ANNA UNIVERSITY, CHENNAI

NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

B.TECH.FOOD TECHNOLOGY

CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3172	அறிவியல் தமிழ் / Scientific Thoughts in Tamil	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3171	Problem Solving & Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory $	EEC	0	0	2	2	1
			TOTAL	**16**	**1**	**10**	**27**	**22**

$ Skill Based Course

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3258	Physics of Materials	BSC	3	0	0	3	3
4.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	GE3252	**தமிழர் மரபு / Heritage of Tamils**	HSMC	1	0	0	1	1
7.		NCC Credit Course Level 1#	-	2	0	0	2	3 #
PRACTICALS								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3272	Basic Electrical, Electronics &Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language $	EEC	0	0	4	4	2
			TOTAL	**14**	**1**	**16**	**31**	**23**

NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
$ Skill Based Course

PROGRESS THROUGH KNOWLEDGE

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3351	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	FD3301	Fluid Mechanics and Mechanical Operations	PCC	3	1	0	4	4
3.	FD3302	Food Chemistry	PCC	3	0	0	3	3
4.	FD3303	Food Microbiology	PCC	3	0	0	3	3
5.	FD3304	Food Process Calculations	PCC	3	1	0	4	4
6.	FD3305	Post Harvest Engineering	PCC	3	0	0	3	3
PRACTICALS								
7.	FD3311	Food Chemistry Lab	PCC	0	0	4	4	2
8.	FD3312	Food Microbiology Lab	PCC	0	0	4	4	2
9.	GE33361	Professional Development$	EEC	0	0	2	2	1
			TOTAL	**18**	**3**	**10**	**31**	**26**

$ Skill Based Course

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3401	Probability And Operations Research	BSC	3	1	0	4	4
2.	FD3401	Biochemistry and Nutrition	PCC	3	0	0	0	3
3.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
4.	FD3402	Food Additives and flavors	PCC	3	0	0	3	3
5.	FD3403	Heat and Mass transfer in Food Processes	PCC	3	1	0	4	4
6.	FD3404	Principles of Thermodynamics	PCC	3	0	0	0	3
7.		NCC Credit Course Level 2#		3	0	0	3	3 #
PRACTICALS								
8.	FD3411	Biochemistry and Nutrition Laboratory	ESC	0	0	0	4	2
9.	FD 3412	Unit operations Laboratory	PCC	0	0	0	4	2
10	FD3513	Industrial Training/Internship*	EEC	-	-	-	-	-
			TOTAL	**17**	**2**	**0**	**21**	**23**

NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

*Two weeks industrial training/internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD3501	Food Processing and Preservation	PCC	3	0	0	3	3
2.	FD3502	Food Analysis	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Mandatory Course-I[&]	MC	3	0	0	3	0
PRACTICALS								
7.	FD3511	Food processing and preservation lab	PCC	0	0	4	4	2
8.	FD3512	Food Analysis Lab	PCC	0	0	4	4	2
9.	FD3513	Industrial Training/Internship*	EEC	-	-	-	-	1
			TOTAL	**18**	**0**	**8**	**26**	**20**

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

*Two weeks industrial training/internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD3601	Food Process Engineering	PCC	3	1	0	4	4
2.		Open Elective – I*	OEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Professional Elective VI	PEC	3	0	0	3	3
6.		Professional Elective VII	PEC	3	0	0	3	3
7.		Mandatory Course-II[&]	MC	3	0	0	3	0
8.		NCC Credit Course Level 3#		3	0	0	3	3 #
PRACTICALS								
9.	FD3611	Food Process Engineering Lab	PCC	0	0	4	2	2
10.	FD3711	Industrial Training/Internship**	EEC	-	-	-	-	-
			TOTAL	**21**	**1**	**4**	**24**	**21**

*Open Elective – I shall be chosen from the emerging technologies.

**Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER VII/VIII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD3701	Refrigeration and Cold Chain Management	PCC	3	0	0	3	3
2.	FD3702	Food plant equipment design	PCC	3	0	0	3	3
3.	GE3791	Human values and Ethics	HSMC	2	0	0	2	2
4.		Elective Management #	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICALS								
8.	FD3711	Industrial Training/Internship##	EEC	-	-	-	-	2
			TOTAL	**20**	**0**	**0**	**20**	**22**

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.

***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes

Elective- Management shall be chosen from the Elective Management courses

##Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

SEMESTER VIII/VII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	FD3811	Internship#/ Project Work	EEC	0	0	20	20	10
			TOTAL	**0**	**0**	**20**	**20**	**10**

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

#15 weeks of continuous Internship in an organization carries 10 credits.

TOTAL CREDITS: 167

ELECTIVE – MANAGEMENT COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

MANDATORY COURSES I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

PROGRESS THROUGH KNOWLEDGE

PROFESSIONAL ELECTIVE COURSES : VERTICALS

Vertical I DAIRY AND BEVERAGE TECHNOLOGY	Vertical II FOOD BIOTECHNOLOGY	Vertical III MEAT, MARINE AND POULTRY TECGNOLOGY	Vertical IV CEREALS, PULSES AND GRAIN TECHNOLOGY	Vertical V NEXT GENERATION TECHNOLOGIES IN FOOD INDUSTRIES	Vertical VI FRUIT AND VEGETABLE TECHNOLOGY	Vertical VII FOOD PACKAGING TECHNOLOGY	Vertical VIII BAKING AND CONFECTIONERY TECHNOLOGY	Vertical IX SPICES AND PLANTATION TECHNOLOGY	Vertical X FOOD SAFETY MANAGEMEMT SYSTEM
Dairy chemistry and microbiology	Introduction To Food Biotechnology	Introduction To Meat, Marine , Poultry	Fat & oil Technology	High Performance Computing	Technology Of Fruit And Vegetable Processing	Packaging Design and Sustainable Development	Introduction to baking & bakery products	Processing, Storage of spices & plantation crops	Introduction to food safety Analysis and Quality Risk Management
Processing of Dairy Products	Enzymes in Food and Feed Industry	Meat & Poultry Processing	Processing Of Cereals, Oil Seeds And Pulses	Food materials science	Fruits And Vegetables as Nutraceutical	Package Printing inks and Coatings	Flour chemistry & Rheology	Blending and Value Addition	HACCP in Food Processing and Preservation
Value added dairy products	Food Fermentation Technology	Byproducts In Meat Processing	Enrichment And Fortification Of Cereals And Oils	Food structuring techniques	Advances In Fruit And Vegetable Processing Technologies	Glass Wood and Metal Processing and Packaging	Confectionery products	Processing of Coffee	FSMS & Food Product and Supply Chain Management
Precision fermentation for dairy alternatives	Biological Instrumentation and Process Control	Preservation Technology of Eggs, Meat, Poultry And Seafood	Milling And Fractionation Technologies	Concepts on experimental design and modelling	Beverage Technology	Plastics and Polymers in Packaging	Industrial production of cookies and biscuits	Processing of Tea	Food laws – Indian and International

Cheese technology	Food Allergens and Toxicology	Marine Food Processing	Technology of Malting and Brewing	Statistical tool in data analysis	Fruit And Vegetable Storage	Paper, CFB and Paper Board based Packaging	Industrial production of bun, bread, cakes and pastries	Processing of cocoa and chocolate	Food Safety in Hospitality industry & GLP in Food Industries
Innovative Packaging of Dairy products	Genetic Engineering and Genetically Modified Foods	Technology of packing meat and marine products	By Products Manageme nt	Food informatic s	Innovative Packaging Of Fruit And Vegetables	Packaging laws and Regulation s	Packaging of bakery & confectioner y products	Packaging of spices. Plantation products	Food Analysis, Testing & Microbial Safety Analysis
Quality and Safety Monitoring in Dairy Industry	Functional Foods and Nutraceutic als	Quality, Laws And Regulations In Meat Industries	Quality, Laws And Regulations In grain processing Industries	Applied Genomics and Proteomic s	Fruit And Vegetable Industry Safety & Laws	Packaging Performan ce Testing & Process, Machinery and equipment	Laws and regulations of Bakery and confectioner y products	Spice Processing and products laws, quality standards and regulations	Food Quality Assurance and Quality Control

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation. Students are permitted to choose all Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to Regulations 2021 Clause 4.10.

PROGRESS THROUGH KNOWLEDGE

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL I: DAIRY AND BEVERAGE TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3001	Dairy chemistry and microbiology	PEC	3	0	0	3	3
2.	FD3002	Processing of Dairy Products	PEC	3	0	0	3	3
3.	FD3003	Value added dairy products	PEC	3	0	0	3	3
4.	FD3004	Precision fermentation for dairy alternatives	PEC	3	0	0	3	3
5.	FD3005	Cheese technology	PEC	3	0	0	3	3
6.	FD3006	Innovative Packaging of Dairy products	PEC	3	0	0	3	3
7.	FD3007	Quality and Safety Monitoring in Dairy Industry	PEC	3	0	0	3	3

VERTICAL II: FOOD BIOTECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3008	Introduction To Food Biotechnology	PEC	3	0	0	3	3
2.	FD3009	Enzymes in Food and Feed Industry	PEC	3	0	0	3	3
3.	FD3010	Food Fermentation Technology	PEC	3	0	0	3	3
4.	FD3011	Biological Instrumentation and Process Control	PEC	3	0	0	3	3
5.	FD3012	Food Allergens and Toxicology	PEC	3	0	0	3	3
6.	FD3013	Genetic Engineering and Genetically Modified Foods	PEC	3	0	0	3	3
7.	FD3014	Functional Foods and Nutraceuticals	PEC	3	0	0	3	3

VERTICAL III: MEAT, MARINE AND POULTRY TECGNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3015	Introduction To Meat, Marine , Poultry	PEC	3	0	0	3	3
2.	FD3016	Meat & Poultry Processing	PEC	3	0	0	3	3
3.	FD3017	Byproducts In Meat Processing	PEC	3	0	0	3	3
4.	FD3018	Preservation Technology of Eggs, Meat, Poultry And Seafood	PEC	3	0	0	3	3
5.	FD3019	Marine Food Processing	PEC	3	0	0	3	3
6.	FD3020	Technology of packing meat and marine products	PEC	3	0	0	3	3
7.	FD3021	Quality, Laws And Regulations In Meat Industries	PEC	3	0	0	3	3

VERTICAL IV: CEREALS, PULSES AND GRAIN TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3022	Fat & oil Technology	PEC	3	0	0	3	3
2.	FD3023	Processing Of Cereals, Oil Seeds And Pulses	PEC	3	0	0	3	3
3.	FD3024	Enrichment And Fortification Of Cereals And Oils	PEC	3	0	0	3	3
4.	FD3025	Milling And Fractionation Technologies	PEC	3	0	0	3	3
5.	FD3026	Technology of Malting and Brewing	PEC	3	0	0	3	3
6.	FD3027	By Products Management	PEC	3	0	0	3	3
7.	FD3028	Quality, Laws And Regulations In grain processing Industries	PEC	3	0	0	3	3

VERTICAL V: NEXT GENERATION TECHNOLOGIES IN FOOD INDUSTRIES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3029	High Performance Computing	PEC	3	0	0	3	3
2.	FD3030	Food materials science	PEC	3	0	0	3	3
3.	FD3031	Food structuring techniques	PEC	3	0	0	3	3
4.	FD3032	Concepts on experimental design and modelling	PEC	3	0	0	3	3
5.	FD3033	Statistical tool in data analysis	PEC	3	0	0	3	3
6.	FD3034	Food informatics	PEC	3	0	0	3	3
7.	FD3035	Applied Genomics and Proteomics	PEC	3	0	0	3	3

VERTICAL VI: FRUIT AND VEGETABLE TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3036	Technology Of Fruit And Vegetable Processing	PEC	3	0	0	3	3
2.	FD3037	Fruits And Vegetables as Nutraceutical	PEC	3	0	0	3	3
3.	FD3038	Advances In Fruit And Vegetable Processing Technologies	PEC	3	0	0	3	3
4.	FD3039	Beverage Technology	PEC	3	0	0	3	3
5.	FD3040	Fruit And Vegetable Storage	PEC	3	0	0	3	3
6.	FD3041	Innovative Packaging Of Fruit And Vegetables	PEC	3	0	0	3	3
7.	FD3042	Fruit And Vegetable Industry Safety & Laws	PEC	3	0	0	3	3

VERTICAL VII: FOOD PACKAGING TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3043	Packaging Design and Sustainable Development	PEC	3	0	0	3	3
2.	FD3044	Package Printing inks and Coatings	PEC	3	0	0	3	3
3.	FD3045	Glass Wood and Metal Processing and Packaging	PEC	3	0	0	3	3
4.	FD3046	Plastics and Polymers in Packaging	PEC	3	0	0	3	3
5.	FD3047	Paper, CFB and Paper Board based Packaging	PEC	3	0	0	3	3
6.	FD3048	Packaging laws and Regulations	PEC	3	0	0	3	3
7.	FD3049	Packaging Performance Testing & Process, Machinery and equipment	PEC	3	0	0	3	3

VERTICAL VIII: BAKING AND CONFECTIONERY TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3050	Introduction to baking & bakery products	PEC	3	0	0	3	3
2.	FD3051	Flour chemistry & Rheology	PEC	3	0	0	3	3
3.	FD3052	Confectionery products	PEC	3	0	0	3	3
4.	FD3053	Industrial production of cookies and biscuits	PEC	3	0	0	3	3
5.	FD3054	Industrial production of bun, bread, cakes and pastries	PEC	3	0	0	3	3
6.	FD3055	Packaging of bakery & confectionery products	PEC	3	0	0	3	3
7.	FD3056	Laws and regulations of Bakery and confectionery products	PEC	3	0	0	3	3

VERTICAL IX: SPICES AND PLANTATION TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3057	Processing, Storage of spices & plantation crops	PEC	3	0	0	3	3
2.	FD3058	Blending and Value Addition	PEC	3	0	0	3	3
3.	FD3059	Processing of Coffee	PEC	3	0	0	3	3
4.	FD3060	Processing of Tea	PEC	3	0	0	3	3
5.	FD3061	Processing of cocoa and chocolate	PEC	3	0	0	3	3
6.	FD3062	Packaging of spices. Plantation products	PEC	3	0	0	3	3
7.	FD3063	Spice Processing and products laws, quality standards and regulations	PEC	3	0	0	3	3

VERTICAL X: FOOD SAFETY MANAGEMEMT SYSTEM

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3064	Introduction to food safety Analysis and Quality Risk Management	PEC	3	0	0	3	3
2.	FD3065	HACCP in Food Processing and Preservation	PEC	3	0	0	3	3
3.	FD3066	FSMS & Food Product and Supply Chain Management	PEC	3	0	0	3	3
4.	FD3067	Food laws – Indian and International	PEC	3	0	0	3	3
5.	FD3068	Food Safety in Hospitality industry & GLP in Food Industries	PEC	3	0	0	3	3
6.	FD3069	Food Analysis, Testing & Microbial Safety Analysis	PEC	3	0	0	3	3
7.	FD3070	Food Quality Assurance and Quality Control	PEC	3	0	0	3	3

OPEN ELECTIVES

Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
7.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
8.	OMF353	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OIE354	Quality Engineering	OEC	3	0	0	3	3
13.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
14.	OML351	Introduction to non-	OEC	3	0	0	3	3

		destructive testing						
15.	OMR351	Mechatronics	OEC	3	0	0	3	3
16.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
17.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
18.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
19.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
20.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
21.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
22.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
23.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3
24.	OCH351	Nano Technology	OEC	3	0	0	3	3
25.	OCH352	Functional Materials	OEC	3	0	0	3	3
26.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
27.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
28.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
29.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
30.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
31.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
32.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
33.	OEC351	Signals and Systems	OEC	3	0	0	3	3
34.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
35.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
36.	OBM352	Assistive Technology	OEC	3	0	0	3	3
37.	OMA352	Operations Research	OEC	3	0	0	3	3
38.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
39.	OMA354	Linear Algebra	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME353	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	OAU352	Batteries and Management system	OEC	3	0	0	3	3
14.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3
15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OIE353	Operations Management	OEC	3	0	0	3	3
19.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
20.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
21.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
22.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
23.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
24.	OMR353	Sensors	OEC	3	0	0	3	3
25.	ORA352	Foundation of	OEC	3	0	0	3	3

		Automation						
26.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
27.	OMV351	Marine Propulsion	OEC	3	0	0	3	3
28.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
29.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
30.	OAE353	Drone Technologies	OEC	3	0	0	3	3
31.	OGI352	Geographical Information System	OEC	3	0	0	3	3
32.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
33.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
34.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
35.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
36.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
37.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
38.	OCH353	Energy Technology	OEC	3	0	0	3	3
39.	OCH354	Surface Science	OEC	3	0	0	3	3
40.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
41.	OTT355	Fibre Science	OEC	3	0	0	3	3
42.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
43.	OPE353	Industrial safety	OEC	3	0	0	3	3
44.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
45.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
46.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
47.	OEC353	VLSI Design	OEC	3	0	0	3	3
48.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
49.	OBM353	Wearable devices	OEC	3	0	0	3	3
50.	OBM354	Medical Informatics	OEC	3	0	0	3	3

SUMMARY

B.Tech. Food Technology										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		12
2	BSC	12	7	4	6					29
3	ESC	5	11		2					18
4	PCC			21	15	10	6	6		58
5	PEC					9	12			21
6	OEC						3	9		12
7	EEC	1	2	1		1		2	10	17
8	Non-Credit /(Mandatory)					√	√			
Total		22	26	26	23	20	21	22	10	167

PROGRESS THROUGH KNOWLEDGE

Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.
Complete details are available in clause 4.10 of Regulations 2021.

Verticals FOR MINOR DEGREE (IN ADDITIONS TO ALL THE VERTICALS OF OTHER PROGRAMMES)

Vertical I Fintech and Block Chain	**Vertical II Entrepreneurship**	**Vertical III Public Administration**	**Vertical IV Business Data Analytics**	**Vertical V Environment and Sustainability**
Financial Management	Foundations of Entrepreneruship	Principles of Public Administration	Statistics For Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining For Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing And Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation And Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	nancial Management	PEC	3	0	0	3	3
2.	CMG332	ndamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	ntech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	roduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneruship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

OBJECTIVES

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

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORMS 9+3

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL: 60 PERIODS

OUTCOMES

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

FD3301 FLUID MECHANICS AND MECHANICAL OPERATIONS L T P C
3 1 0 4

OBJECTIVES:

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

UNIT I PROPERTIES OF FLUIDS 12

Properties of fluids – definition – units of measurement - Mass density – specific weight, specific volume – specific gravity equation of state – perfect gas - Viscosity – vapour pressure – compressibility and elasticity surface tension – capillarity. Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices– manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), center of pressure. Basic equations in integral form: Basic laws for a system; continuity equation- in Cartesian co-ordinates - Euler's equation of motion, momentum balance equation-Introduction to Navier Stoke’s and Euler’s Equation, Types of fluid flow- Introduction to rotational and irrotational flow, momentum correction factor. Fluid pressure and measurement – simple, differential and micro manometers - Mechanical gages – calibration. Pressure diagram – total pressure on curved surface. Archimedes principles

UNIT II FLOW MEASUREMENTS & OPEN CHANNEL FLOW 12

Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseullie equation; introduction to turbulent flow in a pipe-Prandtl mixing length; energy consideration in pipe flow, Bernoulli’s equation–kinetic energy correction factor; Reynold's experiment, Darcy – Weisbach equation for friction head loss – Chezy's formula – Manning's formula – Hazen-William’s

formula - Major and minor losses in pipes; friction factor-Fanning and Darcy, Moody diagram; major and minor losses; Pipe fittings and valves, equivalent diameter. Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturi meter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter.

UNIT III DIMENSIONAL ANALYSIS & PUMPS 12

Dimensional analysis – concept of geometric, kinematic and dynamic similarity.Important nondimensional numbers – Reynolds, Froude, Euler, Mach and Weber. Fluidization: Introduction; different types of fluidizations; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses. Fluid moving machines: Basic classification of pumps: Non-Mechanical Pumps-steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps- cavitation, NPSH, Positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.

UNIT IV SEPARATION AND SIZE REDUCTION 12

Filtration –filter media –-constant rate filtration – constant pressure filtration – filter cake resistance-filtration equipment – rotary vacuum filter – filter press- sedimentation – Stoke's law, sedimentation of particles in gas-cyclones – rate of separations – centrifuge equipment. Crystallization – equilibrium - solubility and equilibrium diagram – rate of crystal growth – equilibrium crystallization-crystallization equipment – classification of distillation –Swenson-Walker vacuum crystallizers- Size reduction – grinding and cutting –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 V CONTACT EQUILIBRIUM SEPARATION 12

Contact equilibrium separation processes – concentrations – gas-liquid and solid-liquid equilibrium – equilibrium concentration relationships – operating conditions-calculation of separation in contact – equilibrium processes-gas absorption – rate of gas absorption –equilibrium gas – absorption equipment-properties of tower packing – types – construction – flow through packed towers-extraction – rate of extraction extractor-extraction of fine material – Dorr agitator – continuous leaching – decantation systems – extraction towers-washing – equipment.

TOTAL: 60 PERIODS

OUTCOMES:

- The students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium.
- They will also gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.

TEXT BOOKS:

1. Modi, P.N. and Seth S.M. "Hydraulics and fluid mechanics". Standard Publishers Distributors, New Delhi,2010.
2. Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. (9th ed) Tata McGraw Hill, New Delhi, 1998.
3. Geankoplis, C.J. "Transport Processes and Separation Process Principles", 4th Edition, Prentice Hall, 2003.
4. McCabe W.L., Smith J.C. "Unit Operations in Chemical Engineering", 7th Edition, McGraw – Hill Int., 2001.
5. Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
6. Geankoplis C.J.1999. Transport Process and Unit Operations. Prentice-Hall of India Private Limited, New Delhi.

REFERENCES:

1. Bansal, R.K., " A text book of fluid mechanics and hydraulic machinery", Laxmi publications (P) Ltd., New Delhi, 2002.
2. Grade, RJ.,."Fluid mechanics through problems". Wiley eastern Ltd., Madras,2002.
   Jain A. K. "Fluid Mechanics". Khanna Publishers 1995.

FD3302 FOOD CHEMISTRY L T P C
3 0 0 3

OBJECTIVES

The course aims to

• develop the knowledge of students in the basic area of Food Chemistry such as the composition and properties of food and the chemical changes of nutrients during handling, processing, and storage.
• effective understanding of food processing and technology.
• appreciate the similarities and complexities of the chemical components in foods.

UNIT I CARBOHYDRATES 10

The principal carbohydrates in the human diet. Chemical properties of carbohydrates dehydration, caramelization, Maillard reaction. Types Simple Sugars mono and disaccharides, solubility; Artificial sweeteners; Glucose syrup, fructose syrup, Sugar alcohols; Oligosaccharides structure, nomenclature, occurrence, uses in foods. Polysaccharides Starch- amylose and amylopectin-properties, thickening & gelatinization, modified starches, resistant starch, Dextrins and dextrans, Starch hydrolysates – Maltodextrins and dextrins; Structure of glycogen. Fiber_Cellulose & hemicellulose Pectins Gums & seaweeds- gel formation & viscosity.

UNIT II PROTEINS 9

The principal proteins in the human diet. Review of protein structure & conformation; Optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Properties & reactions of proteins in food systems and Food enzymes and its role in food spoilage, application of food enzymes; Texturized proteins; Functional role and uses in foods.

UNIT III LIPIDS 10

Review of structure, composition and nomenclature of fats. Properties of fats & oils Edible oil refining processes, winterization, melting points, plasticity, isomerisation, hydrolysis of triglycerides, Saponification number, iodine value, Reichert-Meissl number. Types of fatty acids; Modification of fats hydrogenation- cis and trans isomers, inter-esterification, acetylation, Hydrolytic rancidity & oxidative rancidity; Shortening power of fats, tenderization, frying - smoke point, auto oxidation, polymerization, lipids having emulsifying properties, itsapplication in food industry and detergents; Shortening power of fats, chemistry of steroids, types of fat substitute.

UNIT IV FOOD COMPOSITION, WATER, MINERALS AND VITAMINS 7

Proximate composition of food, water activity in food, moisture content of food, water quality for food processing. Mineral & vitamin content of foods- stability & degradation during food processing.

UNIT V AROMA & IMPORTANT PHYTOCHEMICALS IN FOOD 9

Naturally occurring colours/pigments in food and impact on antioxidant level, Synthetic food grade Colours, enzymatic browning of food, flavour & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; and Naturally similar /artificial flavours, Threshold

values, off flavours & food taints. Naturally occurring toxic substances, protease inhibitors, bioactive components phytates, polyphenols, saponins.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO 1 gain knowledge on chemical nature of food components.

CO 2 imparting knowledge on chemical changes of food components during food handling, processing, and storage.

CO 3 facilitate basic platform for further understanding of food analysis.

TEXT BOOKS:

1. Belitz H.-D, Grosch W and Schieberle P. Food Chemistry, 4th Edition, Springer-Verlag, 2009.
2. Meyer, Lillian Hoagland "Food Chemistry". CBS Publishers, 1987.
3. John M. deMan. "Principles of Food Chemistry". 3rd Edition, Springer, 1999.
4. Chopra, H.K. and P.S. Panesar. "Food Chemistry". Alpha Science International Limited,2010

REFERENCES:

1. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 4th Edition, Kluwer_Academic, Springer, 2014.
2. Richard Owusu-Apenten "Introduction to Food Chemistry" CRC Press, 2005.
3. Srinivasan Damodaran, Kirk L. Parkin, " Fennema's Food Chemistry " 5th Edition, CRCPress, 2008.

FD3303 FOOD MICROBIOLOGY L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I ROLE OF MICROBES IN SPOILAGE OF FOODS 9

Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products.

UNIT II CONTROL OF MICROBES IN FOODS 9

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

UNIT III MICROBES IN FOOD FERMENTATIONS 9

Microbes of importance in food fermentations, – homo & hetero-fermentative bacteria, yeasts & fungi; biochemistry of fermentations – pathways involved, lactic acid bacteria fermentation and starter cultures, alcoholic fermentations -yeast fermentations - characteristics and strain selection, fungal fermentations. microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.

UNIT IV MICROBIAL AGENTS OF FOOD BORNE ILLNESS 9

Food borne infections and food poisoning, microbial toxins, Gram Negative and Gram-positive food borne pathogens; toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.

UNIT V MICROBIAL EXAMINATION OF FOODS 9

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. Botulimum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course the students are expected to

CO1 Be able to understand and identify the various microbes associated with foods and food groups.

CO2 Be able to understand and identify the role of these microbes in food spoilage, food preservation.

CO3 Understand the role of pathogens in food borne infections. • Understand the methods used to detect pathogens in foods.

TEXT BOOKS:

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, 2006.

REFERENCES:

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

PROGRESS THROUGH KNOWLEDGE

FD3304 FOOD PROCESS CALCULATIONS L T P C
3 0 0 3

OBJECTIVE:

To introduce students to basic principles of stoichiometry and its calculations.

UNIT I 9

Units and dimensions, Basic and derived units, use of model units in calculations, Methods of expression, compositions of mixture and solutions. Ideal and real gas laws – Gas constant - calculations of pressure, volume and temperature using ideal gas law

UNIT II 9

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

UNIT III **9**

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

UNIT IV **9**

Energy Balance: Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy

UNIT V **9**

Enthalpy Changes: Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction.

TOTAL: 45 PERIODS

(Use of Psychometric chart is permitted in the examination)

COURSE OUTCOMES:

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

CO 1 make them understand different types of laws of chemistry of materials

CO 2 accurately calculate the stoichiometric relations between the materials involved in the unit operation process.

CO 3 perform elementary material and energy balance for different unit operations.

TEXT BOOKS:

1. Bhatt, B.L and Vora, S.M., "Stoichiometry", Third Edition, McGraw-Hill, New York, 2004.

2. Gavhane, K.A "Introduction to Process Calculations" (Stoichiometery) NiraliPrakashan Publications, Pune, 2009.

REFERENCES: 1. Venkataramani, V. and Anantharaman, N., "Process Calculations" , Prentice Hall of India, New Delhi, 2011.

2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Eighth Edition, Prentice Hall India, New Delhi, 2015.

FD3305 **POST HARVEST ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES

The course aims to

- To develop the knowledge of students in the area of post-harvest processing of various foods and related technology.
- To enable students to appreciate the application of scientific principles in the processing of post harvesting materials.

UNIT I INTRODUCTION **7**

Post-harvest engineering of crops – objectives - post harvest systems and losses in agricultural commodities structure, engineering properties of agricultural materials, optimum stage of harvest, importance of loss reduction; Post Harvest Handling operations. Pre-drying operation, Moisture content, RH measurement, air-grain measurement.

UNITII CLEANING, THRESHING AND GRADING 10

Threshing and shelling operation - principles and operation - various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.

Cleaning – principles and machineries – Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens - rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling, Sorting and Grading - grain grading system, effectiveness of separation and performance index., hydrothermal treatment and conditioning of grains, Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency. Separation - Magnetic separator, de-stoners, electrostatic separators, pneumatic separator

UNIT III MATERIAL HANDLING 10

Introduction to different conveying equipment used for handling of grains, fruits and vegetables; Scope and importance of material handling devices Classification, principles of operation, conveyor system selection/design. Belt conveyor Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper. Chain conveyor -Principle of operation, advantages, disadvantages, capacity and speed, conveying chain. Screw conveyor Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors. Bucket elevator Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement. Pneumatic conveying system types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

UNITIV PRINCIPLES AND PRACTICE OF STORAGE 10

Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables. Damages Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control.Storage structures Traditional storage structures, improved storage structures, modern storage structures; Farm silos Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos. Storage of perishables Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage

UNIT V PEST CONTROL 8

Primary and secondary insect pests, rodents and microorganisms of stored food grains and their control, integrated pest management, Fumigation and controlled atmosphere storage of food grains, Rodent Control.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO 1 understand and identify the specific processing technologies used for different foods and the various products derived from these materials.

CO 2 understand the application of scientific principles in the processing technologies specific to the materials.

CO 3 understand and design storage systems for different food products

TEXTBOOKS:

1. Sahay, K. M. and K.K.Singh.. " Unit operation of Agricultural Processing ", Vikas Publishing House., Pvt Ltd. 2004.
2. Chakravarty et al Handbook of Post-Harvest Technology Marcel Dekker. 2003.
3. Araullo, E.V., dePadna, D.B. and Graham, Michael. Rice Post Harvest Technology.

4. International Development Res. Centre, Ottawa, Canada. 1976.
5. Birewar, B.R., Krishnamurthy, K., Girish, G.K., Varma, B.K. and Kanjilal, S.C.. Modern Storage Structures. Indian Grain Storage Institute, Hapur.1983.
6. Earle, R.L, “Unit Operations in Food Processing”. Pergamon Press. Oxford. U.K, 2003

FD3311 **FOOD CHEMISTRY LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES

The course aims to

- Study and understand the chemical properties of foods.
- Study the physical, chemical, thermal properties of various food constituents

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOMES

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

CO 1 gainpractical knowledge on chemical nature of food components.

CO 2 expertise on the protocols of chemical properties of individual components in foods.

CO 3 facilitate for further understanding of food analysis lab.

REFERENCES

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

FD3312 **FOOD MICROBIOLOGY LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES

The course aims to

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

LIST OF EXPERIMENTS

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques; Culture Media-Types and Use; Preparation of Nutrient broth and agar
2. Culture Techniques, Isolation and Preservation of Cultures- Broth flask, test tubes; Solid Pour plates, streak plates, slants, stabs
3. Microscopy – Working and care of Microscope; Microscopic Methods in the Study of Microorganisms; Staining Techniques - Simple, Differential- Gram's Staining
4. Quantification of Microbes Sampling and Serial Dilution; Bacterial count in food products TVC
5. Microbiological quality of water (MPN)
6. Microbiological quality of milk
7. Enumeration of Lactic acid bacteria from fermented foods
8. Yeast & Mould count from fruits
9. Enumeration of spores from pepper
10. Inhibitory effect of spices on microbial load in fish & flesh foods
11. Enumeration & Isolation of E. coli from processed meat/chicken
12. Thermal destruction of microbes TDT & TDP
13. Enumeration & Isolation of Staphylococci from ready to eat street foods
14. Effect of cleaning and disinfection on microbial load

TOTAL: 60 PERIODS

OUTCOMES:

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

CO 1 different techniques for the identification,isolation and culture of microbes.

CO 2 analyse and identify microbial contamination in food

CO 3 disinfection techniques

REFERENCES

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

MA3401 PROBABILITY AND OPERATIONS RESEARCH

L	T	P	C
3	1	0	4

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III LINEAR PROGRAMMING 9+3

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

UNIT IV TRANSPORTATION AND ASSIGNMENT PROBLEMS 9+3

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

UNIT V NON - LINEAR PROGRAMMING PROBLEMS 9+3

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

TOTAL: 60 PERIODS

TEXT BOOKS :

1. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
2. H.A. Taha , " Operations Research, An introduction , 10 th Edition , Pearson Education , New Delhi, 2017.
3. Kanti Swarup, Guptha P.K. and Man Mohan , " Operations Research, Sultan Chand & Sons, New Delhi, 2010.

REFERENCES :

1. John E. Freund's " Mathematical Statistics with Applications " , 8th Edition, Pearson Education , New Delhi, 2017.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGrawHill, New Delhi, 4th Edition, 3rd Reprint, 2008.
3. Pradeep Prabhakar Pai , " Operations Research and Practice" , Oxford University Press, New Delhi , 2012.
4. Ravindran , Philips and Solberg " Operations Research, Principles and Practice " Wiley , 2nd Edition , New Delhi , 2007.
5. Frederick S Hillier and Gerald J. Lieberman , " Introduction to Operations Research, Mc Graw Hill, New Delhi, 2017.

FD3401 BIOCHEMISTRY AND NUTRITION L T P C
3 0 0 3

OBJECTIVES

The course aims to

- Ensure students have a strong grounding in structures and reactions of biomolecules.
- Introduce them to metabolic pathway of the major biomolecules
- Enable the students to understand roles of each nutrients in growth and metabolism

UNIT I INTRODUCTION TO BIOMOLECULES 5

Basic principles of organic chemistry, role of carbon, types of functional groups, biomolecules, chemical nature of water, pH and biological buffers.

UNIT II STRUCTURE AND PROPERTIES OF IMPORTANT BIOMOLECULES 15

Carbohydrates mutarotation, glycosidic bond, reactions of monosaccharides and reducing sugars. Starch, glycogen, cellulose and chitin structures and functions. Proteoglycans, glycosaminoglycans, hyaluronic acid, chondroitin sulfate. Lipids Fatty acids, glycerol, triacylglycerol, phospholipids, glycolipids, sphingolipids. Inherited metabolic disorders of Lipid-metabolism-Tay-Saach's disease, Niemann-Pick's disease and Gaucher's disease. Cholesterol, steroids, Bile acids and salts, Gluco-and Mineralocorticosteroids. Prostaglandins and their functions.Lipoproteins. Cardiovascular disease and correlation with circulating lipid and lipoprotein concentration Amino Acids, Peptides, and Proteins. Classification based on side-chain properties. Structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins.Nucleic acids Purines, pyrimidines, nucleosides, nucleotides, Chargaff's Rules. Base pairing,A-T and G-C, mRNA, rRNA and tRNA., Watson-Crick structure of DNA. reactions, properties,Tm and hypochromicity, Measurement of DNA and RNA. Nucleoprotein complexes

UNIT III AN OVERVIEW OF NUTRITION AND ENERGY BALANCE 6

Definition, six classes of nutrients, calculating energy values from food, using the RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, dietary recommendations, Balanced diet planning Diet planning principles, dietary guidelines; Glycemic and Non-glycemic carbohydrates, health effects of fiber and starch intake food groups, exchange lists, personal diet analysis; Digestion, Absorption and Transport Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption of nutrients. Energy balance; body weight and body composition; health implications; obesity, BMR and BMI calculations.

UNIT IV VITAMINS AND MINERALS 5

Water Soluble Vitamins B vitamins examined individually (Thiamine, Riboflavin, Niacin, Pyridoxine, Biotin, folate B12, choline, pantothenic acid, and carnitine) and in concert; B vitamin deficiencies, toxicities, and food sources; vitamin C roles and recommended intake, deficiency, toxicity and food sources. Fat Soluble Vitamins A, D, E, and K Function, recommended intakes, toxicities, food sources of vitamin A, D, E, and K; Water and Major Minerals Water balance and recommended intakes; fluid/electrolyte balance, acid-base balance; function, recommended intakes, and regulation of sodium, potassium, and calcium. Trace Minerals Food sources, function, recommended intakes, toxicities, deficiencies and transport of iron and zinc; importance of selenium, copper, fluoride, and chromium.

UNIT V INTERMEDIARY METABOLISM AND REGULATION 14

Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt, glyoxalate shunt, fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yieldduring oxidation of glucose and fatty acids.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the students will be able to
CO 1 understand the fundamentals of biomolecules, biochemical reactions in a living organism.
CO 2 understand the importance of nutrients in growth and metabolism.
CO 3 gain knowledge of importance of nutrients in physiological function and biochemical pathways.

TEXT BOOKS:
1. Nelson, D.L. and M.M. Cox, "Lehninger's Principles of Biochemistry", 4th Edition, W.H. Freemen & Co., 2005.
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. Oxford University Press, 2007.
5. Gibney, Michael J., et al., "Introduction to Human Nutrition". 2nd Edition. Blackwell,2009.

REFERENCES:
1. Berg, Jeremy M. et al. "Biochemsitry", 6th Edition, W.H. Freeman & Co., 2006.
2. Voet, D. and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Sons Inc.,2004.
3. Gropper, Sareen S. and Jack L.Smith "Advanced Nutrition and Human Metabolism". 5th Edition. Wadsworth Publishing, 2008.

GE3451 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY L T P C
2 0 0 2

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

UNIT I 6
State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, Need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks.
Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies.

UNIT II 6
Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers. Threats to Biodiversity, Red Data book, Rare, Endangered and Endemic Species of India. Conservation of

Biodiversity. People's action.Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil / land degradation / pollution

UNIT III **6**

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.
Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, Social impacts of development on the poor and tribal communities, Conservation movements: people's movements and activism, Indigenous knowledge systems and traditions of conservation.

UNIT IV **6**

Common goods and public goods, natural capital / tragedy of commons, Cost benefit analysis of development projects, Environment Impact Assessment (EIA), Environment Management Plan (EMP), Green business, Eco-labeling, Problems and solutions with case studies. Global and national state of housing and shelter, Urbanization, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes / Green buildings, Sustainable communities, Sustainable Cities.

UNIT V **6**

Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

TOTAL: 30 PERIODS

COURSE OUTCOME

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
CO1 Public awareness of environment at infant stage.
CO2 Ignorance and incomplete knowledge has lead to misconceptions.
CO3 Development and improvement in standard of living has lead to serious environmental disasters.

TEXT BOOKS

1. R. Rajagopalan, Environmental Studies: From Crisis to Cure. Oxford University Press, 2011, 358 pages. ISBN: 9780198072089.
2. Daniel D. Chiras, Environmental Science. Jones & Bartlett Publishers, 01-Feb-2012, 669 pages. ISBN: 9781449645311.

REFERENCES

1. Andy Jones, Michel Pimbert and Janice Jiggins, 2011. Virtuous Circles: Values, Systems, Sustainability. IIED and IUCN CEESP, London.
2. Annenberg Learner, The Habitable Planet, Annenberg Foundation 2015.

FD3402 FOOD ADDITIVES AND FLAVOURS L T P C
3 0 0 3

OBJECTIVE

- To expose the students to the use of different chemical additives in foods during food processing and preservation.
- To understand the flavour compounds involved in development of flavor.
- To understand the analytical techniques involved in flavor analysis.

UNIT I ACIDITY REGULATORS, ANTIOXIDANTS AND ANTIMICROBIAL AGENTS 9

Acidity Regulators – definition, chemical structure, role and importance, pH modulation and taste, acidity profile, permitted acidity regulators, levels of usage and food applications. Antioxidants - Chemistry of oxidative deterioration of food and its constituents and its effect on the quality; defining antioxidant; water soluble and oil soluble antioxidants and their chemical structure, permitted antioxidants; mechanism of action, permitted levels and food application. Preservatives of chemical and microbial origin; mode of action on spoilage organisms and pathogens, factors affecting the performance of preservatives, active forms of preservatives, necessity in a food and levels of usage; permitted preservatives and food applications. Case studies / illustrations.

UNIT II EMULSIFIERS, STABILIZERS AND THICKENERS 9

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

UNIT III COLORS, FLAVORS, FLAVOR ENHANCERS AND SWEETENERS 9

Color – Natural and synthetic food colors, their chemical structure, shades imparted, stability, permitted list of colors, usage levels and food application. Flavouring agents- natural and synthetic flavourings, Flavours from vegetables, cocoa, chocolate, coffee, vanilla beans and Spices. Evaluation tests for flavours. Stability of flavours during food processing, Extraction techniques of flavours, Flavour emulsions; Essential oils and Oleoresins; Flavour enhancers- Chemical properties, Functions in foods, Glutamate in foods, Biochemicals & Toxicology Sweeteners – list, structure, taste profile, permitted list, usage levels and food applications.

UNIT IV FLAVOUR PERCEPTION AND FLAVOUR ANALYSIS 9

Flavour and taste perception, smell and taste sensation, olfaction, flavour compounds, volatile flavour compounds, chemesthesis and chemesthetic responses, tactile response, Aromacompounds, flavour profile, bio-flavour and reconstituted flavour Subjective versus Objective methods of analysis; psychophysics and sensory evaluation; Instrumental analysis; sample handling and artifacts; data handling.

UNIT V OTHER FOOD ADDITIVES & FOOD INGREDIENTS 9

Anticaking agents, Antifoaming, Glazing agents, Bulking agents, Humectants, Firming agents, Softening agents, Crystal modifiers, Flour improvers, Flour treatment agents, Dough conditioners, and Enzymes – definition, role and mode of action, permitted list of agents and food application. Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 To understand the principles of chemical preservation of foods.

CO2 To understand the role of different food additives in the processing of different foods and their specific functions in improving the shelf life, quality, texture and other physical and sensory characteristics of foods.
CO3 To know the regulations and the monitoring agencies involved in controlling the safer use of additives in foods.
CO4 Better understanding and knowledge of contribution of different compounds for the development of flavor and Analytical techniques involved in flavor analysis.

TEXTBOOKS:

1. Branen, A. L. “Food Additives” 2nd Edition, CRC press, 2002.
2. Mahindra, S. N. “Food Additives- Characteristics Detection and Estimation”, TATA McGraw Hill, 2000.
3. Reineccius, Gary. “Flavour Chemistry and Technology”. 2nd Edition, Taylor & Francis, 2006.

REFERENCES:

1. Thomas. E. Furia, “Handbook of food additives” 2nd Edition, Volume 2, CRC press, 1980
2. P. Michael Davidson, John N. Sofos, and A. L. Branen, “Antimicrobials in food”, 3rd Edition, CRC press 2005
3. Peter A Williams and Glyn O Philips, “Gums and stabilizers for the Food Industry”, RSC,2007.
4. Madhavi, D. L. S. S. Deshpande, and D. K. Salunkhe. “Food antioxidants”, CRC Press, 1996
5. Fisher, Carolyn and Thomas R. Scott. “Food Flavours Biology and Chemistry”. The Royal Society of Chemistry, 1997.
6. Heath, H.B. and G. Reineccius. “Flavour Chemistry and Technology”. CBS Publishers, 1996.
7. Dr Kay O’Donnell et al, “Sweeteners and sugar alternatives in food technology”, wiley& sons, 2012.
8. Carmen Socaciu, “Food Colorants Chemical and functional properties”, CRC Press,2007.
9. Gary Reineccius, “Flavor chemistry and technology”, 2nd Edition, CRC Press, 2016.
10. Ashurst, Philip R. “Food Flavourings”. 3rd Edition, Aspen Publications, 1999.
11. Shahidi, Fereidoon and Chi-Tang Ho. “Flavour Chemistry of Ethnic Foods”. Kluwer Academic Plenum, 1999.
12. Titus A. M. Msagati. “The Chemistry of Food Additives and Preservatives”, Wiley- Blackwell, 2013.

FD3403 HEAT AND MASS TRANSFER IN FOOD PROCESSES LT P C
3 1 0 4

OBJECTIVES

The course aims to

- learn the principles and applications of heat and mass transfer operations in food industries.
- understand the mechanisms and concept of heat transfer effectively.
- Investigate the mass transfer operational approaches.

UNIT I HEAT TRANSFER – CONDUCTION 12

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

UNIT II HEAT TRANSFER – CONVECTION 12

Heat transfer - convection – free and forced convection - factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in foods.

UNIT III HEAT TRANSFER – RADIATION AND HEAT EXCHANGER 12

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

UNIT IV MASS TRANSFER - DIFFUSION, EVAPORATION AND CONCENTRATION 12

Unit operations in food processing –conservation of mass and energy – overall view of an engineering process-dimensions and units – dimensional and unit consistency – dimensionless ratios-evaporation – definition – liquid characteristics – single and multiple effect evaporation- performance of evaporators and boiling point elevation – capacity – economy and heat balance- types of evaporators – once through and circulation evaporators – short tube evaporators and long tube evaporators – agitated film evaporator.

Mass transfer in foods – introduction – Fick's law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of A through non diffusing B, diffusion coefficients for gases - molecular diffusion in liquids, solids, biological solutions and gels.

UNIT V MASS TRANSFER – DISTILLATION 12

Vapour liquid equilibria - Raoult's law- Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe -Thiele method.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO 1 apply the different heat and mass transfer principles in different approaches.

CO 2 gain knowledge on types of heat exchangers used in food industry

CO 3 design the heat and mass transfer equipments.

TEXT BOOKS:

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

REFERENCES:

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

FD3404 PRINCIPLES OF THERMODYNAMICS LT P C
3 0 0 3

OBJECTIVES

The course aims to

• train the students on the basics and applications of energy in Mechanical Engineering

• impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

UNIT I BASIC CONCEPTS 9

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach.Path and point functions. Intensive and extensive, Total and specific quantities.System and their types.Thermodynamic Equilibrium State, path and process. Quasi_static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work.P-V diagram.

UNIT II LAWS OF THERMODYNAMICS 9

Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship etween temperature scales –new temperature scales. First law of thermodynamics – application to closed and open systems – steady and unsteady flow processes. Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High- and low-grade energy. Available and non-available energy of a source and finite body.Energy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart.Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS 9

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties.Compressibility factor-.Principle of Corresponding states. - Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

UNIT V GAS MIXTURES AND PSYCHROMETRY 9

Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

TOTAL: 45 PERIODS

OUTCOMES:

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

CO 1 apply thermodynamic principles to Engineering Applications

CO 2 apply mathematical fundamentals to study the properties of steam, gas and gas mixture.

CO 3 apply fundamentals of thermodynamics and to perform thermal analysis on their behaviour and performance

TEXT BOOKS:

1. Nag P. K. Thermodynamics, 2005. 5thedition,Tata Mc Graw Hill, New Delhi. 2001.
2. EthirajanRathakrishnan. Fundamentals of Engineering Thermodynamics. (PHI). 2010.
3. Y. Cengel and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,7th Edition, 2011.
4. Chattopadhyay, P, "Engineering Thermodynamics",2nd Ed. Oxford University Press, 2014.
5. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007.
6. E. Rathakrishnan, "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
7. Van Wylen and Sonntag, "Classical Thermodynamics", Wiley Eastern, 1987.

FD3411 BIOCHEMISTRY AND NUTRITION LABORATORY L T P C
0 0 4 2

OBJECTIVES

The course aims to

- Learn and understand the principles behind the qualitative and quantitative estimation of biomolecules.
- Understand the quantitative methods in assessing nutritional status of individuals and groups.

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOMES:

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

CO 1 understand the experimental protocols for qualitative and quantitative analysis of biomolecules.
CO 2 familiarize with the calculation of energy values of foods and composition table.
CO 3 gain knowledge of Nutritional anthropometry techniques.

TEXT BOOKS:

1. Gupta. R.C. and Bhargavan. S. Practical Biochemistry. 5th Edition, CBS Publishers and Distributors 2013.
2. David T. Phummer. Introduction of Practical Biochemistry, 3rd Edition. McGraw- Hill Publishing co. 2017.
3. Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. OxfordUniversity Press, 2007.

REFERENCES:

1. R.K. Murray, D.K. Granner, P.A. Mayes and V.W.Rodwell, Harpers Biochemistry.McGraw- Hill Co. 26th Edition. 2003.
2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers.7th Edition. 2010.
3. .Gibney, Michael J., et al., “Introduction to Human Nutrition”. 2nd Edition. Blackwell, 2009.

FD3412 UNIT OPERATIONS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

•To develop knowledge in handling basic operation equipment’s

EXPERIMENTS:

1.Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
2.Determination of economy and thermal efficiency of rotary flash evaporator
3.Solving problems on single and multiple effect evaporator
4.Determination of separation efficiency of centrifugal separator.
5.Determination of collection efficiency in cyclone separator.
6.Determination of efficiency of liquid solid separation by filtration.
7.Determination of absorption efficiency in a packing tower
8.Determination of porosity, coefficient of friction and angle of repose of grains.
9.Determination of particle size of granular foods by sieve analysis.
10.Determination of performance characteristics in size reduction using the burr mill.
11.Determination of energy requirement in size reduction using the ball mill andhammer mill.
12.Performance evaluation of pin mill and hammer mill.
13.Performance evaluation of a steam distillation process.
14.Visit to a solvent extraction, sugar industry.

TOTAL: 60 PERIODS

Equipment Needed for 30 Students
Orifice meter – 1
Venturi meter-1
Rotameter-1
Packed column-1
Centrifugal separator-1
Steam distillation unit-2
Fluidized bed column-1
Rotary flash evaporator-1
Cyclone separator-1
Ball mill-1
Hammer mill-1
Burr mill-1
Pin mill

COURSE OUTCOMES:

Upon completion of this practical course the student will
CO1 Have knowledge on the basic principles of chemical engineering and its applications.
CO2 Be able to apply the skill of material balance and energy balance in unit operations unit process.