agriculture products, Types of plant-based alternatives (e.g., burgers, sausages, dairy substitutes), Formulation and production methods, Fermentation-Based Products-Products produced through fermentation (e.g., cheese, yogurt, protein alternatives), Innovations and challenges in fermentation processes. Consumer acceptance and market trends, Nutritional considerations and comparisons with traditional products.

UNIT IV **9 Hours**

TECHNOLOGICAL PLATFORMS IN CELLULAR AGRICULTURE

Automation and Robotics-Role of automation in cellular agriculture, Robotics applications in bioprocessing and cultivation, Advantages and challenges of automated systems, Cellular Agriculture Startups and Industry Landscape-Exploration of emerging startups in the cellular agriculture sector.

UNIT V **9 Hours**

INDUSTRY PERSPECTIVES AND FUTURE TRENDS IN CELLULAR AGRICULTURE

Introduction to the current state of the cellular agriculture industry, Challenges faced by companies in the cellular agriculture sector, Opportunities for innovation and growth, Global Perspectives on Cellular Agriculture, Sustainability and Environmental Impact.

FURTHER READING

Cultured meat Production, Plant cell culture and applications.

Total: 45 Hours

Reference(s)

1. "Cellular Agriculture: Developing Sustainable Foods" edited by Lauri Reuter and Marianne Ellis.
2. "Cultured Meat and Animal Welfare: The New Food Revolution" by Walter Veit
3. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
4. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003
5. Jaiwal P K & Singh R P (eds) Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA
6. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

22FD037 FRUIT SCIENCE 3 0 0 3

Course Objectives

- Understand and analyze the fundamentals of horticulture in fruit production.
- Impart knowledge on role and significance of breeding in development of fruits.
- Learn about the general characteristics of tropical, subtropical and temperate fruits and also its post-harvest practices.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the basic fundamentals of horticulture.
2. Assess the techniques of breeding fruit crops and its importance.
3. Analyze the tropical and subtropical fruits and its cropping system.
4. Outline the temperate fruits production and varieties.
5. Evaluate the post-harvest practices of fruits and packaging systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2	1	2	1		1		1			1	1
2	1		2	2	2	1		2		1			1	1
3	1		1	2	3	2		1		1			1	
4	2		2	2	2	1		1		1				
5	1		1			2		2					1	

UNIT I **9 Hours**

FUNDAMENTALS OF HORTICULTURE

Classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India - soil and climate, planning and layout, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops. Types and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, weed management, fertility management, cropping systems, Rejuvenation, principles of organic farming.

UNIT II **9 Hours**

BREEDING OF FRUIT CROPS

Origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement – introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions,

UNIT III **9 Hours**

TROPICAL AND SUBTROPICAL FRUITS

Commercial varieties of regional, national and international importance, recent trends in propagation, rootstock influence, planting systems, cropping systems, nutrient management, water management, fertigation, bioregulation, physiology of flowering, maturity indices, harvesting and ripening techniques; Crops: Apple, pear, quince, grapes, Plums, peach, apricot, cherries, Litchi, loquat, persimmon, kiwifruit, strawberry, Nuts- walnut, almond, pistachio, pecan, hazelnut, Minor fruits-mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate.

UNIT IV **9 Hours**

TEMPERATE FRUITS

Classification of temperate fruits - detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, nutrient and weed management - harvesting, post-harvest handling and storage of apple, pear, peach, apricot, cherry, persimmon, strawberry, kiwi, Queens land nut (Macadamia nut), almond, walnut, pecan nut, hazel nut and chest nut.

UNIT V **9 Hours**

POST HARVEST TECHNOLOGY

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration; Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling; Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage- ventilated, refrigerated, MAS, CA storage, physical injuries and disorders; Packing methods and transport, principles and methods of preservation, food processing methods, processing waste management, food safety standards.

FURTHER READING

Interaction of light, temperature, humidity, CO2, water on crop regulation - Greenhouse heating, cooling, ventilation and shading. Harnessing biotechnology in horticultural crops.

Total: 45 Hours

Reference(s)

1. Prasad and Kumar, 2014. Principles of Horticulture 2nd Edn. Agrobios (India).
2. Neeraj Pratap Singh, 2005. Basic concepts of Fruit Science 1st Edn. IBDC Publishers.
3. Gardner/Bardford/Hooker. J.R., 1957. Fundamentals of Fruit Production. Mac Graw Hill Book Co., New York.
4. Mukherjee, S.K. and Majumdar, P.K.1973.Propagation of fruit crops. ICAR, New Delhi.
5. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22FD038 POST HARVEST MANAGEMENT OF FRUITS AND VEGETABLE 3 0 0 3

Course Objectives

- To provide basic knowledge of postharvest processing methods and processes involved in post-harvest loss reduction.
- To introduce postharvest management practices which are eco-friendly and sustainable by integrating them with existing modern technologies.
- To encourage students in product development, conversion of fresh produce to processed form for value addition (nutritive and economic value).

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the postharvest technologies in their career through practical knowledge.
2. Predict and providing inputs to mitigate postharvest losses during cool chain management.
3. Outline on postharvest loss reduction through processing of fruits and vegetables.
4. Analyse the activities of food processing industries and also drive towards entrepreneurship.
5. Evaluate novel packaging techniques and improving the shelf-life of the horticulture produce.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2					1		1		1			1	1
2	1		2		2	1		2		1				1
3	1		1	2	3	2		1		1				
4	2		2	2	2	1		1		1				
5	1		1	2	2	2		2					2	

UNIT I **9 Hours**

PRINCIPLES OF POST-HARVEST TECHNOLOGY

Introduction, History and role of post-harvest technology; principles and methods of food preservation. Post-harvest handling (harvesting, precooling, sorting, grading and packaging) of perishables. Food storage systems; ripening and senescence of horticultural crops; Post harvest treatment for quality retention of horticultural crops; spoilage of fruits & vegetables, methods to reduce decay. Processing of fruit and vegetables.

UNIT II **9 Hours**

PRE-HARVEST PHYSIOLOGICAL ASPECTS RELATED TO POST-HARVEST MANAGEMENT OF HORTICULTURAL PRODUCE

Introduction, Growth and development - definition, parameters of growth and development. Role of environmental factors and physiological processes on post-harvest life and quality. Physiological changes associated with ripening and seed development, preharvest factors affecting ripening and spoilage. Influence of plant growth regulators as pre harvest application on post-harvest storage life and quality. Growth and developmental processes during stress manipulation of developing crop.

UNIT III **9 Hours**

POST-HARVEST PHYSIOLOGY AND BIOCHEMISTRY OF FRUITS AND VEGETABLES

Introduction, Structure and composition of fruits and vegetables, postharvest factors affecting physiology and biochemical constituents. Maturity and ripening processes and factors affecting them. Presence of constituents and their changes during development; maturation and ripening of fruits and vegetables; Biosynthesis of ethylene and its regulation, Ethylene action and ripening processes. Regulation of ripening and senescence of fruits and vegetables.

UNIT IV **9 Hours**

POST-HARVEST TECHNOLOGY OF VEGETABLE CROPS

Scope and importance of post-harvest management of vegetables; Nature and causes of postharvest losses; Harvesting methods, tools, harvesting practices for specific market requirements; pre cooling methods; grading, washing, pack house operations, pre-treatments, chemicals, wax coating, edible coating, pre-packaging and irradiation; packaging of vegetables, packaging materials; Storage methods and Storage disorders, post-harvest diseases and pests - prevention from infestation.

UNIT V **9 Hours**

POST-HARVEST TECHNOLOGY OF FRUIT CROPS

Scope and importance of post-harvest management of fruits; Factors leading to post-harvest losses; Harvesting methods, tools, harvesting practices for specific market requirements; Pre cooling methods; grading, washing, pack house operations, pre-treatments prior to shipment; Pre-packaging and irradiation, packaging of fruits, packaging materials; Storage methods and storage disorders; quality evaluation, principles and methods of processing and preservation.

FURTHER READING
Difference between Modified Atmospheric Packaging and Controlled Atmospheric Packaging, novel technologies for minimizing the losses, Physiological deterioration.

Total: 45 Hours

Reference(s)

1. Sudheer, K.P. and V. Indira. 2007. Post-harvest technology of horticultural crops. New India Publishing Agency, New Delhi.
2. Verma, L.R. and V.K. Joshi. 2000. Post-harvest technology of fruits and vegetables – Handling, Processing, Fermentation and Waste Management. Indus Publishing Company. New Delhi.
3. Chadha, K.L. 2009. Handbook of Horticulture. IARI Publications, New Delhi.
4. Thompson, A.K. 1996. Post-harvest technology of fruits and vegetables. Blackwell Science Ltd. London.

22FD039 FRUITS AND VEGETABLE PROCESSING 3 0 0 3

Course Objectives

- Implement specific post-harvest handling technique for storage and transport of fruits and vegetables.
- Apply preservation techniques to produce value added fruits and vegetable products.
- Learn the industrial scale processing and preservation methods to extend the shelf life of fruit and vegetable commodities.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply low temperature, modified atmosphere and controlled atmospheric storage methods for storage of fruits and vegetables.
2. Assess value added products from fruits and vegetables by using suitable preservation method (sugar, salt or dehydration).
3. Outline dehydrated fruits and vegetables.

4. Analyze minimal processing and fermentation methods to produce value added products from fruits and vegetables.
5. Evaluate to produce canned and bottled fruits and vegetables.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2					1		1		1			1	1
2	1		2		2	1		2		1				1
3	1		1	2	3	2		1		1			1	
4	2		2	2	2	1		1		1			1	
5	1		1	2	2	2		2					2	

UNIT I **9 Hours**

HARVESTING, HANDLING AND STORAGE OF FRUITS AND VEGETABLES

Fruits and vegetables: classification, nutritional profile - Harvesting of fruits and vegetables - maturity indices - post harvest physiology - handling - precooling and storage - Storage under ambient condition, low temperature storage - chilling, frozen storage- chilling injury, freeze burn. Controlled atmosphere storage, Modified atmosphere storage - concepts and methods - gas composition - Changes during storage.

UNIT II **9 Hours**

PRESERVATION OF FRUITS AND VEGETABLES BY VALUE ADDITION

Methods of fruit and vegetable preservation - Processing using sugar- Preparation of jam, jelly, marmalade, squash, RTS, crush, nectar, cordial, fruit bar, preserves, candies and carbonated, fruit beverages. Processing using salt - Brining - Preparation of pickles, chutney and sauces, ketchup. Machinery involved in processing of fruits and vegetables products.

UNIT III **9 Hours**

PRESERVATION BY DRYING AND DEHYDRATION

Drying and dehydration - Types of driers - Solar, cabinet, fluidized bed drier, spouted bed drier, heat pump drier, vacuum drier and freeze drier - Applications. Preparation of product. Changes during drying and dehydration. Problems related to storage of dried and dehydrated products.

UNIT IV **9 Hours**

MINIMAL PROCESSING AND FERMENTATION

Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables, Minimal Processing of Fruits and Vegetables. Preservation by fermentation - wine, vinegar, cider and sauerkraut.

UNIT V **9 Hours**

CANNING AND BOTTLING

Canning - principles, types of cans - preparation of canned products - packing of canned products - spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations. General considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit.

FURTHER READING

Toping of sugar/salt, Hybrid drier, safe level of irradiation, solid state fermentation, layout of fruit/vegetable canning unit.

Total: 45 Hours

Reference(s)

1. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Third Edition, CBS Publishers & Distributors-New Delhi, 2002.
2. A. Chakraverty, A.S. Mujumdar, G.S.Vijaya Raghavan and H.S. Ramaswamy, Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press, USA, 2003.
3. Girdhari Lal, G. S.Siddappa and G.L. Tandon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 2009.
4. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.
5. K.Sharma, Stevan J.Mulvaney and Syed S.H. Rizvi, Food Process Engineering-Theory and Laboratory equipments, John Wiley & Sons, New York, 2000.
6. Norman W. Desrosier, and James N. Desrosier. The Technology of Food Preservation 4th Edition, CBS Publisher & Distributions, New Delhi, 2004.

22FD040 **BEVERAGE TECHNOLOGY** **3 0 0 3**

Course Objective

- Understand the classification of beverages.
- Impart knowledge and skills of beverage processing techniques.
- Understand the quality aspects of beverages.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the formulation of beverages using selected ingredients.
2. Apply Unit operations involved in the carbonated beverage manufacturing.
3. Analyze the various production techniques in non-carbonated beverages.
4. Outline the quality parameters of fermented beverages.
5. Evaluate the food laws and regulations of beverages.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		1	1	1	1		1		1				1
2	1		2	3	2	1		2		1				1
3	1		1	2	3	2		1		2			1	
4	2		2	2	2	1		2		2			1	
5	1		3	2	2	2		2		2			1	

UNIT I **9 Hours**

INGREDIENTS IN BEVERAGES

Beverage: Introduction, Global and Indian scenario. Classification of beverages. Ingredients- water, quality evaluation, raw and processed water, bulk and intense sweeteners, water miscible and water dispersible flavoring agents, Micro and nano-emulsions of flavors, colors natural and artificial, preservatives, clouding agents, emulsifiers and stabilizers.

UNIT II **9 Hours**

CARBONATED BEVERAGES

Preparation of Syrup making, blending, Carbonation of soft drinks, filling, packaging, containers, closures. Powdered dry mix; Energy drinks and sports drinks; Fruit based carbonated beverages, carbonated water. Equipment used in the manufacture of carbonated beverages.

UNIT III **9 Hours**

NON – CARBONATED BEVERAGES AND BOTTLED WATER

Beverages based on tea, coffee, cocoa, spices, herbs, dairy based beverages, Fruit based non-carbonated beverage - RTS beverages, Squash, Nectar, Cordial and Fruit concentrate. Flash pasteurization, Canning and Aseptic Packaging of beverages. Bottled water, mineral water, spring water, flavored water.

UNIT IV **9 Hours**

FERMENTED BEVERAGES

Alcoholic beverages- Classification. Fermented alcoholic beverage - Beer - ale type beer, lager type beer, the role of yeast in beer, technology of brewing process. Wine, Cider, Perry and Sake. Distilled spirits - Whisky, Brandy, Vodka, Rum, Tequila and gin. Equipment used for brewing and distillation.

UNIT V **9 Hours**

SANITATION AND QUALITY CONTROL

Quality control in beverage industry- System quality control Product quality control and microbial quality control. CIP. Sanitation and hygiene in beverage industry. Standards and regulations of beverages.

FURTHER READING

Traditional natural beverages. Raw materials, quality and technology for producing Wine, Beer, Whiskey, Brandy, and Rum. Tea and Coffee processing.

Total: 45 Hours

Reference(s)

1. L. Jagan Mohan Rao and K. Ramalakshmi, Recent trend in soft beverages, Woodhead Publishing India Pvt Ltd., New Delhi 2011
2. Woodroof, Jasper Guy, and G. Frank Phillips. Beverages: carbonated and noncarbonated. AVI Pub. Co., 1981
3. Mitchell, Alan J. Formulation and Production Carbonated Soft Drinks. Springer Science & Business Media, 1990
4. Richard Coles and Mark Kirwan Food and Beverage Packaging Technology Second Edition Blackwell Publishing Ltd., 2011.
5. Hui, Yiu H., et al., eds. Handbook of food and beverage fermentation technology. Vol. 134. CRC Press, 2004.
6. Boulton, Christopher, and David Quain. Brewing yeast and fermentation. John Wiley & Sons, 2008.

22FD041 VALUE ADDED PRODUCTS FROM FRUITS AND VEGETABLES 3 0 0 3

Course Objectives

- Understand Fruits and Vegetable Processing Techniques and its quality grading
- Analyse the methods of processing for value added products from fruits and vegetables
- Evaluate the packaging requirement and quality control of value-added products

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the trend and selection of raw materials in value added products.
2. Assess the techniques involved in fruit and vegetable processing.
3. Analyse the quality and manufacturing techniques of fruit products.
4. Outline the quality and manufacturing techniques of vegetable products.
5. Evaluate the extraction of flavour components from minor spices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		1	1				1		1				1
2	1		2	3	2	1		2		1				1
3	1		1	2	3	2		1		2				
4	2		2	2	2	1		2		2			2	
5	1		3	2						2			2	

UNIT I **9 Hours**

INTRODUCTION TO VALUE ADDED PRODUCTS

Overview of Value-Added Processing – Definition and significance of value-added products- Market trends and consumer demand for processed fruits and vegetables- Selection of raw materials – importance of quality and ripeness of fruits and vegetables- Heat treatment methods (blanching, pasteurization).

UNIT II **9 Hours**

PROCESSING TECHNIQUES

Canning– Introduction and Method; Drying techniques of fruits and vegetables – benefits and challenges; Freezing methods – benefits and challenges; Packaging consideration of frozen fruits and vegetables.

UNIT III **9 Hours**

VALUE ADDED PRODUCTS FROM FRUITS

Value added products of mango – pulp, juice, concentrates, toffee, kernel flour; value added products of pineapple – canned pineapple, jam, vinegar, toffee; Value added products of grapes – wine, jelly, raisins.

UNIT IV **9 Hours**

VALUE ADDED PRODUCTS FROM VEGETABLES

Value added products of tomato – puree, paste, powder, sauce; Value added products from tuber crops- cassava flour, sago, starch; Value added products of cucurbits – pumpkin seeds, cucumber pickles, bottle gourd tutee fruit, ash gourd pettah. Minimally processed products and vegetable powders, plant-based foods.

UNIT V **9 Hours**

PACKAGING AND QUALITY CONTROL OF VALUE-ADDED PRODUCTS

Packaging and storage of value-added fruits and vegetables; Quality analyses and FSSAI specifications of fruits and vegetable products. Market value; Waste Reduction.

Total: 45 Hours

Reference(s)

1. Chakraverty, A, Arun S. Mujumdar, G.S. Vijayaraghavan, and Hosahalli. S. Ramaswamy. Handbook of Post Havret Technology: Cereals, Fruits, Vegetables, Tea and Spices, Marcel Dekker. Inc. New York.2003
2. K. Sharma, Stevan Mulvaney and Syed S.H. Rizvi, Food Process Engineering-Theory and Laboratory equipments, John Wiley & Sons, New York, 2000.
3. Norman W. Desrosier, and James N. Desrosier. The Technology of Food Preservation 4th Edition, CBS Publisher & Distributions, New Delhi, 2004.

22FD042 FRUIT AND VEGETABLE WASTE MANAGEMENT 3 0 0 3

Course Objectives

- To define fruit and vegetable waste (FVW) and describe its sources and characteristics.
- To describe various FVW valorization techniques.
- To develop strategies for sustainable FVW management.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the significance of fruit and vegetable waste management in the context of sustainability
2. Apply the environmental, economic, and social impacts of fruit and vegetable waste.
3. Analyze effective practices for reducing food waste in households and foodservice establishments.
4. Outline potential applications for valorized and upcycled fruit and vegetable waste.
5. Evaluate the effectiveness of existing policies and suggest improvements for better waste management practices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		1	1				1		1				1
2	1		2	3	2	1		2		1				1
3	1		1	2	3	2		1		2				
4	2		2	2	2	1		2		2			2	
5	1		3	2						2			2	

UNIT I **9 Hours**

INTRODUCTION TO FRUIT AND VEGETABLE WASTE MANAGEMENT

Definition and scope of fruit and vegetable waste management; Sources and types of fruit and vegetable waste; Environmental and economic impact of fruit and vegetable waste; Importance of fruit and vegetable waste management.

UNIT II **9 Hours**

ON - FARM FRUIT AND VEGETABLE WASTE MANAGEMENT

Pre-harvest and post-harvest waste reduction strategies; Segregation and collection of fruit and vegetable waste at the farm level; On-farm composting and vermicomposting techniques; Biogas production from fruit and vegetable waste

UNIT III **9 Hours**

POST - HARVEST FRUIT AND VEGETABLE WASTE MANAGEMENT

Handling and storage practices to minimize post-harvest waste; Segregation and collection of fruit and vegetable waste at the market and processing level; Anaerobic digestion of fruit and vegetable waste for energy production; Recycling and reuse of fruit and vegetable waste

UNIT IV **9 Hours**

FRUIT AND VEGETABLE WASTE VALORIZATION

Production of value-added products from fruit and vegetable waste; Extraction of bioactive compounds from fruit and vegetable waste; Utilization of fruit and vegetable waste for animal feed; Development of innovative products from fruit and vegetable waste

UNIT V **9 Hours**

SUSTAINABLE FRUIT AND VEGETABLE WASTE MANAGEMENT POLICIES AND PARCTICES

Role of government policies and regulations in promoting sustainable fruit and vegetable waste management; Public awareness and education programs for reducing fruit and vegetable waste; Implementation of sustainable waste management practices in the food processing industry; Case studies of successful fruit and vegetable waste management initiatives

FURTHER READING

Case study on Fruits and vegetable waste management systems.

Total: 45 Hours

Reference(s)

1. Food and Agriculture Organization of the United Nations (FAO). (2011). Global food losses and food waste--Extent, causes and prevention. Rome: Food and Agriculture Organization of the United Nations.
2. Parfitt, E., Bartley, J., & Food Waste & Resources Action Programme (WRAP). (2016). Food waste reduction in the UK: A study by WRAP. Banbury, UK: Waste & Resources Action Programme.
3. Kaur, I. (Ed.). (2014). Fruit and vegetable waste management: Concepts, technologies, and policy. Dordrecht: Springer.
4. Singh, A., Kumar, A., & Gupta, S. K. (Eds.). (2020). Fruit and vegetable waste valorization: Challenges, opportunities, and solutions. Cham: Springer.
5. Lee, J. Y., & Choi, H. J. (Eds.). (2021). Sustainable waste management and resource recovery. Cham: Springer.

22FDH01 FOOD PACKAGING TECHNOLOGY 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food packaging for socio-economic needs
2. Analyze the importance of Chemical alteration in Natural macromolecular compounds.
3. Justify the importance of processing Non-renewable materials in traditional packaging.
4. Outline the new innovation in developing advanced packaging material
5. Check the response to the changes in processing foods by modern packaging techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2	1	2	1	1				1			
2	1	2	2	1	2	1								
3	1	1	1	1	3	1	3				1			
4	2	2	2		2	1	2					1	1	2
5	1	2	1								1			1

UNIT I **9 Hours**

INTRODUCTION TO FOOD PACKAGING

Introduction, Definitions, Functions of packaging - Containment, Protection, Convenience, Communication. Packaging Environments - Physical Environment, Ambient Environment, Human Environment. Functions/ Environmental Grid, Socio-Economic Needs. Deterioration reactions in foods - Deteriorative reactions & Factors. Shelf life of Food.

UNIT II **9 Hours**

PLASTIC POLYMERS

Structure and Related Properties of Plastic Polymers-Factors influencing polymers structures and related properties(Molecular structure, Molecular weight , Density , Crystallinity, Physical Transitions in Polymers, Chemical structures , and Additives in plastics).Optical , Mechanical, and Barrier properties of Thermoplastic polymers. Processing and Converting of Thermoplastic Polymers.

UNIT III **9 Hours**

EDIBLE, BIOBASED

Edible Packaging materials- Polysaccharides, Lipids, Proteins, Composite materials, Film additives, Bio-nano composites. Biobased & Biodegradable Packaging materials- Classification, Degradability, Degradability of Biobased polymers, OBD Polymers, Category 1,2,3,4,Properties of Biobased packaging materials (Barrier & Mechanical),Current Limitations, Methods to improve Functionality, Bio-nano composites, Applications. Environmental Aspects & Future trends.

UNIT IV **9 Hours**

ASEPTIC PACKAGING

Aseptic packaging- Introduction (History & Principles of Sterilization),Sterilization of packaging material food contact surface (Irradiation, Heat, Chemical Treatments, Verification of Sterilization process),Aseptic packaging systems(Carton systems, Bottle systems, Sachey & Pouch systems , Cup systems) Integrity Testing of Aseptic Packages. Packaging of Microwavable Foods- Introduction, Basic principles, Effect of food Product, Packaging (Transparent, Absorbent, Shielding & Field modification,Doneness Indicators, Testing methods & Safety)

UNIT V **9 Hours**

ACTIVE AND INTELLIGENT PACKAGING

Active and Intelligent Packaging- Definitions, Active packaging systems (Sachets and Pads, Active packaging materials, Self- Heating and Self- Cooling Packages, changing gas permeability, Wedges), Intelligent Packaging (Indicating Product Quality, Convenience, Theft, counterfeiting & Tampering, safety& regulations). Modified atmospheric packaging- Introduction, Principles, Gas used in MAP, Methods of creating MA conditions, Equipment involved, Applications, Microbiology of MAP, Safety, Refrigerated & Pasteurized Foods with Extended durability and sous vide.

Total: 45 Hours

Reference(s)

1. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, Blackwell Publishers, 2003.
2. Gordon L. Robertson, Food Packaging: Principles and Practice, Third Edition (Food Science and Technology), Taylor & Francis, CRC Press, 2013
3. NIIR Board, Food Packaging Technology Handbook (2nd Revised Edition), NIIR Project Consultancy Services, 2012.
4. Richard Coles and Mark J. Kirwan, Food and Beverage Packaging Technology, Second Edition, Wiley & Blackwell, 2011.
5. K.L. Yam and D.S. Lee, Emerging Food Packaging Technologies, Principles and Practice, A volume in Woodhead Publishing series in Food Science, Technology and Nutrition, 2012.
6. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni, Food Packaging Science and Technology, CRC Press, 2

22FDH02 FOOD PACKAGING DESIGN AND DEVELOPMENT 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the functions of food packaging for food processing industries
2. Demonstrate the importance of 2D & 3D sketching of Packaging Design
3. Outline the importance of fabrication techniques for food packaging materials
4. Justify the importance of printing techniques in food packaging
5. Determine the new innovation in developing advanced packaging material

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2							1
2	2	1	1	1	2	1							2	3
3	2	2	2	1	2	1	3				1			
4	1	2	2	1	2	1	2							
5	1	2	1								1		2	1

UNIT I **9 Hours**

INTRODUCTION

History-Past Innovations-Outline of traditional and modern food packaging system, Residual migration of food packaging system, Dyes- synthetic and non-synthetic. Types of Packaging materials used in foodprocessing industry.

UNIT II **9 Hours**

PACKAGING DESIGN AND PATTERN MAKING

Principles-2D and 3D sketching, Preparation of key line diagram- Primary, Secondary and Tertiary packaging materials , Basics of Computer Aided Engineering and Design. Food packaging design and simulation, CAD and CAM application in Food Industry. Food packaging design as per FSSAI guidelines.

UNIT III **9 Hours**

PACKAGING MOULDING TECHNIQUES

Introduction-Paper & Paper Board, Cartons, Glass, Metals and plastic materials for food packaging system. Types of Molding Techniques- Paper Pulping, Fabrication of corrugated Fiber board. Glass forming techniques, Thermostat & Thermopiles packaging materials. Processing of metal tin/can.

UNIT IV **9 Hours**

PRINTING TECHNIQUES IN PACKAGING MATERIALS

Introduction-Types of printing techniques involved in food packaging materials- Offset, Screen, Flexographic and Digital Printing

UNIT V **9 Hours**

NOVEL FOOD PACKAGING DESIGN

Introduction- Emerging packaging techniques, Design and principles of smart packaging system Design, Recent Innovation- Intelligent packaging, Application of Active packaging system-Anti-microbial, Anti-Oxidant, Anti- Freeze and Fortification in packed food via active materials, Development of packaging materials using novel biomaterials.

Total: 45 Hours

Reference(s)

1. W.Soroka, Fundamentals of packaging Technology, IoPP
2. Plastics: Materials and processing, pearson-prentice Hall
3. Paper and paperboard Packaging Technology, Mark J. Kirwan, Blackwell Publishing
4. Harald Johnson, Understanding Digital Printing, Thomson Publisher, Boston
5. Barnard & peacock, Hand book of print and production
6. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, Blackwell Publishers, 2003.

22FDH03 DIVERSE MATERIALS IN FOOD PACKAGING 3 0 0 3

Course Objectives

- Understand the properties and characteristics of glass, wood, metal, and cardboard as packaging materials.
- Analyze the advantages and disadvantages of each material for different packaging applications.
- Evaluate the sustainability issues related to packaging, including recyclability, biodegradability, and environmental impact.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Show an awareness of the historical and strategic dimensions of food packaging, understanding its protective function, logistic implications, and impact on shelf life in food marketing systems.
2. Predict the environmental impact of paper and paperboard packaging solutions by analyzing and designing based on considerations such as fiber sources, manufacturing processes, and functional properties.
3. Justify the diverse facets of plastics in food packaging, encompassing manufacturing, and types, printing, sealing, and addressing environmental concerns.

4. Analyze the market trends, container designs, raw materials, manufacturing processes, and corrosion challenges in metal packaging, gaining a deep understanding of its role in the food industry.
5. Evaluate the knowledge in glass container packaging, recognizing glass as a marketing tool, by understanding its composition, manufacturing, closure techniques, thermal processing, and environmental considerations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	2	1	2	1							1
2	1	2	2	2	1	3	1							
3	1	1	2	1	3	1	3							
4	2	1	2			3	1							
5	1	1	2	1	1	1	3	1					1	

UNIT I **8 Hours**

FUNDAMENTALS OF FOOD

Introduction, Packaging developments-an historic perspective, Food supply and the protective role of packaging, basic functions of packaging, packaging strategy, packaging design and development, food bio deterioration and methods of preservation, packaged product quality and shelf life, Logistic packaging for food marketing systems.

UNIT II **8 Hours**

PAPER AND PAPERBOARD PACKAGING

Introduction, Paper and Paperboard- fibre source and fibre separation, Paper and paperboard manufacture-methods and process involved. Packaging papers and paperboards, properties of paper and paperboard, Additional functional properties of paper and paperboard, Design for paper and paperboardpackaging, package types, systems, environmental profile.

UNIT III **10 Hours**

PLASTICS IN FOOD PACKAGING

Introduction, Manufacture of plastics packaging, types of plastic used in packaging, coating of plastic films-types and properties, secondary conversion techniques, printing, printing and labelling of rigid plastic containers, food contact and barrier properties, sealabilty and closure, cold seal, plastic closures for bottles, jar and tubs, adhesive systems used with plastics, retort pouch, environmental and waste management issue, plastic manufacturing and life cycle assessment (CLA), plastic waste management.

UNIT IV **9 Hours**

METAL IN FOOD PACKAGING

Overview of market for metal cans, container performance requirements, container designs, raw materials for can making-steel, aluminum, recycling of packaging metal, can-making processes, end making processes, coatings, film laminates and inks, processing of food and drinks in metal packages, shelf life of canned foods, internal corrosion, stress corrosion cracking, environmental stress cracking corrosion of aluminum alloy beverage can ends, Sulphur staining, external corrosion.

UNIT V **10 Hours**

PACKAGING OF FOOD IN GLASS CONTAINERS

Definition of glass, brief history, glass packaging, glass containers market sectors for foods and drinks, glass composition, attributes of food packaged in glass containers, glass and glass container manufacture, closure section, thermal processing of glass packaged foods, plastic sleeving and

decorating possibilities, strength in theory and practice, glass pack design and specification, packaging-due diligence in the use of glass containers, environmental profile, glass as a marketing tool.

Total: 45 Hours

Reference(s)

1. Food packaging technology by Richar coles, Derek MsDowelll and Mark J. Kirwan. Blackwell publishing, CRC press, 2003.
2. Food Packaging by Takashi Kadoya, Kanagawa University, Hiratsuka, Japan. Academic press,1990
3. Glass Packaging Technology" by Walter Sperling and Werner Holleis, Wiley-VCH, 2012.
4. Corrugated Packaging: The Essential Guide" by Neil McGuire, DEStech Publications, Inc., 2013.
5. Metal Packaging: Materials, Markets and Applications" by D.R. Gabe, Smithers Rapra Technology, 2010.
6. Cardboard in Architecture: Volume 7 of the Research in Architectural Engineering Series" edited by Reza Mokhtarian and Ali Araghi, CRC Press, 2018.

22FDH04 **EMERGING TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY** **3 0 0 3**

Course Objectives

- Analyze and critically evaluate current trends and innovations in food packaging technology, including emerging materials, design concepts, and sustainability practices.
- Apply theoretical knowledge to assess the impact of technological advancements on food packaging, considering factors such as shelf-life extension, preservation methods, and consumer preferences.
- Explore and synthesize information on cutting-edge developments in food packaging, fostering the ability to adapt and implement innovative technologies to address challenges in the ever-evolving food industry.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the fundamentals of quality preservation in food through new technologies in packaging
2. Show the active packaging technologies and evaluate their applications in food packaging.
3. Outline the packaging properties for various fresh foods and comprehend their significance.
4. Determine a deep understanding of edible and biodegradable coatings.
5. Relate the knowledge of new packaging technologies and anticipating future trends in the dynamicfield of food packaging.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2		1					
2	2	1	1	2	1									1
3	2	2	2	1	2	1	3		1					2
4	1	2	2			1	2		2					
5	1	2	1										2	

8 Hours

UNIT I

FUNDAMENTALS OF QUALITY PRESERVATION OF FOOD

New technologies in food packaging: overview, Mass transfer of gas and solute through packaging materials, quality of packaged foods, surface chemistry of food, packaging and biopolymer materials.

UNIT II **8 Hours**

ACTIVE PACKAGING

Introduction to active packaging technologies, antimicrobial packaging systems, packaging containing natural antimicrobial or antioxidative agents, oxygen-scavenging packaging, intelligent packaging

UNIT III **10 Hours**

MODIFIED ATMOSPHERIC PACKAGING

Introduction of Modified Atmospheric Packaging (MAP), internal modified atmospheres of coated fresh fruits and vegetables: relative humidity effects, MAP of ready to eat foods, preservative packaging for fresh meats, poultry and fin fish. Centralized packaging systems for meats.

UNIT IV **10 Hours**

EDIBLE AND BIODEGRADABLE COATINGS AND FILMS

Introduction to edible films and coatings, agro-polymers for edible and biodegradable films, edible films and coatings from plant origin proteins; animal origin proteins; starches; non-starch polysaccharides, lipid-based edible films and coatings, emulsion and bi-layer edible films, plasticizers in edible films and coatings, sensory quality of foods associated with edible films and coating systems and shelf-life extension.

UNIT V **9 Hours**

COMMERICAL ASPECTS OF NEW PACKAGING TECHNOLOGIES

Commercial uses of active food packaging and MAP systems, US Food and Drug Administration regulations - The food additive petition process, Food contact substance notifications, special considerations for antimicrobial food additives, packaging from non-thermal food processing, Future trends.

Total: 45 Hours

Reference(s)

1. Innovations in Food Packaging by Jung H. Han. Elsevier academic press, Food science and Technology, International series, 2005.
2. Food Packaging by Takashi Kadoya, Kanagawa University, Hiratsuka, Japan. Academic press,1990
3. Food packaging technology by Richar coles, Derek Ms Dowelll and Mark J. Kirwan. Blackwellpublishing, CRC press, 2003.

4. Corrugated Packaging: The Essential Guide" by Neil McGuire, DE Stech Publications, Inc.,2013.
5. Metal Packaging: Materials, Markets and Applications" by D.R. Gabe, Smithers Rapra Technology, 2010.
6. Food Packaging: Principles and Practice" by Gordon L. Robertson, CRC Press, 2012.

22FDH05 PACKAGING PERFORMANCE TESTING AND MACHINERY 3 0 0 3

Course Objectives

- To provide an overview of the laws and regulations governing food packaging
- Impart knowledge about the regulatory framework for food packaging in different countries and regions, including the United States, the European Union, and other global markets.
- Learn about food safety, packaging materials and properties, labeling and claims, and emerging issues in food packaging regulations.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the regulatory framework for food packaging in different countries and regions
2. Predict the different types of food packaging materials and their properties
3. Conclude the role of packaging in ensuring food safety
4. Outline labeling and claims on food packaging
5. Evaluate emerging issues in food packaging regulations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		1	2			1	2	1						
2	1	2	2			1	2	1					2	2
3		2	2	1		1	3							1
4		1		1	1	1		1						2
5	2	2		2		1						-	2	1

UNIT I **8 Hours**

FOOD PACKAGING LAWS AND REGUALATIONS

History of Food Packaging regulations, Overview of global regulatory framework for food packaging, Types of food packaging materials and their properties. Food safety & packaging- Microbial hazards, Physical hazards & Chemical hazards associated with food packaging. Packaging as a control measurein HACCP.

UNIT II **8 Hours**

FOOD PACKAGING STANDARDS AND GUIDELINES

Overview of food packaging standards and guidelines, Food contact materials regulations, Standards for specific food packaging materials (Plastic, glass, metal, paper, etc.). Regulatory agencies and their roles in food packaging - FDA regulations & guidelines, USDA regulations & guidelines, EU regulations & guidelines and other global regulatory agencies & their roles.

UNIT III **11 Hours**

LABELING AND CLAIMS

Overview of global regulatory framework for labelling claims, Types of labeling claims and their definitions. Overview of food labeling requirements, Nutrition labeling requirements, Health and wellness claims, Environmental claims. The role of labelling claims in consumer behavior. Emerging issues in labelling claims-Novel foods & labelling claims, health claims for functional food & supplements, allergen labelling & claims, Sustainable packaging claims.

UNIT IV **10 Hours**

HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP) IN FOOD PACKAGING

Introduction to HACCP in Food packaging - Historic development of HACCP, Overview of global regulatory framework for HACCP, principles of HACCP in food packaging. HACCP plan development& implementation - Overview of HACCP plan development, Hazard analysis & identification, Critical control points and critical limits, Monitoring, corrective actions & verification. Risk assessment in Food Packaging - Overview, Types of hazards in food packaging, Risk assessment methods for foodpackaging materials and processes.

UNIT V **8 Hours**

TESTING AND QUALITY ASSURANCE

Food packaging materials, shelf life of packed food & packaging functionality, testing of physical, optical, electrical, thermal, and rheological properties for plastic packaging materials, permeation testing of synthetic polymers, testing glass as a food packaging material, metal packaging: testing and quality assurance, testing of paper as packaging material for food industry, testing and quality assurance of bioplastics, shock and vibration testing, testing migration, food package testing authorities & regulations.

Total: 45 Hours

Reference(s)

1. Food Packaging: Principles and Practice" by Gordon L. Robertson, 3rd Edition, 2012.
2. Food Packaging and Shelf Life: A Practical Guide" by Gordon L. Robertson, 2nd Edition, 2011.
3. The Certified HACCP Auditor Handbook" by ASQ Quality Press, 3rd Edition, 2016.
4. Hazard Analysis and Critical Control Point (HACCP) - A Systematic Approach to Food Safety" by Sara E. Mortimore and Carol Wallace, 3rd Edition, 2013.
5. Nutrition Labeling Handbook" by Marion Greaser and Geraldine June, 2nd Edition, 2013.
6. Consumer Behavior in Action: Real-Life Applications for Marketing Managers" by Geoffrey P. Lantos, 4th Edition, 2016.

22FDH06 NEXT GENERATION PACKAGING 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on developing high barrier packaging materials to safe guard the quality offood products
- Learn about modern techniques in food packaging system.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food packaging for food processing industries
2. Find the importance of active and intelligent packaging materials in food preservation.
3. Outline the importance of edible coating and film formation.
4. Analyse the importance of Nano technology in food packaging industry.
5. Evaluate the new innovation in developing advanced packaging material

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2							
2	2	1	1	1	2	1							1	
3	2	2	2	1	2	1	3				1			
4	1	2	2	1	2	1	2							
5	1	2	1								1		1	2

UNIT I **9 Hours**

INTRODUCTION

History-Past Innovations in food packaging materials: Outline of recent techniques involved in the development of food packaging system: Active packaging, Intelligent Packaging - Freshness indicator, Sensor based - Temperature, Gas Scavengers. Traditional practice in the development of edible packaging matrix- Barrier enhancement via blends and multi-layer.

UNIT II **9 Hours**

ACTIVE PACKAGING

Introduction-Active Packaging: Types of active compounds migration studies from the packaging materials to food. Intelligent Packaging - mechanism and application in food industry. Application of RFID and Barcode in novel packaging materials.

UNIT III **9 Hours**

INTELLIGENT PACKAGING

Introduction-Intelligent Packaging: mechanism and application in food industry. Application of RFID and Barcode in novel packaging materials. Authentication using smart technologies, and Non-invasive biometric sensory tools.

UNIT IV **9 Hours**

EDIBLE COATING FILMS

Introduction- Molecular interaction of Edible source (polysaccharides, protein and lipids) during film matrix formation. Application of Nano materials in edible film and coatings. Biochemical aspects of edible packaging. Current research progress in the development of edible film coating.

UNIT V **9 Hours**

RECENT ADVANCEMENTS IN MULTI-LAYER PACKAGING

Introduction - multi-layer packaging. Emerging packaging techniques - Microwavable food packaging, Functional packaging materials - Fortification of active ingredients like flavour and color. Application of Nano techniques and Nano composite in food packaging materials.

Total: 45 Hours

Reference(s)

1. Innovations in Food Packaging. (2013). Netherlands: Elsevier Science.
2. Food Packaging: Advanced Materials, Technologies, and Innovations (2020). UnitedKingdom: CRC Press.
3. Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods (FMCG):Markets, Materials and Technologies. (2013). United Kingdom: Elsevier Science.
4. Food Packaging: The Smarter Way. (2022). Singapore: Springer Nature Singapore.
5. Ghosh, T., Katiyar, V. (2021). Nanotechnology in Edible Food Packaging: Food PreservationPractices for a Sustainable Future. Germany: Springer Nature Singapore.

6. Edible Food Packaging: Materials and Processing Technologies. (2017). United States: CRCPress.

22FDM01 **FOOD PACKAGING TECHNOLOGY** **3 0 0 3**

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food packaging for socio-economic needs
2. Analyze the importance of Chemical alteration in Natural macromolecular compounds.
3. Justify the importance of processing Non-renewable materials in traditional packaging.
4. Outline the new innovation in developing advanced packaging material
5. Check the response to the changes in processing foods by modern packaging techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2	1	2	1	1				1			
2	1	2	2	1	2	1								
3	1	1	1	1	3	1	3				1			
4	2	2	2		2	1	2					1	1	2
5	1	2	1								1			1

UNIT I **9 Hours**

INTRODUCTION TO FOOD PACKAGING

Introduction, Definitions, Functions of packaging - Containment, Protection, Convenience, Communication. Packaging Environments - Physical Environment, Ambient Environment, Human Environment. Functions/ Environmental Grid, Socio-Economic Needs. Deterioration reactions in foods - Deteriorative reactions & Factors. Shelf life of Food.

UNIT II **9 Hours**

PLASTIC POLYMERS

Structure and Related Properties of Plastic Polymers-Factors influencing polymers structures and related properties(Molecular structure, Molecular weight , Density , Crystallinity, Physical Transitions in Polymers, Chemical structures , and Additives in plastics).Optical , Mechanical, and Barrier properties of Thermoplastic polymers. Processing and Converting of Thermoplastic Polymers.

UNIT III **9 Hours**

EDIBLE, BIOBASED

Edible Packaging materials- Polysaccharides, Lipids, Proteins, Composite materials, Film additives, Bio-nano composites. Biobased & Biodegradable Packaging materials- Classification, Degradability, Degradability of Biobased polymers, OBD Polymers, Category 1,2,3,4,Properties of Biobased packaging materials (Barrier & Mechanical),Current Limitations, Methods to improve Functionality, Bio-nano composites, Applications. Environmental Aspects & Future trends.

UNIT IV **9 Hours**

ASEPTIC PACKAGING

Aseptic packaging- Introduction (History & Principles of Sterilization),Sterilization of packaging material food contact surface (Irradiation, Heat, Chemical Treatments, Verification of Sterilization process),Aseptic packaging systems(Carton systems, Bottle systems, Sachey & Pouch systems , Cup systems) Integrity Testing of Aseptic Packages. Packaging of Microwavable Foods- Introduction, Basic principles, Effect of food Product, Packaging (Transparent, Absorbent, Shielding & Field modification,Doneness Indicators, Testing methods & Safety)

UNIT V **9 Hours**

ACTIVE AND INTELLIGENT PACKAGING

Active and Intelligent Packaging- Definitions, Active packaging systems (Sachets and Pads, Active packaging materials, Self- Heating and Self- Cooling Packages, changing gas permeability, Wedges), Intelligent Packaging (Indicating Product Quality, Convenience, Theft, counterfeiting & Tampering, safety& regulations). Modified atmospheric packaging- Introduction, Principles, Gas used in MAP, Methods of creating MA conditions, Equipment involved, Applications, Microbiology of MAP, Safety, Refrigerated & Pasteurized Foods with Extended durability and sous vide.

Total: 45 Hours

Reference(s)

1. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, Blackwell Publishers, 2003.
2. Gordon L. Robertson, Food Packaging: Principles and Practice, Third Edition (Food Science and Technology), Taylor & Francis, CRC Press, 2013
3. NIIR Board, Food Packaging Technology Handbook (2nd Revised Edition), NIIR Project Consultancy Services, 2012.
4. Richard Coles and Mark J. Kirwan, Food and Beverage Packaging Technology, Second Edition, Wiley & Blackwell, 2011.
5. K.L. Yam and D.S. Lee, Emerging Food Packaging Technologies, Principles and Practice, A volume in Woodhead Publishing series in Food Science, Technology and Nutrition, 2012.
6. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni, Food Packaging Science and Technology, CRC Press, 2

22FDM02 FOOD PACKAGING DESIGN AND DEVELOPMENT 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery ofgoods to the ultimate consumer in best condition.
- Impart knowledge on processing macromolecular organic compounds by chemical alteration.
- Learn about modern techniques of preserving food materials from various factors.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Find the functions of food packaging for food processing industries
2. Demonstrate the importance of 2D & 3D sketching of Packaging Design
3. Outline the importance of fabrication techniques for food packaging materials
4. Justify the importance of printing techniques in food packaging
5. Determine the new innovation in developing advanced packaging material

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2							1
2	2	1	1	1	2	1							2	3
3	2	2	2	1	2	1	3				1			
4	1	2	2	1	2	1	2							
5	1	2	1								1		2	1

UNIT I **9 Hours**
INTRODUCTION

History-Past Innovations-Outline of traditional and modern food packaging system, Residual migration of food packaging system, Dyes- synthetic and non-synthetic. Types of Packaging materials used in foodprocessing industry.

UNIT II **9 Hours**
PACKAGING DESIGN AND PATTERN MAKING
Principles-2D and 3D sketching, Preparation of key line diagram- Primary, Secondary and Tertiary packaging materials , Basics of Computer Aided Engineering and Design. Food packaging design and simulation, CAD and CAM application in Food Industry. Food packaging design as per FSSAI guidelines.

UNIT III **9 Hours**
PACKAGING MOULDING TECHNIQUES
Introduction-Paper & Paper Board, Cartons, Glass, Metals and plastic materials for food packaging system. Types of Molding Techniques- Paper Pulping, Fabrication of corrugated Fiber board. Glass forming techniques, Thermostat & Thermopiles packaging materials. Processing of metal tin/can.

UNIT IV **9 Hours**
PRINTING TECHNIQUES IN PACKAGING MATERIALS
Introduction-Types of printing techniques involved in food packaging materials- Offset, Screen, Flexographic and Digital Printing

UNIT V **9 Hours**
NOVEL FOOD PACKAGING DESIGN
Introduction- Emerging packaging techniques, Design and principles of smart packaging system Design, Recent Innovation- Intelligent packaging, Application of Active packaging system-Anti-microbial, Anti-Oxidant, Anti- Freeze and Fortification in packed food via active materials, Development of packaging materials using novel biomaterials.

Total: 45 Hours

Reference(s)

1. W.Soroka, Fundamentals of packaging Technology, IoPP
2. Plastics: Materials and processing, pearson-prentice Hall
3. Paper and paperboard Packaging Technology, Mark J. Kirwan, Blackwell Publishing
4. Harald Johnson, Understanding Digital Printing, Thomson Publisher, Boston
5. Barnard & peacock, Hand book of print and production
6. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, Blackwell Publishers, 2003.

22FDM03 DIVERSE MATERIALS IN FOOD PACKAGING 3 0 0 3

Course Objectives

- Understand the properties and characteristics of glass, wood, metal, and cardboard as packaging materials.
- Analyze the advantages and disadvantages of each material for different packaging applications.
- Evaluate the sustainability issues related to packaging, including recyclability, biodegradability, and environmental impact.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Show an awareness of the historical and strategic dimensions of food packaging, understanding its protective function, logistic implications, and impact on shelf life in food marketing systems.
2. Predict the environmental impact of paper and paperboard packaging solutions by analyzing and designing based on considerations such as fiber sources, manufacturing processes, and functional properties.
3. Justify the diverse facets of plastics in food packaging, encompassing manufacturing, and types, printing, sealing, and addressing environmental concerns.

4. Analyze the market trends, container designs, raw materials, manufacturing processes, and corrosion challenges in metal packaging, gaining a deep understanding of its role in the food industry.
5. Evaluate the knowledge in glass container packaging, recognizing glass as a marketing tool, by understanding its composition, manufacturing, closure techniques, thermal processing, and environmental considerations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	2	1	2	1							1
2	1	2	2	2	1	3	1							
3	1	1	2	1	3	1	3							
4	2	1	2			3	1							
5	1	1	2	1	1	1	3	1					1	

UNIT I **8 Hours**

FUNDAMENTALS OF FOOD

Introduction, Packaging developments-an historic perspective, Food supply and the protective role of packaging, basic functions of packaging, packaging strategy, packaging design and development, food bio deterioration and methods of preservation, packaged product quality and shelf life, Logistic packaging for food marketing systems.

UNIT II **8 Hours**

PAPER AND PAPERBOARD PACKAGING

Introduction, Paper and Paperboard- fibre source and fibre separation, Paper and paperboard manufacture-methods and process involved. Packaging papers and paperboards, properties of paper and paperboard, Additional functional properties of paper and paperboard, Design for paper and paperboardpackaging, package types, systems, environmental profile.

UNIT III **10 Hours**

PLASTICS IN FOOD PACKAGING

Introduction, Manufacture of plastics packaging, types of plastic used in packaging, coating of plastic films-types and properties, secondary conversion techniques, printing, printing and labelling of rigid plastic containers, food contact and barrier properties, sealabilty and closure, cold seal, plastic closures for bottles, jar and tubs, adhesive systems used with plastics, retort pouch, environmental and waste management issue, plastic manufacturing and life cycle assessment (CLA), plastic waste management.

UNIT IV **9 Hours**

METAL IN FOOD PACKAGING

Overview of market for metal cans, container performance requirements, container designs, raw materials for can making-steel, aluminum, recycling of packaging metal, can-making processes, end making processes, coatings, film laminates and inks, processing of food and drinks in metal packages, shelf life of canned foods, internal corrosion, stress corrosion cracking, environmental stress cracking corrosion of aluminum alloy beverage can ends, Sulphur staining, external corrosion.

UNIT V **10 Hours**

PACKAGING OF FOOD IN GLASS CONTAINERS

Definition of glass, brief history, glass packaging, glass containers market sectors for foods and drinks, glass composition, attributes of food packaged in glass containers, glass and glass container manufacture, closure section, thermal processing of glass packaged foods, plastic sleeving and

decorating possibilities, strength in theory and practice, glass pack design and specification, packaging-due diligence in the use of glass containers, environmental profile, glass as a marketing tool.

Total: 45 Hours

Reference(s)

1. Food packaging technology by Richar coles, Derek MsDowelll and Mark J. Kirwan. Blackwell publishing, CRC press, 2003.
2. Food Packaging by Takashi Kadoya, Kanagawa University, Hiratsuka, Japan. Academic press,1990
3. Glass Packaging Technology" by Walter Sperling and Werner Holleis, Wiley-VCH, 2012.
4. Corrugated Packaging: The Essential Guide" by Neil McGuire, DEStech Publications, Inc., 2013.
5. Metal Packaging: Materials, Markets and Applications" by D.R. Gabe, Smithers Rapra Technology, 2010.
6. Cardboard in Architecture: Volume 7 of the Research in Architectural Engineering Series" edited by Reza Mokhtarian and Ali Araghi, CRC Press, 2018.

22FDM04 **EMERGING TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY** **3 0 0 3**

Course Objectives

- Analyze and critically evaluate current trends and innovations in food packaging technology, including emerging materials, design concepts, and sustainability practices.
- Apply theoretical knowledge to assess the impact of technological advancements on food packaging, considering factors such as shelf-life extension, preservation methods, and consumer preferences.
- Explore and synthesize information on cutting-edge developments in food packaging, fostering the ability to adapt and implement innovative technologies to address challenges in the ever-evolving food industry.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the fundamentals of quality preservation in food through new technologies in packaging
2. Show the active packaging technologies and evaluate their applications in food packaging.
3. Outline the packaging properties for various fresh foods and comprehend their significance.
4. Determine a deep understanding of edible and biodegradable coatings.
5. Relate the knowledge of new packaging technologies and anticipating future trends in the dynamicfield of food packaging.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2		1					
2	2	1	1	2	1									1
3	2	2	2	1	2	1	3		1					2
4	1	2	2			1	2		2					
5	1	2	1										2	

8 Hours

UNIT I

FUNDAMENTALS OF QUALITY PRESERVATION OF FOOD

New technologies in food packaging: overview, Mass transfer of gas and solute through packaging materials, quality of packaged foods, surface chemistry of food, packaging and biopolymer materials.

UNIT II **8 Hours**

ACTIVE PACKAGING

Introduction to active packaging technologies, antimicrobial packaging systems, packaging containing natural antimicrobial or antioxidative agents, oxygen-scavenging packaging, intelligent packaging

UNIT III **10 Hours**

MODIFIED ATMOSPHERIC PACKAGING

Introduction of Modified Atmospheric Packaging (MAP), internal modified atmospheres of coated fresh fruits and vegetables: relative humidity effects, MAP of ready to eat foods, preservative packaging for fresh meats, poultry and fin fish. Centralized packaging systems for meats.

UNIT IV **10 Hours**

EDIBLE AND BIODEGRADABLE COATINGS AND FILMS

Introduction to edible films and coatings, agro-polymers for edible and biodegradable films, edible films and coatings from plant origin proteins; animal origin proteins; starches; non-starch polysaccharides, lipid-based edible films and coatings, emulsion and bi-layer edible films, plasticizers in edible films and coatings, sensory quality of foods associated with edible films and coating systems and shelf-life extension.

UNIT V **9 Hours**

COMMERICAL ASPECTS OF NEW PACKAGING TECHNOLOGIES

Commercial uses of active food packaging and MAP systems, US Food and Drug Administration regulations - The food additive petition process, Food contact substance notifications, special considerations for antimicrobial food additives, packaging from non-thermal food processing, Future trends.

Total: 45 Hours

Reference(s)

1. Innovations in Food Packaging by Jung H. Han. Elsevier academic press, Food science and Technology, International series, 2005.
2. Food Packaging by Takashi Kadoya, Kanagawa University, Hiratsuka, Japan. Academic press,1990
3. Food packaging technology by Richar coles, Derek Ms Dowelll and Mark J. Kirwan. Blackwellpublishing, CRC press, 2003.

4. Corrugated Packaging: The Essential Guide" by Neil McGuire, DE Stech Publications, Inc.,2013.
5. Metal Packaging: Materials, Markets and Applications" by D.R. Gabe, Smithers Rapra Technology, 2010.
6. Food Packaging: Principles and Practice" by Gordon L. Robertson, CRC Press, 2012.

22FDM05 PACKAGING PERFORMANCE TESTING AND MACHINERY 3 0 0 3

Course Objectives

- To provide an overview of the laws and regulations governing food packaging
- Impart knowledge about the regulatory framework for food packaging in different countries and regions, including the United States, the European Union, and other global markets.
- Learn about food safety, packaging materials and properties, labeling and claims, and emerging issues in food packaging regulations.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Assess the regulatory framework for food packaging in different countries and regions
2. Predict the different types of food packaging materials and their properties
3. Conclude the role of packaging in ensuring food safety
4. Outline labeling and claims on food packaging
5. Evaluate emerging issues in food packaging regulations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		1	2			1	2	1						
2	1	2	2			1	2	1					2	2
3		2	2	1		1	3							1
4		1		1	1	1		1						2
5	2	2		2		1						-	2	1

UNIT I **8 Hours**

FOOD PACKAGING LAWS AND REGUALATIONS

History of Food Packaging regulations, Overview of global regulatory framework for food packaging, Types of food packaging materials and their properties. Food safety & packaging- Microbial hazards, Physical hazards & Chemical hazards associated with food packaging. Packaging as a control measurein HACCP.

UNIT II **8 Hours**

FOOD PACKAGING STANDARDS AND GUIDELINES

Overview of food packaging standards and guidelines, Food contact materials regulations, Standards for specific food packaging materials (Plastic, glass, metal, paper, etc.). Regulatory agencies and their roles in food packaging - FDA regulations & guidelines, USDA regulations & guidelines, EU regulations & guidelines and other global regulatory agencies & their roles.

UNIT III **11 Hours**

LABELING AND CLAIMS

Overview of global regulatory framework for labelling claims, Types of labeling claims and their definitions. Overview of food labeling requirements, Nutrition labeling requirements, Health and wellness claims, Environmental claims. The role of labelling claims in consumer behavior. Emerging issues in labelling claims-Novel foods & labelling claims, health claims for functional food & supplements, allergen labelling & claims, Sustainable packaging claims.

UNIT IV **10 Hours**

HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP) IN FOOD PACKAGING

Introduction to HACCP in Food packaging - Historic development of HACCP, Overview of global regulatory framework for HACCP, principles of HACCP in food packaging. HACCP plan development& implementation - Overview of HACCP plan development, Hazard analysis & identification, Critical control points and critical limits, Monitoring, corrective actions & verification. Risk assessment in Food Packaging - Overview, Types of hazards in food packaging, Risk assessment methods for foodpackaging materials and processes.

UNIT V **8 Hours**

TESTING AND QUALITY ASSURANCE

Food packaging materials, shelf life of packed food & packaging functionality, testing of physical, optical, electrical, thermal, and rheological properties for plastic packaging materials, permeation testing of synthetic polymers, testing glass as a food packaging material, metal packaging: testing and quality assurance, testing of paper as packaging material for food industry, testing and quality assurance of bioplastics, shock and vibration testing, testing migration, food package testing authorities & regulations.

Total: 45 Hours

Reference(s)

1. Food Packaging: Principles and Practice" by Gordon L. Robertson, 3rd Edition, 2012.
2. Food Packaging and Shelf Life: A Practical Guide" by Gordon L. Robertson, 2nd Edition, 2011.
3. The Certified HACCP Auditor Handbook" by ASQ Quality Press, 3rd Edition, 2016.
4. Hazard Analysis and Critical Control Point (HACCP) - A Systematic Approach to Food Safety" by Sara E. Mortimore and Carol Wallace, 3rd Edition, 2013.
5. Nutrition Labeling Handbook" by Marion Greaser and Geraldine June, 2nd Edition, 2013.
6. Consumer Behavior in Action: Real-Life Applications for Marketing Managers" by Geoffrey P. Lantos, 4th Edition, 2016.

22FDM06 NEXT GENERATION PACKAGING 3 0 0 3

Course Objectives

- Understand the Socio-scientific discipline that operates in society to ensure the delivery of goods to the ultimate consumer in best condition.
- Impart knowledge on developing high barrier packaging materials to safe guard the quality offood products
- Learn about modern techniques in food packaging system.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1 Execute innovative and high-quality research to solve emerging problems in Food Technology by applying scientific knowledge.

PSO2 Practical and research training will pave way for introducing novel technologies in Food Processing sectors for global sustenance.

Course Outcomes (COs)

1. Apply the functions of food packaging for food processing industries
2. Find the importance of active and intelligent packaging materials in food preservation.
3. Outline the importance of edible coating and film formation.
4. Analyse the importance of Nano technology in food packaging industry.
5. Evaluate the new innovation in developing advanced packaging material

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1		1	1	2							
2	2	1	1	1	2	1							1	
3	2	2	2	1	2	1	3				1			
4	1	2	2	1	2	1	2							
5	1	2	1								1		1	2

UNIT I **9 Hours**

INTRODUCTION

History-Past Innovations in food packaging materials: Outline of recent techniques involved in the development of food packaging system: Active packaging, Intelligent Packaging - Freshness indicator, Sensor based - Temperature, Gas Scavengers. Traditional practice in the development of edible packaging matrix- Barrier enhancement via blends and multi-layer.

UNIT II **9 Hours**

ACTIVE PACKAGING

Introduction-Active Packaging: Types of active compounds migration studies from the packaging materials to food. Intelligent Packaging - mechanism and application in food industry. Application of RFID and Barcode in novel packaging materials.

UNIT III **9 Hours**

INTELLIGENT PACKAGING

Introduction-Intelligent Packaging: mechanism and application in food industry. Application of RFID and Barcode in novel packaging materials. Authentication using smart technologies, and Non-invasive biometric sensory tools.

UNIT IV **9 Hours**

EDIBLE COATING FILMS

Introduction- Molecular interaction of Edible source (polysaccharides, protein and lipids) during film matrix formation. Application of Nano materials in edible film and coatings. Biochemical aspects of edible packaging. Current research progress in the development of edible film coating.

UNIT V **9 Hours**

RECENT ADVANCEMENTS IN MULTI-LAYER PACKAGING

Introduction - multi-layer packaging. Emerging packaging techniques - Microwavable food packaging, Functional packaging materials - Fortification of active ingredients like flavour and color. Application of Nano techniques and Nano composite in food packaging materials.

Total: 45 Hours

Reference(s)

1. Innovations in Food Packaging. (2013). Netherlands: Elsevier Science.
2. Food Packaging: Advanced Materials, Technologies, and Innovations (2020). UnitedKingdom: CRC Press.
3. Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods (FMCG):Markets, Materials and Technologies. (2013). United Kingdom: Elsevier Science.
4. Food Packaging: The Smarter Way. (2022). Singapore: Springer Nature Singapore.
5. Ghosh, T., Katiyar, V. (2021). Nanotechnology in Edible Food Packaging: Food PreservationPractices for a Sustainable Future. Germany: Springer Nature Singapore.

6. Edible Food Packaging: Materials and Processing Technologies. (2017). United States: CRCPress.

22OCE01 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

Course Objectives

- To develop an understanding and analyze the energy data of industries
- To carry out energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings
- To utilize the available resources in optimal ways

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Classify and characterize the energy resources.
2. Illustrate the concept of green building.
3. Outline the sustainable construction practices.
4. Understand the hydropower production and conservation of water.
5. Emphasis the significance of energy and resource recovery from waste materials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1											1			
2	1	2					2					1			
3	1	2					2					1			
4	1	2					2					1			
5	1	2					2					1			

UNIT I **9 Hours**

INTRODUCTION TO ENERGY SOURCE

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. Energy - Past & Present scenario of World; Renewable and Nonrenewable energy resources.

UNIT II **9 Hours**

ENERGY CONSERVATION IN BUILDINGS

Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building- classification of buildings. Green building - LEED building assessment standard – LEED certification process - Building rating system - Building energy issues – Building energy design strategies – Energy Auditing.

UNIT III **9 Hours**

SUSTAINABLE CONSTRUCTIONS

Equipment use in excavations, foundation, concreting. Advanced Techniques in tunneling, under water construction, piling techniques, Innovations & efficiency in Highways, Railways & Harbours - linkages between economic and environmental outcomes

UNIT IV **9 Hours**

WATER CONSERVATION & SUSTAINABILITY

Types of reservoirs and its functions – Hydropower production – Types of Turbines & selections of turbines & Energy calculations. Water losses from reservoirs and channels – Canal lining & its economic aspects. Water supply systems & Irrigation methods - Rain Water Harvesting methods & benefits.

UNIT V **9 Hours**

ENERGY RECOVERY FROM WASTE

Classification and sources of wastes- Factors affecting MSW generation – Waste management hierarchy - Energy recovery from wastes: Thermochemical methods for energy production - Details of incineration, gasification and pyrolysis & biochemical conversions - Landfill gas recovery system - Principles of fermentation - Concept of MFC - Trans-esterification process - Biofuel processing - Biomass gasification - Organic waste for hydrogen production.

Total: 45 Hours

Reference(s)

1. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, Inc., New Jersey, 2008.
3. H. M. Raghunath, Irrigation Engieering, Wiley India (P) Ltd, 2011
4. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company
5. M. Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, ISBN-10: 8173191409,1997.
6. Lal, P.M. Sarma, Priyangshu M, Wealth from Waste: Trends and Technologies, 3rd Edition, The Energy and Resources Institute, New Delhi, ISBN: 9788179934241, 2011.
7. W. McDonough, M. Braungart, Cradle to Cradle: Remaking the Way We Make Things, United States: North Point Press, ISBN-10: 0865475873, 2002.

3 0 0 3

22OCS01 OBJECT ORIENTED PROGRAMMING

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2			3										
2	1	2	3		3										
3	1	2	2		3										
4	1	2	3		3										
5	1	2	3		3										

UNIT I **8 Hours**
INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona)

UNIT II **8 Hours**
OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types- CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**
OPERATOR OVERLOADING AND INHERITANCE

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators- Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance:Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV
POLYMORPHISM AND FILE STREAMS **10 Hours**

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **10 Hours**
TEMPLATES AND EXCEPTION HANDLING

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

22OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2		2										
2	2	3	2		2										
3	3	3	3		3										
4	2	2	2		2										
5	2	2	2		2										

UNIT I **9 Hours**

BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

22OCS03 KNOWLEDGE DISCOVERY IN DATABASES

3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate the various data mining techniques on complex data objects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2	2	3	2												
3	2	2	2												
4	3	2	2	2											
5	2	2	2	2											

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS- Metadata-Multidimensional data model - Data Extraction, Cleanup and Transformation Tools -Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **8 Hours**
INTRODUCTION TO DATA MINING
Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

UNIT III **9 Hours**
ASSOCIATION RULE MINING
Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

UNIT IV **9 Hours**
CLASSIFICATION AND CLUSTERING
Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k- medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **10 Hours**
DATA MINING APPLICATIONS
Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining - Application and trends in data mining - Social impacts of Data mining.

Total: 45 Hours

Reference(s)

1. Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2. Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
3. David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4. Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

22OCS04 E-LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2	2	3												
3	3	3	3												
4	2	2	2												
5	2	2	2												

UNIT I **9 Hours**
INTRODUCTION
Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**
TECHNOLOGIES
Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**
MANAGEMENT
Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**
TEACHING-LEARNING PROCESS
Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**
APPLICATIONS
Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

22OCS05 SOCIAL TEXT AND MEDIA ANALYTICS

3 0 0 3

Course Objectives

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2	3										
2	2	3		2	2										
3	2	3		3	3										
4	2	2	2	3	2										
5	2	3		2	3										

UNIT I **7 Hours**
TEXT MINING
Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II **9 Hours**
METHODS
Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**
WEB ANALYTICS
Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV **10 Hours**
SOCIAL NETWORK ANALYTICS
Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**
SOCIAL MEDIA ANALYTICS
Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

22OEC01 BASICS OF ANALOG AND DIGITAL ELECTRONICS

3 0 0 3

Course Objectives

- Understand the working of diodes and transistors in electronic circuits.
- Understand the analog operational amplifier and its applications.
- Understand the implementation of combinational and sequential circuits in digital systems.

Programme Outcomes (POs)

Course Outcomes (COs)

1. Apply the diodes and transistors in regulators and amplifiers and analyze their characteristics.
2. Illustrate the working of analog IC with different configurations and its applications.
3. Simplification of Boolean expressions using K-map and implementation of combinational circuits.
4. Analyze the Flip flops and memory configurations in digital circuits.
5. Classify and analyze A/D and D/A converters with its parameters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1										2	
2		3	1										2	
3			2		1								2	
4			2		3								2	
5			3		2								2	

UNIT I **9 Hours**

SEMICONDUCTORS DEVICES

Conductor, Semiconductors & Insulators, Semiconductors: intrinsic & extrinsic, energy band diagram - Mobility - Electrons and holes - The P-N junction diode - Zener diode - Avalanche effect- Rectifier Circuits Half wave, Full wave circuits, Efficiency, PIV, Ripple factor and AC and DC current and voltage in rectifier. PNP and NPN Bipolar junction Transistors - H parameters equivalent circuit - Common emitter amplifier - DC behavior: the load slope and the Q point - AC behavior - Emitter follower amplifier - Field effect transistors: JFET and MOSFET.

UNIT II **9 Hours**

OPERATIONAL AMPLIFIERS: DC PERFORMANCE

The operational amplifier - Input resistance, Output resistance, Open loop gain - Bias currents - Offset currents - Offset voltage - Differential mode gain - Common mode gain - Common mode rejection ratio - Negative feedback - Open loop gain and closed loop gain - Inverter amplifier - Non-inverter amplifier - The voltage follower - Transimpedance amplifier (Current to voltage converter) - Differential amplifier. Adders, Subtractors, Comparator, Integrator and Differentiator.

UNIT III **9 Hours**

DIGITAL TECHNIQUES : COMBINATIONAL CIRCUITS

Numbering systems - Binary, octal and hexadecimal numbers - Boole algebra - Conversion and operations - AND gate- OR gate - Inverter - NAND gate - NOR gate - Exclusive OR gate. Morgans laws.

Combinational Circuits: Truth tables, logic expressions, Logic simplification using K- map, , half and full adder/subtractor, multiplexers, demultiplexers, Logic families :TTL and CMOS.

UNIT IV **9 Hours**

DIGITAL TECHNIQUES: SEQUENCIAL CIRCUITS

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Flip Flop Conversion. Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAM. Volatiles Memories: RAM, SRAM, DRAM. Addressing modes.

UNIT V **9 Hours**

DIGITAL TO ANALOG CONVERTERS AND ANALOG TO DIGITAL CONVERTERS

DIGITAL TO ANALOG CONVERTERS : Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network.Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time.Glitches. ANALOG TO DIGITAL CONVERTERS: Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti-aliasing filtering. Sampling and holding. Conversion.

Total: 45 Hours

Reference(s)

1. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education,2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw-Hill,2010.
3. Ramakant A.Gayakwad, OP-AMP and Linear IC"s , Prentice Hall of India, 2002.
4. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
6. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

22OEC02 MICROCONTROLLER PROGRAMMING 3 0 0 3

Course Objectives

- Understand Series of Microcontrollers in terms of architecture, Programming and Interfacing.
- Learn Programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers
- Learn the emerging trends in the design of advanced Microncontrollers.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. Able to design new concepts in the domains of Microelectronics and Communication Engineering.

Course Outcomes (COs)

1. Interpret the components and functionalities of 8051 Microcontrollers.
2. Develop microprocessor applications using Assembly Language Program
3. Illustrate the working nature of PIC microcontroller on various versions
4. Illustrate the interfacing of different peripherals using PIC Microcontroller
5. Analyze the architecture and instruction set of ARM Microcontroller

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1										2	
2		3	1										2	
3			2		1								2	
4			2		3								2	
5			3		2								2	

UNIT I **9 Hours**

8-BIT MICROCONTROLLER

Introduction-Intel 8051 architecture-Counters and Timers-Serial Interface- Interrupts- Interfacing to external memory and 8255- Instruction set- Address modes.

UNIT II **9 Hours**

8051 ALP AND APPLICATIONS

Assembly language program- Timers and Counters programming- DAC- ADC- Sensor- Keyboard and LCD.

UNIT III **9 Hours**

PIC MICROCONTROLLER

PIC Microcontroller features- PIC Architecture, Program Memory, Addressing Modes, Instruction Set, Instruction Format- Byte-oriented Instructions- Bit-oriented Instructions- Literal Instructions- Control Instructions (CALL & GOTO)- Destination Designator. MPLAB overview: Using MPLAB, Toolbars, Select Development Mode and Device type, Project, Text Editor, Assembler, MPLAB operations.

UNIT IV **9 Hours**

PIC HARDWARE

Reset, Clock, Control registers, Register banks, Program Memory Paging, Ports, Interrupts, Timer and Counter, Watchdog Timer, Power up timer, Sleep mode, I2C bus- A/D converter.

UNIT V **9 Hours**

HIGH PERFORMANCE RISC ARCHITECTURE

ARM: The ARM architecture- ARM organization and implementation- The ARM instruction set- The THUMB instruction set- Basic ARM Assembly Language Program- ARM CPU Cores.

FOR FURTHER READING

Introduction- Architecture- Registers- Memory- Instruction set- Addressing Modes- I/O Pins- Timers- Counters- Interrupts.

Total: 45 Hours

Text Book(s)

1. Ayala, Kenneth, "The 8051 Microcontroller", Thomson, 3rd Edition, 2004
.

Reference(s)

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Person Education, 2nd Edition, 2004.
2. John B.Peatman, "Design with Microcontrollers", Person Education", 1st Edition, 2004.
3. Steave Furber, "ARM system-on-chip architecture" Addison Wesley, 2nd Edition, 2000.
4. A.V.Deshmukh, "Microcontrollers: Theory and Applications", Tata Mc Graw Hill, 12th reprint, 2005.

21OEC03 PRINCIPLES OF COMMUNICATION SYSTEMS 3 0 0 3

Course Objectives

- To study the various analog and digital modulation techniques
- To study the various digital communication techniques
- To enumerate the idea of spread spectrum modulation
- To study the design concepts of satellite and optical communication

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. Able to design new concepts in the domains of Microelectronics and Communication Engineering.

Course Outcomes (COs)

1. Illustrate the process involved in Amplitude, Frequency and phase modulation systems.
2. Analyze the performance of different digital modulation /demodulation techniques.
3. Analyze Pulse Code Modulation scheme for the transmission of analog data in digital format.
4. Apply the concepts of spread spectrum modulation techniques to eradicate interference in wireless communication.
5. Analyze the system design of satellite and optical communication.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2										2		
2	3	2											2		
3	3	2											2		
4	2	2	2										2		
5	3	2											2		

UNIT I **9 Hours**

FUNDAMENTALS OF ANALOG COMMUNICATION

Principles of amplitude modulation, AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM Voltage distribution, AM power distribution, Angle modulation. FM andPM waveforms, phase deviation and modulation index, frequency deviation and percent modulation,Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves

UNIT II **9 Hours**

DIGITAL COMMUNICATION

Introduction, Shannon limit for information capacity, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) Minimum Shift Keying (MSK),Phase Shift Keying (PSK), BPSK, QPSK, 8 PSK Quadrature Amplitude Modulation (QAM), Bandwidth Efficiency,Comparison of various Digital Communication System (ASK - FSK - PSK - QAM).

UNIT III **9 Hours**

DIGITAL TRANSMISSION

Introduction, Pulse modulation, PCM , PCM sampling, sampling rate, signal to quantization noise rate,companding, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission, Intersymbol interference, eye patterns.

UNIT IV **9 Hours**

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES

Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques, wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

UNIT V **9 Hours**

SATELLITE AND OPTICALCOMMUNICATION

Satellite Communication Systems-Keplers Law,LEO and GEO Orbits, footprint, Link model-OpticalCommunication Systems-Elements of Optical Fiber Transmission link, Types, Losses, Sources and Detectors.

FOR FURTHER READING

RADAR Communication: Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Applications of Radar.

Total: 45 Hours

Reference(s)

1. Wayne Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson Education, 2007.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons., 2001.
3. H.Taub,D L Schilling,G Saha ,Principles of Communication,3/e,2007.
4. B.P.Lathi,Modern Analog And Digital Communication systems, 3/e, Oxford University Press, 2007
5. Dennis Roddy, "Satellite Communications", Third Edition, Mc Graw Hill International Editions, 2001.
6. Gerd Keiser, Optical Fiber Communication, McGraw-Hill International, Singapore, 4th edition., 2011.

22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	1											
2	1	2	2	3											
3	1	1	2	3											
4	1	1	3												
5	1	2	3	3											

UNIT I **9 Hours**

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch, Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

22OEI01 PROGRAMMABLE LOGIC CONTROLLER 3 0 0 3

Course Objectives

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate a suitable logical programming for given applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1		2	2		3								
2	2	1		2	2		3								
3	2	1		2	2		3								
4	2	1		2	2		3								
5	2	1		2	2		3								

UNIT I **10 Hours**

INTRODUCTION TO AUTOMATION

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

UNIT II **9 Hours**

ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485,Ethernet - Selection criteria for PLC.

UNIT III **8 Hours**

PLC PROGRAMMING

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

UNIT IV **10 Hours**

ADVANCED PLC FUNCTONS

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions:Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

UNIT V **8 Hours**

APPLICATIONS OF PLC

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 wayswith pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentationand control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall ofIndia Pvt. Ltd., New Delhi, 2013.

22OEI02	SENSOR TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite	Assessment Pattern	
• NIL	**Mode of Assessment**	**Weightage(%)**
	Continuous Internal Assessment	40
	Semester End Examinations	60

Course Objectives

- To impart knowledge about various sensors in multidisciplinary engineering domain.
- To familiarize students with different applications and its material handling technology
- To understand the concept of sensing circuits and its static and dynamic characteristics

Programme Outcomes (POs)

PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

The students will be able to

CO1	Conclude the static and dynamic characteristics of measuring instruments.
CO2	Compare the characteristics and working principles of Resistance, Inductance and Capacitance type sensors.
CO3	Construct the interfacing and signal conditioning circuit for measurement system using different types of sensor.
CO4	Analyze and select the suitable sensor for different industrial applications.
CO5	Combine the modern technologies and smart materials to design various sensors.

Articulation Matrix

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1											
2	2	3	2	1	1									
3	1	2	3	3	1									
4	2	1	1	3	3									
5	1	2	1	2	3									

Unit I	**SENSORS FUNDAMENTALS AND CHARACTERISTICS**	**8 Hours**

Sensors: Principles of Sensing - Sensor Classification and terminology- Units of Measurements -Measurands-Sensor Characteristics: Static and Dynamic.

Unit II	**PHYSICAL PRINCIPLES OF SENSING**	**8 Hours**

Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

Unit III	**INTERFACE ELECTRONIC CIRCUITS**	**9 Hours**

Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

Unit IV	**SENSORS IN DIFFERENT APPLICATION AREA**	**10 Hours**

Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

UNIT V	**SENSOR MATERIALS AND TECHNOLOGIES**	**10 Hours**

Materials, Surface Processing- MEMS microsystem components- Microfluidics microsystem components - Nano Technology- Smart Materials.

Total	**45 Hours**

References

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.
2. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, New Delhi, 2009.
3. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 1st Edition, World Scientific Publishing Co, Singapore, 2015.
4. Horowitz, P., and W. Hill. The Art of Electronics. 2nd ed. Cambridge University Press, 1989.

22OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Pre-requisite	Assessment Pattern	
• NIL	**Mode of Assessment**	**Weightage(%)**
	Continuous Internal Assessment	40
	Semester End Examinations	60

Course Objectives

- Understand the basic components of Virtual Instrumentation system.
- Learn the developing VIs based on Lab VIEW software.
- To learn to develop applications based on Virtual Instrumentation system.

Programme Outcomes (POs)

PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

The students will be able to

CO1	Outline the concepts of traditional instruments and virtual instruments
CO2	Conclude the overview of modular programming and the structuring concepts in VI programming
CO3	Attribute the procedure to install DAQ in various OS and its interfacing methods
CO4	Implement the VI toolsets for specific applications
CO5	Generate the applications using Virtual Instrumentation software

Articulation Matrix

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	1										
2	3	3	2	2	2					2	2	2		
3	2	2	2	1										
4	3	3	3	1	2					1	2	2		
5	3	2	2	1	2					1	2	2		

Unit I	INTRODUCTION	9 Hours

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

Unit II	VI PROGRAMMING TECHNIQUES	9 Hours

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Unit III	DATA ACQUISITION	9 Hours

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

Unit IV	VI TOOLSETS	9 Hours

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipment like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

UNIT V	APPLICATIONS	9 Hours

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total	**45 Hours**

References

1. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.

3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

22OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	L	T	P	C
		3	0	0	3

Pre-requisite	Assessment Pattern	
	Mode of Assessment	**Weightage(%)**
• NIL	Continuous Internal Assessment	40
	Semester End Examinations	60

Course Objectives

- To enhance the student knowledge in fiber optics fundamentals and fabrication.
- To be recognized with industrial applications of fibers
- To understand the fundamental concepts about lasers
- To identify and describe various fiber optic imaging and optoelectronic sensor applications

Programme Outcomes (POs)

PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

The students will be able to

CO1	Attribute the properties of optical fibers, their light sources and detectors.
CO2	Implement the fiber-optic sensor for the measurement of various physical quantities.
CO3	Conclude the fundamentals of laser, types of laser and its working.
CO4	Outline the applications of laser for industrial applications.
CO5	Differentiate the use of laser instruments for various medical applications.

Articulation Matrix

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1											
2	3	2	1	2										
3	3	2	1											
4	3	2	2	2										
5	3	2	2	2										

Unit I	OPTICAL FIBERS AND THEIR PROPERTIES	9 Hours

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, Photo detectors, source coupling, splicing and connectors.		
Unit II	**INDUSTRIAL APPLICATION OF OPTICAL FIBERS**	**9 Hours**
Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators -detectors.		
Unit III	**LASER FUNDAMENTALS**	**9 Hours**
Fundamental characteristics of lasers: laser rate equation - three level system - four level system -properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking -cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.		
Unit IV	**INDUSTRIAL APPLICATION OF LASERS**	**9 Hours**
Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials -removal and vaporization - calculation of power requirements of laser for material processing.		
UNIT V	**HOLOGRAM AND MEDICAL APPLICATIONS**	**9 Hours**
Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynecology and oncology.		
	Total	**45 Hours**
References		

1. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
4. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
5. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
6. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

22OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2		2										
2	2	2	2		2										
3	2	2	2		2										
4	2	2	2		2										
5	2	2	2		2										

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
6. www.grabcad.com, www.all3dp.com

22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1		1										
2	3	3	1		2										
3	1	3	3		2										
4	2	3	1		2										
5	2	3	1		2										

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches- seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

22OME03 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2	2													
3					2	2	1								
4	1	2	1		2	2	2								
5	2	2	2		1	1	1								

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OME04 SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1					2	1		1							
2					1			3							
3	2											3			
4	2	3							2						
5					2					3					

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, ,Building and other construction works act 1996, Electricity Rules.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop,- Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

22OFD04 CEREAL, PULSES AND OIL SEED TECHNOLOGY

3 0 0 3

Course Objectives

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		2		2									
2	1	2		2		1									
3	2	2		1		2									
4	2	3		2		2									
5	2	2		2		3									

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP 3 0 0 3

Course Objectives

- To impart theoretical and practical knowledge about various handicraft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	3				2		2	2		2			
2	3	2	3				1		2	3		2			
3	3	2	3				2		2	3		2			
4	3	2	3				2		2	3		2			
5	3	2	3				2		2	3		2			

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNIT IV **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition (October 20,2009)
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007
3. All about Techniques in Illustration, Barron Educational Series, 2001
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000
6. https://www.marthastewart.com/274411/fashion-crafts

22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3			1									
2	3	2	3		2	3		2							
3	3	3	3		2	2		2							
4	3	3	3		2	3		2							
5	3	2			2			3							

UNIT I **9 Hours**
INTRODUCTION
Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

22OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2					1							
2	2	3	2						2						
3	2	3	2		3										
4	2	2	2						2						
5	2	2	2						2						

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole,Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work,Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitchapplication, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil- dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and ContemporaryApplications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd,UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY

3 0 0 3

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Understand religo-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		1				1					3			
2	2		2				2					2			
3	2		1				1					2			
4	2		3				3					3			
5	2		1				1					2			

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to NationalSecurity. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation.
Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji,Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling,SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth andNCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.
Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga- Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.
Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, ClearJump, Gate Vault, ZigZagBalance, High Wall etc.
COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure,Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture- Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

Total: 45 Hours

Reference(s)

1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/

22OAI01 FUNDAMENTALS OF DATA SCIENCE 3 0 0 3

Course Objectives

- To learn the basics of data science and statistical inference.
- To understand the concept of data pre-processing.
- To visualize the processed data using visualization techniques

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering, fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, naturalsciences, and engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Interpret the basics of data science and exploratory data analysis.
2. Represent the useful information using mathematical skills.
3. Demonstrate the usage of statistical inference and regression models.
4. Perform various data operations for cleaning and grouping of data.
5. Implement the visualization of data using visualization tools.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	2										
2	3	3	3	3	3										
3	3	3	3	3	3										
4	3	3	3	3	3										
5	3	3	3	3	3										

UNIT I **9 Hours**

INTRODUCTION

Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleaning, integrating, and transforming data – exploratory data analysis – buildthe models – presenting and building applications.

UNIT II **9 Hours**

DESCRIPTIVE STATISTICS I

Frequency distributions – Outliers – relative frequency distributions – cumulative frequency distributions – frequency distributions for nominal data – interpreting distributions – graphs – averages
– mode – median – mean – averages for qualitative and ranked data – describing variability– range – variance – standard deviation – degrees of freedom – interquartile range.

UNIT III **9 Hours**

DESCRIPTIVE STATISTICS II

Normal distributions – z scores – normal curve problems – finding proportions – finding scores – more about z scores – correlation – correlation coefficient for quantitative data – computational formula for correlation coefficient – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2.

UNIT IV **9 Hours**

PYTHON FOR DATA HANDLING

Basics of Numpy arrays – aggregations – computations on arrays – comparisons, masks, boolean logic
– fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – hierarchical indexing – combining datasets – aggregation and grouping.

UNIT V **9 Hours**

DATA VISUALIZATION

Types of data visualization: Exploratory, Explanatory, visualization with matplotlib – line plots – scatterplots – visualizing errors – density and contour plots – histograms, binnings, and density – threedimensional plotting– geographic data – data analysis using statmodels and seaborn – graph plotting using Plotly - Visualization Tools: Tableau

Total: 45 Hours

Reference(s)

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, ManningPublications, 2016. (Unit I)
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.(Units II and III)
3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016. (Units IV and V)
4. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green TeaPress, 2014

22OAM01 Computer Vision in Healthcare Application 3 0 0 3

Course Objectives

- Understand the algorithms and techniques used in image formation.
- Implement the motion computation and 3D vision to generate 3-dimensional images of an object.
- Develop computer vision tools to assist surgeons during procedures, providing real- time feedback and guidance.

Program Outcomes (POs)

a. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
b. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
m. Ability to design and develop Artificial Intelligence algorithms, tools and techniques for solving real world problems.

Course Outcomes (COs)

1. Interpret the image processing techniques for computer vision.
2. Implement the image pre-processing techniques.
3. Demonstrate 3D vision and motion related techniques.
4. Computer Vision for physical rehabilitation and training
5. Analysis of Medical Image for Predictive Analytics and Therapy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
1	1	1	1										2	
2	2	3	2		3								3	
3	2	2	2		2								3	
4	2	3	3		3								3	
5	2	3	3	2	3								3	

UNIT I **10 Hours**

COMPUTER VISION FOUNDATIONS

History of Computer Vision – Basics of Image Processing, Machine Learning – Information Retrieval – Neuroscience – Robotics – Speech – Cognitive Sciences –Algorithms, Systems and Theory .Image Processing - Colour - Linear Algebra Primer - Pixels and Filters - Edge Detection - Features and Fitting - Feature Descriptors - Image Resizing - Segmentation -

Semantic Segmentation - Clustering - Object recognition - Dimensionality Reduction - Face Identification - Visual Bag of Words - Object Detection from Deformable Parts - Semantic Hierarchies and Fine Grained Recognition - Motion - Tracking - Deep Learning

UNIT II **10 Hours**

IMAGE FORMATION AND IMAGE PRE-PROCESSING

Geometric primitives and transformations – Photometric image formation – The digital camera – Point operators – Linear Filtering – More neighbourhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization. Feature detection and matching – Segmentation – Edge detection - 2D and 3D feature based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation – Two-Frame Structure from motion – Factorization – Bundle adjustment – Constrained Structure and Motion – Dense motion estimation.

UNIT III **7 Hours**

3D VISION

Methods for 3D Vision - 3D reconstruction – Image based rendering, Image Recognition – Object Detection – Space, Instance and Category Recognition – Recognition Databases and test sets.

UNIT IV **9 Hours**

COMPUTER VISION FOR ASSISTING HEALTHCARE APPLICATIONS

Computer Vision to see - Computer Vision for Cognition - Computer Vision for physical rehabilitation and training - Computer Vision for CAD systems in surgery - Computer Vision for human-machine interaction - Computer Vision for Ambient Assisted Living - Egocentric (first person) vision.

UNIT V **9 Hours**

HEALTH CARE APPLICATIONS AND CONTEMPORARY ISSUES

Analysis of Medical Image - Computer Vision for Predictive Analytics and Therapy - Fundamental Algorithms for Medical Images - Machine Learning Algorithms for Medical Images – Deep learning approaches for healthcare applications - Contemporary issues.

Total: 45 Hours

Reference(s)

1. Ranjay Krishna, "Computer Vision: Foundations and Applications", Stand ford University, December 2017.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011.
3. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012.
4. Forsyth D A and Ponce J, "Computer Vision: A Modern Approach", Prentice Hall 2003.
5. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
6. Forsyth D A and Ponce J, "Computer Vision: A Modern Approach", Prentice Hall 2003.

22OAM02 Neural Networks 3 0 0 3

Course Objectives

- To understand the major concepts in deep neural networks.
- To apply Convolutional Neural Network architectures for any real-life applications.
- To analyse the key computations underlying deep learning to build and train deep neural networks for various tasks.

Program Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. Apply suitable algorithmic thinking and data management practices to design, develop, and evaluate effective solutions for real-life and research problems.

Course Outcomes (COs)

1. Apply Convolution Neural Network for any suitable applications.
2. Analyze the various classifiers of Single-layer perceptron.
3. Apply Convolutional Neural Networks and its variants for any suitable applications.
4. Analyze the Single-layer Feedback Networks with its mathematical foundation.
5. Analyze the various categories of associative memory with its case studies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
1	2	1	1		1								2	
2	2	2	3		3								2	
3	1	3	3		3								2	
4	2	2	2		3								2	
5	2	2	1		3								2	

UNIT I **9 Hours**

INTRODUCTION

Fundamental concepts and Model: Models of artificial Neural Networks, Neural processing, Learning and Adaptation, Neural network Learning rules- Hebbianrule, Perceptron rule, Delta rule.

UNIT II **9 Hours**
SINGLE LAYER PERCEPTRON MODEL

Single-layer perceptron classifiers: Classification model, Features and decision regions, Discriminant functions, Linear machine and Minimum distance classification, Non- parametric training concept, Training and Classification using the Discrete perceptron: algorithm and example, Single layer continuous Perceptron networks for linearly separable classifications.

UNIT III **9 Hours**
MULTI LAYER FEED FORWARD NETWORKS

Multilayer feed forward Networks: Linearly separable Pattern classification, Delta learning rule for Multiperceptron model, Generalized Delta learning rule, Feed forward recall and error back propagation training.

UNIT IV **9 Hours**
SINGLE LAYER FEEDBACK NETWORKS

Single-layer Feedback Networks: Basic concepts of dynamic systems, Mathematical foundations of Discrete-time Hopfield Networks, Mathematical foundations of Gradient type Hopfield networks, Associative memories: Basic concepts, Linear Associator.

UNIT V
9 Hours
ASSOCIATIVE MEMORY

Bidirectional associative memory - associative memory for spatio-temporal patterns - Case study: Implementation of NN in anysimulator. Self-Learning: Bidirectional Associative memory.

Total: 45 Hours

References

1. E. A.E and S. J.E, "Introduction to Evolutionary Computing | The on-line accompaniment to the book Introduction to Evolutionary Computing", Evolutionary computation.org, 2015.
2. F. Lobo, "Evolutionary Computation 2018/2019", Fernandolobo.info, 2018.
3. "EC lab Tools", Cs.gmu.edu, 2008.
4. "Kanpur Genetic Algorithms Laboratory", Iitk.ac.in, 2008.
5. "Course webpage Evolutionary Algorithms", Liacs.leidenuniv.nl, 2017.

22OBM01 OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES **3 0 0 3**

Course Objectives

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

Course Outcomes (COs)

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
1		3	2	1				1				2		2	
2		2	2	2				1				2		2	
3		3	2	2				1				2		2	
4		2	2	2				1				2		2	
5		3	2	2				1				2		2	

UNIT I **9 Hours**

MANAGEMENT ASPECTS

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance

UNIT II **9 Hours**

STRATEGIES AND TOOLS

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

UNIT III **9 Hours**

COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT IV **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

UNIT V **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS

Sources and scenarios of radiation incidents – guidance for protection of emergency responders -Occupational health surveillance of persons occupationally exposed to radiation in emergencies

Total: 45 Hours

Reference(s)

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety andHealth; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition.Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

22OBM02 AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT

3 0 0 3

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Course Outcomes (COs)

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2												2	
2	2													3	
3		2												2	
4	2	2													
5	2												2		

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligationsSwitch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett,"Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006

22OBM03 HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Course Outcomes (COs)

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
1	2													2	
2		2												2	
3		2											3		
4		2												2	
5	3													2	

UNIT I **9 Hours**
AUTOMATION IN HEALTHCARE
Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

UNIT II **9 Hours**
POWER GENERATION AND MEDICAL GAS PRODUCTION
Power generator, Battery : Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III **9 Hours**
AUTOMATION IN PIPING
Monitoring of flow and pressure of medical gas System components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**
INSTRUMENTATION SYSTEMS
Optical sensors , Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

UNIT V **9 Hours**
APPLICATIONS
Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3 rd edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4 th edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

22OIT01 DATA STRUCTURES 3 0 0 3

Course Objectives

- To understand the basic concepts such as Abstract Data Types, Linear and Non-Linear Data structures
- To analyze the performance of algorithms using time and space complexity.
- To understand the behavior of Linear and Non-Linear data structures
- To choose the appropriate data structures for a specified application
- To write programs in C++ to solve problems using various data structures.

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3 Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5 Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7 Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Analyze the performances of the sorting and searching algorithms
2. Apply linked list linear data structures operations using dynamic memory allocation
3. Apply stack and Queue data structure operations to solve computational problems
4. Design tree data structures and hashing techniques for effective searching of data
5. Build algorithms for solving real world problems using Graph data structure

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2		2										
2	3	3	2		2		2								
3	3	3	2		2		2								
4	3	3	2		2		2								
5	3	3	2		2		2								

UNIT I **8 Hours**

INTRODUCTION

Introduction to data structures-types of data structures- Pseudo code - Abstract data types - ADT Implementations performance analysis- time complexity and space complexity- basics of OOPS concepts.

UNIT II **9 Hours**

SORTING AND SEARCHING TECHNIQUES

Searching methods: Linear and binary search methods, Sorting techniques: Insertion Sort - Selection Sort - Bubble Sort - Merge sort - Quick sort.

UNIT III **11 Hours**

LINEAR DATA STRUCTURES

Stack operation - Stack ADT - Applications of stack - Queues operations - Queue ADT - Queue applications – Linked List - Circular - Doubly linked list.

UNIT IV **11 Hours**

TREE

Basic Tree concepts - Binary Trees - Tree Traversals - Binary Search Trees – B Tree - Heap concepts - Heap ADT

UNIT V **6 Hours**

GRAPHS

Introduction – types of graph- Shortest Path Algorithms: Unweighted Shortest Paths - Dijkstra's Algorithm. Minimum Spanning Tree: Prim's Algorithm - Kruskal's Algorithm- graph search methods DFS, BFS

Total: 45 Hours

Reference(s)

1. A Abirami, Priya R L , Advanced Data Structures and Algorithms , BPB publisher, 2023 March.
2. Data Structures using C++, Special Edition-MRCET, Tata McGraw-Hill Publishers 2017.
3. Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and Mount, Wiley student edition, John Wiley and Sons, 2011.
4. Data structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education. Ltd., Second Edition, 2013.
5. D.S. Malik, Data Structures Using C++, Second Edition 2010

22OIT02 C++ PROGRAMMING 2 0 2 3

Course Objectives

- To understand the concept of Object-Oriented Programming
- To apply the Object-Oriented concepts to solve problems using C++

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3 Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5 Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Implement C++ programs using classes and objects.
2. Develop C++ programs using the concept of Inheritance.
3. Design applications using virtual functions.
4. Understand the concept of Operator overloading.
5. Develop GUI applications using C++ library classes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2			2										
2	1	2			2										
3	1	3	2		2										
4	1	3	1		2										
5	1	3	3		2										

UNIT I 5 Hours

BASICS OF C++ PROGRAMMING

C++ Program Structure, Character Set and Tokens, Data Type, Type Conversion, Preprocessor Directives, Namespace, Input/output Streams and Manipulators, Dynamic Memory Allocation with new and delete, Control Statements. Functions: Function Overloading, Inline Functions, DefaultArgument, Pass by Reference, Return by Reference, Scope and Storage Class. Pointers: Pointer variables declaration & initialization, Operators in pointers, Pointers and Arrays, Pointer and Function.

UNIT II **6 Hours**

CLASSES & OBJECTS

A Simple Class and Object, accessing members of class, Initialization of class objects: (Constructor, Destructor), Default Constructor, Parameterized Constructor, Copy Constructor, The Default Copy Constructor, Objects as Function Arguments, Returning Objects from Functions, Structures and Classes, Memory allocation for Objects, Static members, Member functions defined outside the class.

UNIT III **7 Hours**

OPERATOR OVERLOADING & INHERITANCE

Fundamental of operator overloading, Restriction on operator overloading, Operator functions as a class member, Overloading unary and binary operator, Introduction to inheritance, Derived Class and Base Class, Access Specifiers (private, protected, and public), Types of inheritance.

UNIT IV **6 Hours**

VIRTUAL FUNCTION & POLYMORPHISM

Concept of Virtual functions, Late Binding, Abstract class and pure virtual functions, Virtual Destructors, Virtual base class, Friend function and Static function, Assignment and copy initialization, Copy constructor, This pointer, Concrete classes, Polymorphism and its roles.

UNIT V **6 Hours**

FUNCTION TEMPLATES AND EXCEPTION HANDLING

Function templates, Function templates with multiple arguments, Class templates, templates and inheritance, Exceptional Handling (Try, throw and catch), Use of exceptional handling.

List of Laboratory Experiments

Experiment 1 **3 Hours**

Introduction to Object Oriented Programming- Classes and Objects.

Experiment 2 5 Hours

Programs using Constructor, Destructor

Experiment 3 4 Hours

Programs on operator overloading.

Experiment 4 5 Hours

Programs on Inheritance

Experiment 5 3 Hours

Programs on Virtual Function

Experiment 6 3 Hours

Programs on Friend Function

Experiment 7 3 Hours

Programs on exception handling

Experiment 8 4 Hours

Programs on Function and Class Templates

Total: 60 Hours

Reference(s)

1. Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OIT04 FUNDAMENTALS OF DATABASE MANAGEMENT SYSTEMS **2 0 2 3**

Course Objectives

- Understand functional components of the Database Management System
- Understand need for concurrency and transaction property
- Compare and contrast various indexing strategies in different database systems

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5 Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Identify and analyze the essential concepts and key issues involved in the design of a relational database
2. Apply the concepts of normalization and ER model to guarantee an efficient database
3. Analyze the concurrent execution of transaction process and various recoveries from failures
4. Apply indexing and query optimization techniques for a database design
5. Analyze the various advanced database systems for efficient data storage & NOSQL concepts.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3		2		2			3							
2	2	3	3		2										
3	3		2		3										
4	3		3		3										
5	3	2	3												

UNIT I **6 Hours**

RELATIONAL DATABASES

Purpose of Database System - Views of data - Data Models - Database System Architecture - Introduction to relational databases - Relational Model - Keys - Relational Algebra - SQL fundamentals - Advanced SQL features.

UNIT II **6 Hours**

DATABASE DESIGN

Entity-Relationship model - E-R Diagrams - Enhanced-ER Model - ER-to-Relational Mapping - Functional Dependencies - First, Second, Third Normal Forms, - Boyce/Codd Normal Form- Multivalued Dependencies and Fourth Normal Form

UNIT III **6 Hours**

TRANSACTION

Transaction Concepts - ACID Properties - Schedules - Serializability - Concurrency Control -Need for Concurrency - Locking Protocols - Two-Phase Locking - Deadlock - Transaction Recovery - Save Points - Isolation Levels.

UNIT IV **6 Hours**

FILE AND QUERY PROCESSING

RAID - File Organization - Organization of Records in Files - Indexing and Hashing -Ordered Indices - Static Hashing - Dynamic Hashing - Query Processing Overview - Algorithms for SELECT and JOIN operations.

UNIT V

ADVANCED DATABASES

Distributed Databases: Architecture, Data Storage, Transaction Processing - Object-based Databases: Object Database Concepts, Object-Relational features, ODMG Object Model, ODL, OQL - Graph Database.

List of Laboratory Experiments

Experiment 1 **5 Hours**

Data Definition Commands, Data Manipulation Commands for inserting, deleting, updating and retrieving Tables with suitable examples

Experiment 2 5 Hours

Implementation of different types of operators in SQL

- Arithmetic Operators
- Logical Operators
- Comparison Operator
- Special Operator
- Set Operation

Experiment 3 3 Hours

Database Querying - Simple queries, Nested queries, Sub queries & Joins

Experiment 4 3 Hours

Implement

- Group By & having clause
- Order by clause
- Indexing

Experiment 5 4 Hours

Create a student database table currently stored as a single table. Normalize these structures to meet the 3NF requirements and draw ER model Diagram

Experiment 6 5 Hours

Implementation of Database Backup & Recovery commands, Rollback, Commit & Savepoint.

Experiment 7 5 Hours

Develop database for a BOOK PUBLISHING COMPANY.

Total: 60 Hours

Reference(s)

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, Sixth Edition, Tata McGraw Hill, 2011.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Sixth Edition, Pearson Education, 2011.
3. C.J.Date, A.Kannan, S.Swamynathan, An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.
4. Raghu Ramakrishnan, Database Management Systems, Fourth Edition, McGraw-Hill College Publications, 2015.
5. G.K.Gupta,Database Management Systems, Tata McGraw Hill, 2011.

Online Resource(s)

1. https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system-set-1/
2. https://www.javatpoint.com/dbms-tutorial
3. https://onlinecourses.nptel.ac.in/noc22_cs91

22OAG01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

Course Objectives

- To enhance the awareness about water resources management and conservation.
- To acquire knowledge about water harvesting techniques and their implementation. To practice the design aspects of sustainable rainwater harvesting solutions for communities.

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Assess the sources, availability and challenges in water resources management
2. Assess various water harvesting systems in practice
3. Execute design considerations for comparing surface runoff harvesting methods
4. Compare the characteristics and impacts of flood water harvesting techniques
5. Evaluate various rainwater harvesting methods for groundwater recharging

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1						3								
2	2	1													
3	1	1	3				2								
4	1	2	3				2								
5	1	1	3				2								

UNIT I 8 Hours

WATER RESOURCES AND CONSERVATION CHALLENGES

Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

UNIT II **10 Hours**

WATER RESOURCES AND CONSERVATION CHALLENGES

Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

UNIT III **9 Hours**

SURFACE RUNOFF HARVESTING

Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction

UNIT IV **9 Hours**

FLOOD WATER HARVESTING

Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

UNIT V **9 Hours**

GROUNDWATER HARVESTING

Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failures

Total: 45 Hours

Reference(s)

1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd edition, **Rainsource Press. 2019.**
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain **Brothers, New Delhi, 2003.**
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation **Practices, CSWCR&TI, Dehradun, 1990**

22OEE01 VALUE ENGINEERING 3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Programme Outcomes (POs)
PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan.
2. Analyze the cost and worth of a product/service using the principles of economics.
3. Evaluate the value of a product/service to take managerial decisions.
4. Apply the soft skills in understanding team building, team work and report writing.
5. Asses the functions and values of product/services in industries using case studies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1											3	1			
2										1	3	1			
3											3	1			
4										1	3	2			
5										2	3	1			

UNIT I **8 Hours**
INTRODUCTION TO VALUE ENGINEERING
Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

UNIT II **9 Hours**
FUNCTIONAL ANALYSIS
Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **10 Hours**

EVALUATION OF VALUE ENGINEERING

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

Total: 45 Hours

Reference(s)

1. Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OEE02 ELECTRICAL SAFETY 3 0 0 3

Course Objectives

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, naturalsciences, and engineering sciences.
PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7: Environment and sustainability: Understand the impact of the professional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and normsof the engineering practice.
PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Explore the different hazardous zones in Industries and their safety measures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1				2	1								
2	1	1				1	2	2							
3	1	1				2		2	1						
4	1	1				2	1								
5	1	1				2	1	2	1						

INTRODUCTION **9 Hours**

Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - working principles of major electrical equipment - Typical supply situation - Indian electricity act and rules - statutory requirements from electrical inspectorate- International standards on electrical safety.

UNIT II **9 Hours**

ELECTRICAL HAZARDS

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy- current surges- over current and short circuit current-heating effects of current- Lightning, hazards, lightning arrestor, - national electrical safety code ANSI.

UNIT III **9 Hours**

ELECTRICAL SAFETY EQUIPMENT

Fuse, circuit breakers and overload relays - safe distance from lines - capacity and protection of conductor joints and connections, overload and short circuit protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

UNIT IV **9 Hours**

ELECTRICAL SAFETY OPERATION AND MAINTENANCE

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance - installation – earthing, specifications, earth resistance, earth pit maintenance - Fire Extinguishers - CO2 and Dry Powder schemes.

UNIT V **9 Hours**

HAZARDOUS AREAS

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies – electrical safety standards. (IS, API and OSHA standards)

Total: 45 Hours

Reference(s)

1. Fordham Coope W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition, 2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”, Fourth Edition, Tata Mcgraw Hill, 2014.

Department of Food Technology

Academic Year	**2024-2025**
One Credit courses	

Course offering Details

Course Code	Course Title	Hours/ Week			C	Maximum Marks			Category
		L	T	P		Test	Quiz/A Sign	Total	
22FD0XA	Functional Food Processing	1	0	0	1	50	50	100	OC
22FD0XB	Analytical Methods for Food Quality Assessment	1	0	0	1	50	50	100	OC
22FD0XC	Food Processing Automation	1	0	0	1	50	50	100	OC
22FD0XD	Natural Compounds and Biopolymers in Food Processing	1	0	0	1	50	50	100	OC
22FD0XE	FSSC V6 & ISO 22000:2018	1	0	0	1	50	50	100	OC
22FD0XF	Technological and Health Aspects of Nutraceuticals and Functional Foods	1	0	0	1	50	50	100	OC
22FD0XG	Data Analytics in the Food Industry	1	0	0	1	50	50	100	OC
22FD0XH	Food Additives and Contaminants	1	0	0	1	50	50	100	OC
22FD0XI	Starch Chemistry	1	0	0	1	50	50	100	OC
22FD0XJ	Starch Waste Management and Valorization	1	0	0	1	50	50	100	OC

22FD0XA	**Functional Food Processing**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Fortification Basics • Encapsulation Techniques	**Mode: Continuous Internal Assessment 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- Analyzing, identifying and classifying various bioactive compounds present in functional foods, and understanding their respective health benefits.
- Apply the strategies for fortifying foods with bioactive compounds and the role of encapsulation in enhancing controlled release for sustained bioactivity.
- Evaluate the emerging trends in functional food processing, including advanced technologies like high-pressure processing and the role of sustainability.

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply the various techniques used for creating microcapsules and nanoparticles, considering factors such as encapsulation efficiency, stability, and bioactivity preservation.
2. Analyze the strategies for enhancing the bioavailability of bioactive compounds through encapsulation.
3. Evaluate the process of protection from degradation, improved solubility, and targeted delivery to specific physiological sites

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	3	2		2						2	3	1
2	2	2	2	2	2							2	3	2
3		2	2	2	2							2	2	2

Strategies for Fortifying Foods- Importance of fortification in functional foods – Fortification methods: direct addition and indirect methods. Microencapsulation and Nanoencapsulation: Techniques for creating microcapsules and nanoparticles, Controlled release mechanisms for sustained bioactivity. Enhancing Bioactive Delivery and Absorption: Bioavailability enhancement through encapsulation - Strategies for efficient delivery to the target site. Personalized Nutrition and 3D Food Printing- Customization of functional foods based on individual needs - Role of 3D food printing in creating functional food products. Sustainability in Functional Food Processing-Sustainable processing technologies and practices - Environmentally friendly approaches to functional food production

Total	**15 Hours**

References

1. Reference Book: Title: "Functional Foods: Biochemical and Processing Aspects" by John Shi and Chi-Tang Ho
2. Reference Book: Title: "Introduction to Food Analysis" by G. E. Inglett and A. M.Spanier
3. Reference Book: Title: "Food Processing Technology: Principles and Practice" by P.Fellows
4. Reference Book: Title: "Encapsulation Technologies and Delivery Systems for Food Ingredients and Nutraceuticals" edited by Nissim Garti and D. Julian McClements
5. Reference Book: Title: "Food 3D Printing: Fundamentals, Advances, and Applications" by Zhonghua Sun and Xipeng Xu

22FD0XB	**Analytical Methods for Food Quality Assessment**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Basic Chemistry • Analytical Techniques • Food Science	**Mode: Continuous Internal Assessment 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- Analyse the importance of food quality, its significance, and the parameters that influence it, including safety, sensory attributes, and nutritional value.
- Knowledge on Chromatographic methods to separate and quantify the food components

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply the food quality based on safety, sensory attributes, and nutritional value. Understand thefactors that influence shelf life and the regulatory standards that ensure quality.
2. Analyze the knowledge to perform gravimetric and volumetric analyses accurately for quantifying food components

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2	2		2						1	3	1
2	2	2	2	2	2							2	2	2

Chromatographic Techniques in Quality analysis. - Classification of chromatographic methods: Thin-Layer Chromatography (TLC)- Principle and procedure - Applications in food colourants and flavours, Paper Chromatography- Separation of food dyes and pigments. Gas Chromatography (GC): Instrumentation and working principle- Analysis of volatile compounds (flavours, aromas)- Application in lipid and fatty acid analysis. Instrumentation and Applications - HPTLC, GC-MS, LC-MS. Atomic Absorption Spectroscopy (AAS): Theory of atomic absorption- Heavy metal analysis in foods- Mercury and arsenic detection in seafood. Gravimetric and Volumetric Analysis -Principles of gravimetric analysis, Principles of volumetric analysis, Applications in food component quantification.

Total	**15 Hours**

References

1. Reference Book: Title: "Food Analysis" by S. Suzanne Nielsen
2. Reference Book: Title: "Food Chemistry" by Owen R. Fennema
3. Reference Book: Title:” Instrumental Methods of Analysis" by Willard, Merritt, and Dean
4. Reference Book: Title: “Molecular Microbiology: Diagnostic Principles and Practice" by David H. Persing and Fred C. Tenover.

22FD0XC	**Food Processing Automation**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Food Science Knowledge	**Mode: Continuous Internal Assessment 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- This course provides an in-depth exploration of automation technologies in the food processing industry.
- It covers the principles, methods, and applications of automation in various aspects of food production, from raw material handling to packaging and quality control.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (Cos)

The students will be able to

1. Apply the impact of automation on food safety, quality, and efficiency.
2. Analyze knowledge to find out the economic and environmental implications of automation in the food industry.

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	1	2				2			1	1	1
2		2	3	2	2				2			1	3	2

Overview of Automation in The Food Industry, Importance of Automation in Food Safety and Quality- Types of Sensors used in Food Processing- Data Acquisition and Measurement Techniques- Role of Sensors in Process Control- Principles of Control Systems -Automated Inspection and Sorting Systems- Non-Destructive Testing Methods Systems in Quality Control. Real-World Case Studies of Food Processing Automation-Emerging Trends in Food Automation

Total	**15 Hours**

References

1. Moore, C. A. (2012). Automation in the Food Industry. Germany: Springer US.
2. Robotics and Automation in the Food Industry: Current and Future Technologies. (2012). United Kingdom: Elsevier Science.
3. Huang, Y., Whittaker, A. D., Lacey, R. E. (2001). Automation for Food Engineering: Food Quality Quantization and Process Control. United States: CRC Press. United Kingdom: Taylor & Francis.
4. Measurement, Modeling and Automation in Advanced Food Processing. (2017). Germany: Springer International Publishing.
5. Mittal. (2018). Computerized Control Systems in the Food Industry. Hong Kong: CRC Press.

22FD0XD	**Natural Compounds and Biopolymers in Food Processing**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Organic Chemistry Basics • Biochemistry Fundamentals • Food Science Overview	**Mode: Continuous Internal Assessment 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- This course explores the fundamental concepts of biopolymers, focusing on roles of natural compounds and biopolymers.
- To assess the sustainability and health implications of using natural compounds and biopolymers in the food processing industry.

Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food processing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. To analyze the role of natural compounds and biopolymers in food processing.
2. To apply the techniques for commercial applications of natural compounds and biopolymers in food processing.

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	1	2				2			1	1	1
2	2	2	2	2	2				2			1	2	2

Introduction to Natural compounds and Biopolymers, Importance and relevance of natural compounds and biopolymers, Types and sources of natural compounds and biopolymers. Functional properties of natural compounds and biopolymers, Role of natural compounds and biopolymers in food processing and preservation & its applications in specific food products. Texture modification and sensory enhancement in food products, impact on sensory attributes, health implications for consumers, Emerging technologies on natural compounds and biopolymers.

Total	**15 Hours**

References

1. Reference Book: Recent Advances in Biopolymers edited by Farzana Khan Perveen.
2. Natural Products and Bioactive Compounds in Foods by Prof. Chao Zhao, Dr. Rong Taso, Prof, Bradley Bolling.
3. Natural Compounds as Sustainable Additives for Biopolymers by Nadka Tzankova Dintcheva, Giulia Infurna, Marilena Baiamonte and Francesca D'Anna.
4. Additive manufacturing of natural biopolymers and composites for bone tissue engineering by Susmita Bose, Caitlin Koski and Ashley A. Vu.
5. Handbook of Biopolymers by Sabu Thomas, Ajitha AR, Cintil Jose Chirayil, Bejoy Thomas

22FD0XE	FSSC V6 & ISO 22000:2018	L	T	P	C
		1	0	0	1

Pre-requisite	Assessment Pattern	
• Food safety management system	**Mode: Continuous Internal Assessment (CIA) 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- To understand the principles and requirements of ISO 22000:2018 and FSSC 22000 v6 standards.
- To learn audit planning principles and techniques for effective auditing.
- To understand the concept of continual improvement and its application in FSMS.
- To gain insights into performance evaluation methodologies within the FSMS framework.

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in ateam, to manage projects and in multidisciplinary environment
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological chang
PSO1	Execute innovative and high quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply the concepts and principles of food safety management systems, standards, and regulations, and theirrelevance to the food industry.
2. Analyze the PDCA cycle and the process approach to design, implement, maintain, and improve food safetymanagement systems based on FSSC 22000 v6 and ISO 22000:2018.
3. Asses the Plan, conduct, and report internal and external audits of food safety management systems based on FSSC22000 v6 and ISO 22000:2018, and ISO 19011:2018.
4. Evaluate the performance and effectiveness of the food safety management system, and identify opportunities for improvement and corrective actions.
5. Create the techniques to identify the Hazards and Evaluate the food defense mechanisms using the tools and techniques of VACCP andTACCP.

Articulation Matrix

COs. No.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
1		3	3	2		3	3	3						
2		2	3	2	2	2	3	3					3	2
3	2		3		2	2	1	3				1	3	
4			3	3	2	3	3	3	1		1			3
5		2	3	3	1	2	3	3				1	2	1

ISO 22000:2018 with FSSC 22000 v6 – I : Overview of ISO 22000:2018 - PDCA Cycle - PDCA Approach in FSMS -Context of the organization -Leadership – Planning - Competence- Awareness – FSSC Additional Requirements - PRPTS- OPRP- VACCP- TACCP. ISO 22000:2018 with FSSC 22000 v6 – II: Food Defense - Food Fraud & Mitigation.
Audit Planning - Operation -Traceability system -Emergency preparedness and response - Performance Evaluation -Non-Conformity and Corrective Action - Continual Improvement. Audit Principles with ISO 19011 – 2018: Introduction of ISO 19011-2018- Terms & Definitions - Audit Nature & Types - Principle of Auditing- Managementof Audit Programmed – Conducting of Audit – Competence & Evaluation of Auditor

Total 15 **Hours**

References

1. Hazard Analysis and Critical Control Point Training Curriculum – 6th Edition – 2020
2. ISO 22000:2018 Generic Model by Vindika Lokunarangodage – 10th Aug 2018
3. ISO/IEC 22000:2018 Food Safety management Standard & FSSC 22000 v6 Standard
4. ISO/TS 22002-1:2009, 22002-2:2013, 22002-4:2013, 22002-5:2019, 22002-6:2016

22FD0XF	Technological and Health Aspects of Nutraceuticals and Functional Foods	L	T	P
		1	0	0

Pre-requisite	Assessment Pattern	
• Functional foods and nutraceuticals	**Mode: Continuous Internal Assessment (CIA) 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- To discuss the historical reviews, teleology, models, classification and sources of nutraceuticals
- To explain the role of flavonoids and carotenoids as antioxidant agents
- To understand the metabolism, mechanism, sources and analysis of omega-3 fatty acids & CLA
- To summarize the health implications of lycopene, garlic, olive oil, nuts, prebiotics and probiotics
- To discuss the various aspects of herbs, stability testing, marketing strategies and regulatory issues in nutraceutical and functional foods

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activitieswith an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the needfor sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader ina team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1	Execute innovative and high-quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply the knowledge of historical, technological aspects and classification of nutraceuticals.
2. Asses the significance of flavonoids and carotenoids as antioxidants.
3. Analyze the potential health benefits, sources, mechanism of action and metabolism of omega- 3 fatty acidsand CLA.
4. Evaluate the multiple aspects of consuming lycopene, garlic, olive oil, nuts, prebiotics and probiotics as anutraceutical.
5. Create and understand the role of herbs as a nutraceutical and conduct the accelerated shelf-life testing of variousnutraceuticals and functional foods.
6. Evaluate marketing strategies and regulatory issues in the nutraceutical and functional food market

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		2		2			1			1		2		
2						1	1			1			2	2
3	1	1	1	2			2			1		3	2	
4		1			2				1	2	1	2	3	2
5	2	1		3	1		1		1				2	2
6			1	1			1	2	2				2	2

Introduction - Historical Reviews - Teleology of nutraceuticals - Organization models for nutraceuticals - Classification of Nutraceuticals based on the sources- Animal, Plant and Microbial - Nutraceuticals in specific foods - Mechanism of Action - Chemical nature. Antioxidants And Functional Foods: Flavonoids and carotenoids as antioxidants: Sources, chemical structure, and health benefits; Omega 3 fatty acids and Conjugated Linoleic Acid (CLA): Dietary sources, health benefits, and role in disease prevention; Lycopene, garlic, olive oil, nuts, probiotics, and prebiotics: Nutritional profile, health benefits, and role in disease prevention. Herbs as functional foods: Common herbs, nutritional profile, and health benefits; Stability and testing of nutraceuticals: Techniques for ensuring product stability, quality control, and testing methods; Marketing issues for nutraceuticals and functional foods: Market trends, regulatory issues, and consumer perception.

Total	**15 Hours**

References

1. Shi, John, Fereidoon Shahidi and Chi-Tang Ho "Asian Functional Foods". CRC/Taylor & Francis, 2007.
2. Watson, Robald Ross "Functional Foods and Nutraceuticals in Cancer Prevention". Blackwell Publishing,2007.
3. Gibson, G.R. and C.M. Willams. "Functional Foods: Concept to Product". Woodhead, 2000
4. Wildman, Robert "Handbook of Nutraceuticals and Functional Foods". CRC, 2006.
5. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2nd Edition, CRC, 2001.
6. Webb, P P. "Dietary Supplements and Functional Foods". Blackwell, 2006

22FD0XG	Data Analytics in the Food Industry	L	T	P	C
		1	0	0	1

Pre-requisite	Assessment Pattern	
• Probability and statistics	**Mode: Continuous Internal Assessment (CIA) 100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- To understand data analytics basics and its importance in the food industry.
- To learn to apply data analytics ethically and securely.
- To master data collection, cleaning, and quality assurance techniques for food data.
- To use statistical methods to optimize food processes and predict quality.
- To develop skills in predictive modeling and machine learning for food industry applications, and effectivelycommunicate insights using visualization tools.

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, naturalsciences, and engineering sciences.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal,health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1	Execute innovative and high quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in food Processing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply the data analytics techniques to food industry data.
2. Asses statistical analysis and predictive modeling for quality control and optimization.
3. Analyze data collection and pre-processing methods to ensure data accuracy.
4. Evaluate the big data technologies and visualization tools for insights communication.
5. Create ethical standards and data privacy principles in food analytics

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		3	2			3					2	2
2	3	3		3	2			3					2	2
3	3	3		3	2			3					2	2
4	3	3		3	2	3		3					2	2
5	3	3		3	2	3		3					2	2

Overview of Data Analytics: Concepts and Techniques - Importance of Data Analytics in the Food Sector - Data Privacy and Security in Food Analytics - Types of Data in the Food Industry - Data Collection Methods: Sensors, IoTDevices, Surveys - Cleaning and Pre-processing Techniques for Food Data - Handling Missing Data and Outliers in Food Datasets - Data Quality Assurance in the Food Analytics Pipeline. Statistical Process Control (SPC) in Food Industry - Hypothesis Testing for Quality Assurance - Design of Experiments (DOE) for Food Process Optimization - Regression Analysis for Predicting Food Quality Parameters - Statistical Software Applications in Food Analytics - Introduction to Predictive Modelling in the Food Sector - Machine Learning Algorithms - Forecasting Demand and Supply in the Food Supply Chain - Case Studies: Predictive Analytics Success Stories in the Food Industry. Big Data Analytics and Visualization in Food Industry: Handling Large Datasets in the Food Sector - Introduction to Big Data Technologies for Food Analytics - Data Visualization Tools and Techniques for Food Data - Dashboards and Reporting in Food Analytics – Communicating Data Insights to Stakeholders in the Food Industry.

Total	**15 Hours**

References

1. "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking" byFoster Provost and Tom Fawcett (Published by O'Reilly Media)
2. "Big Data: Principles and Best Practices of Scalable Realtime Data Systems" by Nathan Marz and JamesWarren (Published by Manning Publications)
3. "Statistical Quality Control" by Douglas C. Montgomery (Published by John Wiley & Sons)
4. "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel (Published byWiley)
5. "Data Visualization: A Practical Introduction" by Kieran Healy (Published by Princeton University Press)

22FD0XH	**Food Additives and Contaminants**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Basics of food adulteration	**Mode: Continuous Internal Assessment (CIA)100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	10 0

Course Objectives

- To understand the fundamental concepts of food additives, including their definition, classification, and theirroles in food processing and preservation.
- To identify and analyze specific food additives along with understanding the significance of INS numbersand category-wise approval.
- To gain knowledge about different types of contamination in food and their potential impacts on food safetyand public heal.

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialisation for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activitieswith an understanding of the limitations.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the needfor sustainable development.
PSO1	Execute innovative and high quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in foodProcessing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply and classify various food additives, comprehending their functions and roles in food processing andpreservation.
2. Analyze different types of food contamination, including physical and chemical contaminants, anddemonstrate proficiency in detecting and assessing their presence in food products.
3. Evaluate the chromatographic techniques for the analysis of food additives, contaminants, and other food components, and understand the regulatory frameworks governing food safety and additives to ensure compliance in food processing and production.

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	3	2		2						2	
2	3	3		2	2		2						2	
3	3	3		3	2		2						1	2

Introduction to food additives - definition, classification, and the role they play in food processing and preservation. Specific food additives - food colors, antioxidants, sweeteners, preservatives, and processing aids, INS numbers and category-wise approval. Contamination in food, Types of contamination (physical and chemical), common contaminants - heavy metals, pesticide residues, and antibiotics. Detection of adulterants and contaminants - basic principles of chromatography, paper and thin layer chromatography for detection of adulterants, column chromatography for purification of pigments, and High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) for analysis of food additives, phytochemicals, aflatoxins, contaminants, and other food components. Regulation of food additives and contaminants, including food laws and standards, licensing and registration of food businesses, and packaging and labelling regulations.

Total	***15*** **Hours**

References

1. "Food Additives" by A. Larry Branen, P. Michael Davidson, and Seppo Salminen.
2. "Food Additives: An Overview" by Jim Smith and Lily Sperber.
3. "Handbook of Food Additives" by Michael Ash and Irene Ash.
4. "Handbook of Food Analysis" by Leo M.L. Nollet and Fidel Toldrá.
5. "Analytical Chemistry of Foods" by James F. Lawrence and David R. Knevel.

22FD0XI	**Starch Chemistry**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Food Chemistry	**Mode: Continuous Internal Assessment (CIA)100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- To understand the chemical structure and composition of starch.
- To explore the physicochemical properties of starch, including solubility, gelatinization, and retro gradation.
- Analyze current research trends and advancements in starch chemistry.

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialisation for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineeringproblems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems anddesign system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmentalconsiderations.
PO7	**Environment and sustainability:** Understand the impact of the professional engineeringsolutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
PSO1	Execute innovative and high quality research to solve emerging problems in food technology by applying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in foodProcessing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply the molecular composition and structural organization of starch, including the differences between amylose and amylopectin.
2. Analyze the various methods of starch modification, discerning their effects on starch functionality, and predictingtheir utility in different industrial and food applications.
3. Evaluate and discuss current trends for further studies in related fields.

Articulation Matrix

COs. No.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
1	1						1					2		
2		2	2									2	2	
3		2	2									2		2

Overview of carbohydrates and polysaccharides - Importance of Starch - Classification and sources of starch - Molecular composition and structure of amylose and amylopectin - Factors influencing starch structure – Physiochemical properties of starch – Solubility behavior, gelatinization phenomenon, Retrogradation kinetics – Effects of modifications on functional properties - Applications of modified starches in various industries - Recent advancements in starch modification techniques.

Total	***15*** **Hours**
References	

1. **"**Starch: Chemistry and Technology" by Roy L. Whistler, James N. BeMiller, and Eugene F. Paschall
2. Research articles from journals such as Carbohydrate Polymers, Food Hydrocolloids, and Starch

22FD0XJ	**Starch Waste Management and Valorization**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
• Liquid and solid food waste managementtechniques	**Mode: Continuous Internal Assessment (CIA)100%**	
	Assessments	**Weightage (%)**
	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- To understand the sources and composition of starch waste.
- To explore different methods for the management and treatment of starch waste.
- To learn about valorization techniques to convert starch waste into valuable products.

Programme Outcomes (Pos)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialisation for the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, naturalsciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant tothe professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineeringsolutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and
PO12	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
PSO1	Execute innovative and high quality research to solve emerging problems in food technology byapplying scientific knowledge.
PSO2	Practical and research training will pave way for introducing novel technologies in foodProcessing sectors for global sustenance.

Course Outcomes (COs)

The students will be able to

1. Apply different methods for the management and treatment of starch waste, including physical, chemical, and biological approaches.
2. Analyze the principles and applications of valorization techniques used to convert starch waste into value-addedproducts, such as biofuels and bioplastics.
3. Evaluate the environmental impact and sustainability implications of starch waste management strategies,considering factors such as resource conservation and waste reduction.

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2									2		
2	1		2				2	1					2	
3			2			2	2	1						2

Introduction to Starch waste - Composition and characteristics of starch waste streams - Physical, chemical, and biological treatment methods - Anaerobic digestion and biogas production - Solid-state fermentation for starch waste treatment - Conversion of starch waste into biofuels - Production of value-added products – bioplastics, enzymes, dietary fibers - Sustainability considerations and environmental impact mitigation - Economic feasibility and market opportunities for starch waste valorization.		
Total	***15***	**Hours**
References		

1. BeMiller, J. N., & Whistler, R. L. (2009). Starch: Chemistry and Technology (3rd ed.). Academic Press.
2. Jane, J. L., & Kasemsuwan, T. (2009). Starch: Properties and Potential. Wiley-Blackwell.
3. Fausto F Dias, Starch: Perspective and Opportunities, Journal of Scientific & Industrial Research, Vol.58, June 1999