



ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021

B.TECH. FOOD TECHNOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)

PROGRAMME OUTCOMES (POs):

Graduates of Food Technology will be able to:

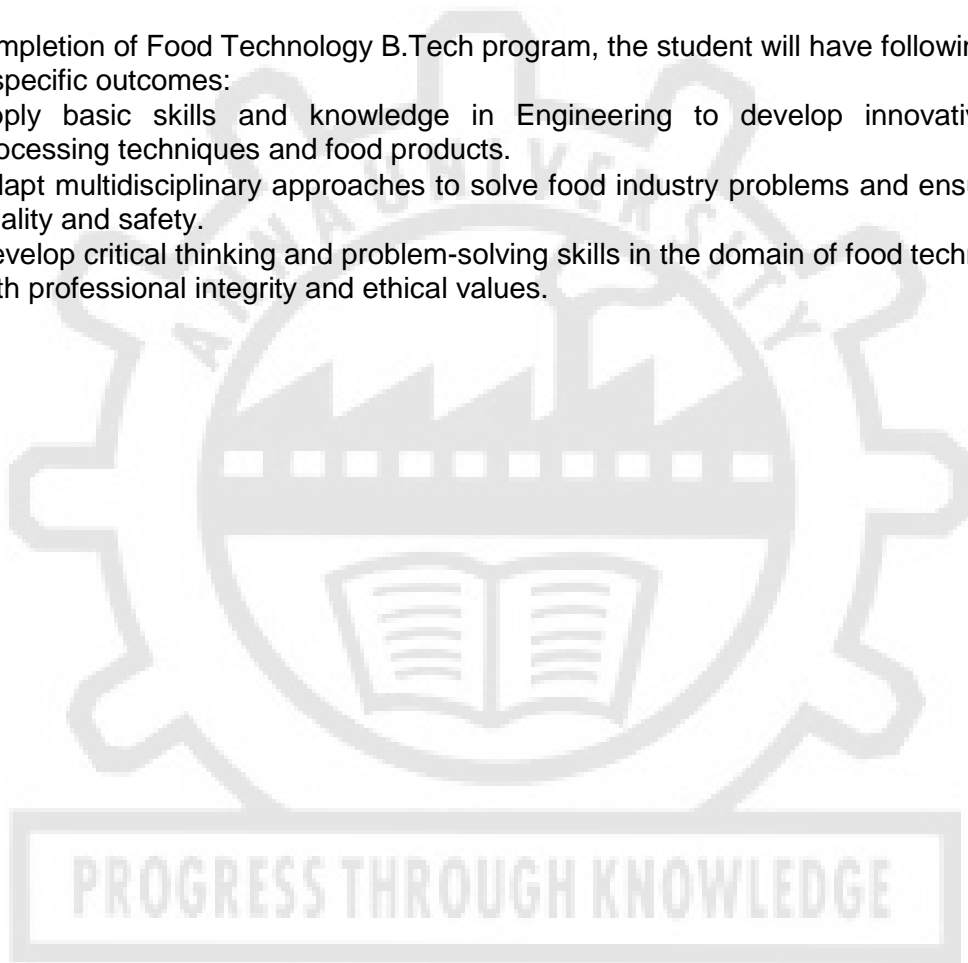
1. **PO1 Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **PO2 Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **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.
4. **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.
5. **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.
6. **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.
7. **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.
8. **PO8 Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **PO9 Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **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.
11. **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.
12. **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.

2. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Food Technology B.Tech program, the student will have following program specific outcomes:

- Apply basic skills and knowledge in Engineering to develop innovative food processing techniques and food products.
- Adapt multidisciplinary approaches to solve food industry problems and ensure food quality and safety.
- Develop critical thinking and problem-solving skills in the domain of food technology with professional integrity and ethical values.



3. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	
YEAR 1	SEMESTER 1	Professional English - I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-	
		Matrices and Calculus	3	3	1	1	0	0	0	0	0	2	0	2	3	-	-	-
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	-	1	-	-	-
		Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	-	1.5	-	-	-
		Problem Solving and Python Programming	2	3	3	3	2	-	-	-	-	-	-	2	2	3	3	
		தமிழர் மரபு /Heritage of Tamils																
		Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	-	2	2	3	3	
		Physics and Chemistry Laboratory	3	2.4	2.6	1	1											
			2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	-	1.3	-	-	-
	English Laboratory §	3	3	3	3	1	3	3	3	3	3	3	3	3	-	-	-	
	SEMESTER 2	Professional English - II	3	3	3	3	2.7 5	3	3	3	2.2	3	3	3	3	-	-	-
		Statistics and Numerical Methods	3	3	1	1	1	0	0	0	0	2	0	2	3	-	-	-
		Physics of Materials	3	2.25	2	1.66	2	1.6	1.75	1					1			
		Basic Electrical,	2	1	1						1					-	-	-

		Electronics and Instrumentation Engineering															
		Engineering Graphics	3	1	2		2					3		2	2	2	
		தமிழரும் தொழில்நுட்பமும் / Tamils and Technology															
		Engineering Practices Laboratory	3	2			1	1	1					2	2	1	1
		Basic Electrical, Electronics & Instrumentation Engineering Laboratory	1.6	1.4	0.8	1.6					1.2	1.6					
		Communication Laboratory / Foreign Language §	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-
YEAR 2	SEMESTER 3	Food Chemistry	1.8	2.2	2.2	2.4	2	2.6	2	-	-	-	1.6	2.3	2	1.8	2.1
		Food Microbiology	2	2.2	2.2	2.2	2.8	2.4	0	0	0	0	1.4	2.2	2	2.2	2
		Food Process Calculation	2	2	2	2.2	2.4	2.6	0	0	0	0	1.4	2	2	1.8	2
		Post-Harvest Engineering	2	2	2.2	2.2	2.6	2.6	1.8	0	0	0	1	2.4	2	2.2	2
		Food Chemistry Laboratory	2.2	2.2	2	2.6	2.3	2.3	2	0	0	0	1.6	2.2	2	0	0
		Food Microbiology Laboratory	1.8	2	2	2.5	2	2.5	1.6	0	0	0	1.8	2	2	1.8	0
		Transforms and Partial Differential	3	3	1	1	0	0	0	0	0	2	0	0	3	-	-

YEAR 3	SEMESTER 4	Equations																
		Biochemistry and Nutrition	2.2	2.4	2	2.2	2.6	2.6	2.2	0	0	0	1.2	2	1.6	0	1.6	
		Probability and Operations Research	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-	
		Food Additives and Flavors	1.6	1.8	2	1.6	2.6	2.6	1.6	0	0	0	1.6	2	1.6	2	0	
		Environmental Sciences and Sustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-	
		Heat and Mass Transfer in Food Processes	2.4	2.4	1.8	2.4	2.4	2.4	1.4	0	0	0	1.4	2.6	1.8	0	2	
		Principles of Thermodynamics	2.6	2.2	2.6	2.4	2.4	2.4	1.6	0	0	0	1.2	2.4	1.8	0	2	
		Biochemistry and Nutrition Laboratory	1.8	2.4	1.6	2.5	2	2.5	1	0	0	0	1.2	2.6	0	2	1.6	
		Unit Operations Laboratory	1.8	1.8	2.4	2.2	2	2.8	1.4	0	0	0	2	2.6	2.2	0	2	
		YEAR 3	SEMESTER 5	Food Processing and Preservation	2.4	2.4	1.8	2.4	2.4	2.4	1.4	0	0	0	1.4	2.6	2.2	2.2
Food Analysis	2.2			2.2	2	2.6	3	2.2	2	0	0	0	1.2	2.6	2	2	0	
Food Processing and Preservation Laboratory	1.2			1.8	3	2.8	3	2	0	0	0	1.8	2	3	1.8	2	0	
SEMESTER 5	Food Analysis Laboratory		2.2	2.2	2	2.6	3	2.2	2	0	0	0	1.2	2.6	2	2	0	
	SEMESTER 5		Food Process Engineering	2.4	2.6	2	2.4	2.2	0	1.6	0	0	0	1.6	2.4	2.2	2	2
			Food Process Engineering Laboratory	2.4	2.6	2	2.4	2.2	0	1.6	0	0	0	1.6	2.4	2.2	2	2
SEMESTER 5	Refrigeration and	3	2.8	2.4	2.2	2.6	2.4	2.4	0	0	0	1.4	2.6	1.6	0	2		

		Cold Chain Management															
		Food Plant Equipment Design	3	2	3	2	3	3	3	0	0	0	1.4	2.6	2	2	0
V E R T I C A L S	V E R T I C A L S	Dairy Chemistry and Microbiology	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.75
		Processing of Dairy Products	2	2.4	1.4	2.2	1.6	1	0	0	0	0	1.4	2.4	2.4	1.4	2.2
		Value added dairy products	2.2	2.4	1.8	2.4	0	1.4	1.4	0	0	0	1.2	2.6	2.2	0	2
		Precision fermentation for dairy alternatives	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.25
		Cheese Technology	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	1.5	1.75	0
		Quality and Safety Monitoring in Dairy industry	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	1.75	2.25	1.5
		Introduction to Food Biotechnology	2.6	2.2	2.6	2.4	2.4	2.4	1.6	0	0	0	1.2	2.4	2	0	1.6
V E R T I C A L S	V E R T I C A L S	Enzymes in food and feed industry	2.6	2.2	2.6	0	2.4	2.4	1.6	0	0	0	0	2.4	1.6	1.6	1.6
		Food allergens and Toxicology	2.6	2.2	2.6	2.4	2.4	2.4	1.6	0	0	0	1.2	2.4	1.8	0	1.6
		Genetic Engineering and Genetically Modified Foods	2.25	1.5	2	2.75	0	2.5	1.5	0	0	0	1	2.5	1.75	1.75	1.75
		Functional Foods and Nutraceuticals	2.4	2.2	2.4	2.4	2.4	2.4	0	0	0	0	1.4	2.4	2	0	2.4
		Introduction to meat, marine and poultry	1.8	1.6	2.2	1.6	0	2.4	1.6	0	0	0	1.2	2.4	1.8	0	2.2

		Meat & poultry processing	1.8	1.6	2.2	1.6	0	2.4	1.6	0	0	0	1.2	2.4	2.2	0	2
		By-products in meat processing	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	1	2.25
		Preservation Technology of eggs, meat, poultry and seafood	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.75
		Marine Foods Processing	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2.25	0	2.25
		Technology of packaging meat and marine products	2.75	2	2	2.5	2.5	2.5	1.5	0	0	0	1	2.5	1.75	2	0
		Quality, Laws, and regulations in Meat industries	2.5	2.25	2	2.5	0	2.5	1.5	0	0	0	0	2.25	2.25	0	2.25
	VERTICAL 4	Fat and Oil Technology	2.75	2.25	1.75	1.5	2.75	2	1.5	0	0	0	1.75	2.5	2	2	0
		Processing of Cereals, oil seeds and pulses	2.6	2.6	2.6	2.6	2.6	3	3	0	0	0	1.2	2.4	2.2	0	2.2
		Enrichment and Fortification of cereals and oils	2.5	2.25	2.25	2.5	0	2.5	2	0	0	0	2	2.5	2	2	0
		Milling and Fractionation Technologies	2.75	2	2.25	2.5	0.75	2.5	1.5	0	0	0	0	2.5	2.25	0	2
		Technology of Malting and Brewing	2	2.5	2	2.25	2.5	2.5	1.5	0	0	0	1.5	2.5	2	2	0
		Byproducts Management	2.5	2.5	2	2.5	0.5	2.25	1.5	0	0	0	1.25	2.5	2	0	1.75

		Quality, Laws and Regulations in grain processing industries	2.5	2	2.25	2.5	2.5	1.5	0	0	0	1.5	2.5	0	2	2	2.5
	VERTICA	Food Material Science	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1.25	2.5	1.75	2	0
		Food Structuring Techniques	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1.75	2.5	2	0	2
		Food Informatics	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1.25	2.5	2	0	2.25
	VERTICAL 6	Technology of fruit and vegetable processing	3	2.8	2.8	2.4	2.8	2.6	2.6	0	0	0	1.2	2.6	2.2	0	1.8
		Fruits and vegetables as nutraceuticals	2.6	2.4	2.6	2	3	2.4	2	-	-	-	1.3	2.4	1.7	-	2.2
		Advances in fruit and vegetable processing technologies	2.5	2.25	2	2	2.5	2.5	1.5	0	0	0	1.5	2.5	2.25	0	2
		Beverage technology	2.4	2.4	1.8	2.2	2.4	2.4	1.8	0	0	0	1.2	2.4	2.2	0	2.2
		Fruit and vegetable storage	1	0.9	0.8	0.8	1	1	0.6	0	0	0	0.6	1	0.8	0.4	0.7
		Innovative packaging of fruit and vegetables	2.5	2	2	2.25	1.75	2	1.5	0	0	0	0	2.5	2.5	0	2
		Fruit and vegetable industry safety & laws	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	2
	VERTICA	Packaging design and sustainable development	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2.25	0	2.25
		Packaging printing inks and coatings	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.75

		Glass, wood and metal processing and packaging	2.5	2	1.75	2.25	0	2.25	1.5	0	0	0	0	2.5	2	0	1.5
		Plastics and polymers in packaging	2.5	2	1.75	2.25	0	2.25	1.5	0	0	0	0	2.5	2.25	0	1.5
		Paper, CFB and paper board based packaging	1.75	2.25	1.75	2.5	0	1.5	1.5	0	0	0	1	2.5	1.75	0	1.75
		Packaging laws and regulations	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	2
		Packaging performance testing & machinery and equipment	2.5	2.5	1.75	2	2.25	2.5	1.5	0	0	0	1.5	2.25	2	2	0
	VERTICAL 8	Introduction to baking & bakery products	2.4	2	2.2	2.2	0	2.4	1.8	0	0	0	1.2	2.4	2	1.4	1.6
		Flour chemistry and rheology	1.75	2	1.75	1.5	2	1.5	1.5	0	0	0	1	2.5	1.75	1.5	1.5
		Confectionery products	2.2	2	1.8	2	0	2.4	1.8	0	0	0	1.2	2.4	2	0	1.8
		Industrial production of cookies and biscuits	2.5	2.25	2.25	2.5	0	2.5	1.75	0	0	0	1.25	2.5	1.75	1.5	2.5
		Industrial production of bun, bread, cakes and pastries	2.75	2.25	1.75	2.5	0	2.5	1.5	0	0	0	1	2.5	1.75	1.75	0

		Packaging of bakery and confectionery products	2.25	1.5	1.75	2.25	1.25	2	1.5	0	0	0	1	2.5	2.25	1	2
		Laws and regulations of bakery and confectionery products	2.5	2.25	2.25	2.5	1.25	2.5	1.5	0	0	0	1	2.5	2	0	1.5
VERTICAL 9		Processing and storage of spices & plantation crops	2.5	1.75	1.5	2.5	0	2.5	2	0	0	0	1	2.5	1.75	0	2.25
		Blending and value addition	2	1.75	2	2.5	0	2.5	1.5	0	0	0	1	2.5	2	1.75	2.25
		Processing of coffee	2.5	1.75	1.75	1.5	0	2.5	1.5	0	0	0	1	2.25	2.25	1.5	1.25
		Processing of tea	2.5	1.75	1.75	1.5	0	2.5	1.5	0	0	0	1	2.25	2	0	1.75
		Processing of cocoa and chocolate	2.25	1.75	1.75	2.25	0	2.5	1.5	0	0	0	1	2.5	2	2	2
		Packaging of spices & plantation products	2.25	2	1.75	2.25	0	2.25	1.5	0	0	0	1	2.5	2	1.75	2.25
		Spice processing and products laws, quality standards and regulations	2.5	1.75	2	2.5	0	2.25	1.75	0	0	0	1	2.25	2	0	2

VERTICAL 10	Introduction to food safety analysis and quality risk management	2.5	1.5	1.75	2.25	0	2.25	1.5	0	0	0	1	1.75	2.25	0	2.25
	HACCP in food processing and preservation	2.75	2	1.75	2.5	0	2.5	1.5	0	0	0	1	2.5	1.75	0	1.75
	FSMS & Food product and supply chain management	2.5	2	2	2.5	1.25	2.25	1.5	0	0	0	1	2	2.25	0	2.25
	Food laws – Indian and International	2	1.75	1.75	1.75	0	2.5	1.5	0	0	0	1	2	1.5	1	2
	Food safety in hospitality industry & GLP in food industries	2.75	2	1.75	2.5	0	2.5	1.5	0	0	0	1	2.5	2	0	2.25
	Food analysis, testing & microbial safety analysis	2	2	2	2	0	1.75	1.5	0	0	0	1	1.75	3	1.75	0
	Food quality assurance and quality control	1.5	2.25	1.75	2	0	2	1.5	0	0	0	1	2	1.75	1	1.5

1-Low,2-Medium,3-High,"-no correlation

PROGRESS THROUGH KNOWLEDGE

ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B.TECH. FOOD TECHNOLOGY
CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS
SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3152	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.	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3171	Problem Solving and 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	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3252	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	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	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

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 Laboratory	PCC	0	0	4	4	2
8.	FD3312	Food Microbiology Laboratory	PCC	0	0	4	4	2
9.	GE3361	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 flavours	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	4	4	2
9.	FD3412	Unit operations Laboratory	PCC	0	0	4	4	2
10.	FD3513	Industrial Training/ Internship I*	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 laboratory	PCC	0	0	4	4	2
8.	FD3512	Food Analysis Laboratory	PCC	0	0	4	4	2
9.	FD3513	Industrial Training /Internship I*	EEC	0	0	0	0	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 Laboratory	PCC	0	0	4	4	2
10.	FD3711	Industrial Training / Internship II ^{##}	EEC	-	-	-	-	-
TOTAL				21	1	4	24	21

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

^{##} Four weeks industrial training/internship carries two 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 II##	EEC	0	0	0	0	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

Four weeks industrial training/internship carries two 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	Project Work / Internship#	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 PER WEEK			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

S. 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 Risk Reduction and Management	MC	3	0	0	3	0

MANDATORY COURSES II

S. 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	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI	Vertical VII	Vertical VIII	Vertical IX	Vertical X
DAIRY AND BEVERAGE TECHNOLOGY	FOOD BIOTECHNOLOGY	MEAT, MARINE AND POULTRY TECHNOLOGY	CEREALS, PULSES AND GRAIN TECHNOLOGY	NEXT GENERATION TECHNOLOGIES IN FOOD INDUSTRIES	FRUIT AND VEGETABLE TECHNOLOGY	FOOD PACKAGING TECHNOLOGY	BAKING AND CONFECTIONERY TECHNOLOGY	SPICES AND PLANTATION TECHNOLOGY	FOOD SAFETY MANAGEMENT SYSTEM
Dairy chemistry and microbiology	Introduction To Food Biotechnology	Introduction To Meat, Marine , Poultry	Fat and 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 and Poultry Processing	Processing Of Cereals, Oil Seeds And Pulses	Food materials science	Fruits And Vegetables as Nutraceu-tical	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 Management	Food informatics	Innovative Packaging Of Fruit And Vegetables	Packaging laws and Regulations	Packaging of bakery & confectionery products	Packaging of spices. Plantation products	Food Analysis, Testing & Microbial Safety Analysis
Quality and Safety Monitoring in Dairy Industry	Functional Foods and Nutraceuticals	Quality, Laws And Regulations In Meat Industries	Quality, Laws And Regulations In grain processing Industries	Applied Genomics and Proteomics	Fruit And Vegetable Industry Safety & Laws	Packaging Performance Testing & Process, Machinery and equipment	Laws and regulations of Bakery and confectionery 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. (Amendments)



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 and 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 and 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	CATEGORY	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	CATEGORY	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 and Laws	PEC	3	0	0	3	3

VERTICAL VII: FOOD PACKAGING TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	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 and Process, Machinery and equipment	PEC	3	0	0	3	3

VERTICAL VIII: BAKING AND CONFECTIONERY TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3050	Introduction to baking and bakery products	PEC	3	0	0	3	3
2.	FD3051	Flour chemistry and 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 and 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 and 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 MANAGEMENT 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 and 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 and GLP in Food Industries	PEC	3	0	0	3	3
6.	FD3069	Food Analysis, Testing and 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.	CCS333	Augmented Reality / 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.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
7.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
8.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	AU3791	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-destructive testing	OEC	3	0	0	3	3
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.	OCH351	Nano Technology	OEC	3	0	0	3	3
24.	OCH352	Functional Materials	OEC	3	0	0	3	3
25.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
26.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
27.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
28.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
29.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
30.	CPE334	Energy Conservation and Management	OEC	3	0	0	3	3
31.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
32.	OEC351	Signals and Systems	OEC	3	0	0	3	3
33.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
34.	CBM348	Foundation Skills in Integrated Product Development	OEC	3	0	0	3	3
35.	CBM333	Assistive Technology	OEC	3	0	0	3	3
36.	OMA352	Operations Research	OEC	3	0	0	3	3
37.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
38.	OMA354	Linear Algebra	OEC	3	0	0	3	3
39.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
40.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
41.	OBT354	Fundamentals of Cell and Molecular Biology	OEC	3	0	0	3	3

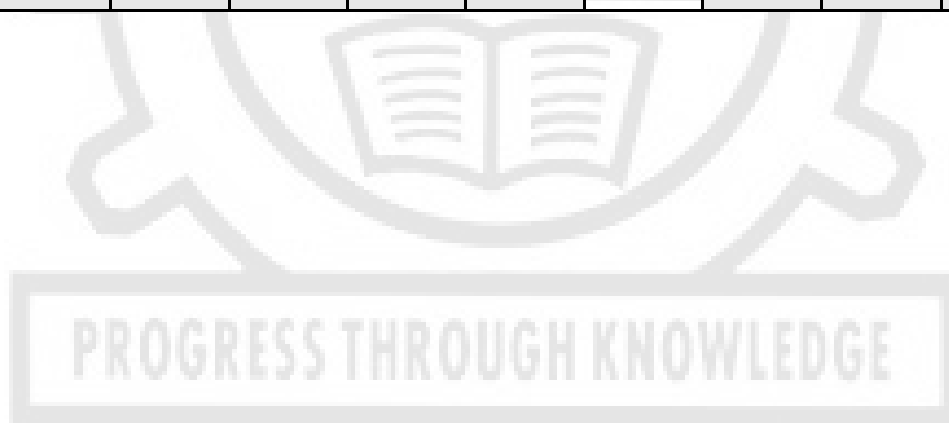
OPEN ELECTIVES – IV

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.	CME343	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	MF3010`	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	AU3002`	Batteries and Management system	OEC	3	0	0	3	3
14.	AU3008	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	Concepts in Mobile Robots	OEC	3	0	0	3	3
26.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
27.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
28.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
29.	CRA332	Drone Technologies	OEC	3	0	0	3	3
30.	OGI352	Geographical Information System	OEC	3	0	0	3	3
31.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
32.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
33.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
34.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
35.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
36.	OCH353	Energy Technology	OEC	3	0	0	3	3
37.	OCH354	Surface Science	OEC	3	0	0	3	3
38.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
39.	FT3201	Fibre Science	OEC	3	0	0	3	3
40.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
41.	OPE353	Industrial safety	OEC	3	0	0	3	3
42.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
43.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
44.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
45.	OEC353	VLSI Design	OEC	3	0	0	3	3
46.	CBM370	Wearable devices	OEC	3	0	0	3	3
47.	CBM356	Medical Informatics	OEC	3	0	0	3	3
48.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
49.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
50.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

SUMMARY

Name of the Programme										
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



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 (Amendments) 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 Entrepreneurship	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	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals 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	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction 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 Entrepreneurship	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

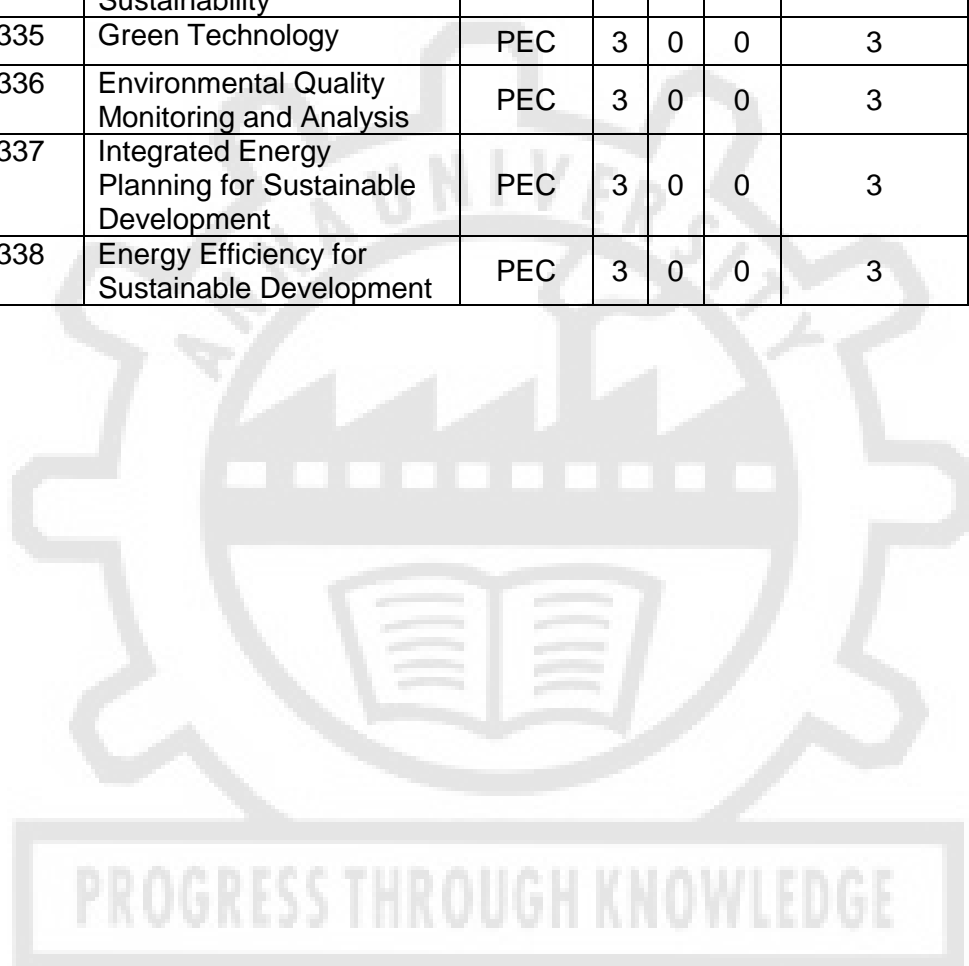
VERTICAL 4: BUSINESS DATA ANALYTICS

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

PROGRESS THROUGH KNOWLEDGE

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



This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don't's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

REFERENCES:

Guide to Induction program from AICTE

HS3152

PROFESSIONAL ENGLISH I

**L T P C
3 0 0 3**

OBJECTIVES :

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION

1

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION

8

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags.

Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION 9

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9

Reading – Newspaper articles; Journal reports –and Non Verbal Communication (tables, pie charts etc,.). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart , graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V EXPRESSION 9

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

TOTAL : 45 PERIODS

LEARNING OUTCOMES :

At the end of the course, learners will be able

- To use appropriate words in a professional context
- To gain understanding of basic grammatical structures and use them in right context.
- To read and interpret information presented in tables, charts and other graphic forms
- To write definitions, descriptions, narrations and essays on various topics

TEXT BOOKS :

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
AVg.	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

MA3151

MATRICES AND CALCULUS

L T P C
3 1 0 4

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I **MATRICES**

9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

UNIT II **DIFFERENTIAL CALCULUS**

9+3

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

UNIT III **FUNCTIONS OF SEVERAL VARIABLES**

9+3

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV **INTEGRAL CALCULUS**

9+3

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

UNIT V **MULTIPLE INTEGRALS**

9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- CO1 : Use the matrix algebra methods for solving practical problems.
- CO2 : Apply differential calculus tools in solving various application problems.
- CO3 : Able to use differential calculus ideas on several variable functions.
- CO4 : Apply different methods of integration in solving practical problems.
- CO5 : Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS :

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., " Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7th Edition, 2009.
3. Jain .R.K. and Iyengar. S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., " Calculus " Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, " Engineering Mathematics " Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14th Edition, Pearson India, 2018.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

PH3151

ENGINEERING PHYSICS

L T P C
3 0 0 3

COURSE OBJECTIVES

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I MECHANICS

9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of continuous bodies –

M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

UNIT II ELECTROMAGNETIC WAVES 9

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS 9

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment.^[1] Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO₂ laser, semiconductor laser –Basic applications of lasers in industry.

UNIT IV BASIC QUANTUM MECHANICS 9

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS 9

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students should be able to

- CO1 : Understand the importance of mechanics.
- CO2 : Express their knowledge in electromagnetic waves.
- CO3 : Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- CO4 : Understand the importance of quantum physics.
- CO5 : Comprehend and apply quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017. ^[1]_[SEP]
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

REFERENCES:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009. ^[1]_[SEP]
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag,

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-	-
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-	-
AVG	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-	-

1-Low,2-Medium,3-High,"-no correlation

Note: the average value of this course to be used for program articulation matrix.

CY3151

ENGINEERING CHEMISTRY

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I WATER AND ITS TREATMENT

9

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

UNIT II NANO CHEMISTRY

9

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES

9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV FUELS AND COMBUSTION

9

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil

- cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO₂ emission and carbon foot print.

UNIT V ENERGY SOURCES AND STORAGE DEVICES

9

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles; Working principles; Fuel cells: H₂-O₂ fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 :To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

CO2 :To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

CO3 :To apply the knowledge of phase rule and composites for material selection requirements.

CO4 :To recommend suitable fuels for engineering processes and applications.

CO5 :To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.

REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
Avg.	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation

OBJECTIVES:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL : 45 PERIODS**OUTCOMES:**

Upon completion of the course, students will be able to

CO1: Develop algorithmic solutions to simple computational problems.

CO2: Develop and execute simple Python programs.

CO3: Write simple Python programs using conditionals and looping for solving problems.

CO4: Decompose a Python program into functions.

CO5: Represent compound data using Python lists, tuples, dictionaries etc.

CO6: Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

COs- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	-	-	-	-	-	2	2	3	3	-
2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-
AVg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

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தமிழர் மரபு

LTPC

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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 திருவள்ளூர் 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, ஓயிலாட்டம், 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, கையெழுத்துப்படிக்கல்கள் - தமிழ்ப் புத்தகங்களின் அச்ச 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. பொருளை – 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) (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.

GE3152

HERITAGE OF TAMILS

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1 0 0 1**

UNIT I LANGUAGE AND LITERATURE

3

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 HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3
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 - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyllattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3
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 CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3
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 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. பொருளை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
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8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
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12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures – lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1: Develop algorithmic solutions to simple computational problems

CO2: Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems..

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
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6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

COs- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	3	2	3	3	-
2	3	3	3	3	3	-	-	-	-	-	3	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	3	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	-	-	-	2	-	-	-	-	-	1	-	2	-	-
AVg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

BS3171

PHYSICS AND CHEMISTRY LABORATORY

L T P C
0 0 4 2

PHYSICS LABORATORY : (Any Seven Experiments)

COURSE OBJECTIVES:

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

LIST OF EXPERIMENTS

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids

10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

- CO1 : Understand the functioning of various physics laboratory equipment.
- CO2 : Use graphical models to analyze laboratory data.
- CO3 : Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- CO4 : Access, process and analyze scientific information.
- CO5 : Solve problems individually and collaboratively.

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-	-
AVG	3	2.4	2.6	1	1											

- 1-Low,2-Medium,3-High,"-“-no correlation
- Note: the average value of this course to be used for program articulation matrix.

CHEMISTRY LABORATORY: (Any seven experiments)

OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

1. Preparation of Na₂CO₃ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
 - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO₂/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

TOTAL : 30 PERIODS

OUTCOMES:

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles
- To quantitatively analyse the impurities in solution by electroanalytical techniques

TEXT BOOK:

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
Avg	2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation

GE3172

ENGLISH LABORATORY

L T P C
0 0 2 1**OBJECTIVES :**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION

6

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions(filling out a bank application for example).

UNIT II NARRATION AND SUMMATION

6

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT

6

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving

instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

UNIT V EXPRESSION 6

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions-understanding a website-describing processes

TOTAL : 30 PERIODS

LEARNING OUTCOMES:

At the end of the course, learners will be able

- To listen to and comprehend general as well as complex academic texts information
- To listen to and understand different points of view in a discussion
- To speak fluently and accurately in formal and informal communicative contexts
- To describe products and processes and explain their uses and purposes clearly and accurately
- To express their opinions effectively in both formal and informal discussions

ASSESSMENT PATTERN

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
AVg.	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

HS3252

PROFESSIONAL ENGLISH -II

**L T P C
2 0 0 2**

OBJECTIVES:

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

UNIT I MAKING COMPARISONS 6

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III PROBLEM SOLVING 6

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV REPORTING OF EVENTS AND RESEARCH 6

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

TOTAL : 30 PERIODS

OUTCOMES:

At the end of the course, learners will be able

- To compare and contrast products and ideas in technical texts.
- To identify and report cause and effects in events, industrial processes through technical texts
- To analyse problems in order to arrive at feasible solutions and communicate them in the written format.
- To present their ideas and opinions in a planned and logical manner
- To draft effective resumes in the context of job search.

TEXT BOOKS :

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
AVg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

MA3251

STATISTICS AND NUMERICAL METHODS

L T P C
3 1 0 4

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS

9+3

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS

9+3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 2² factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION

9+3

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

9+3

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential

equations.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

PH3258

PHYSICS OF MATERIALS

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To make the students to understand the basics of phase diagrams and various materials preparation techniques
- To equip the students to have a knowledge on different types of electron theory, basics of quantum mechanics and about superconductors
- To introduce the physics of semiconducting materials and applications of semiconductors in device fabrication
- To familiarize the students with the theory and applications of magnetic and dielectric materials
- To provide the students a sound platform towards learning about advanced materials and their applications.

UNIT I	PREPARATION OF MATERIALS	9
Phases - phase rule – binary systems – tie line – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.		
UNIT II	ELECTRICAL PROPERTIES OF MATERIALS	9
Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law - Quantum free electron theory – tunneling - degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.		
UNIT III	SEMICONDUCTING PROPERTIES MATERIALS	9
Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in metals - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.		
UNIT IV	DIELECTRIC AND MAGNETIC MATERIALS	9
Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials.		
UNIT V	NEW MATERIALS AND APPLICATIONS	9
Ceramics – types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Metallic glasses – Shape memory alloys – Copper, Nickel and Titanium based alloys – graphene and its properties – Relaxor ferroelectrics - Biomaterials – hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – Polymer semiconductors – Photoconducting polymers.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students should be able to

- CO1 : Acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques
- CO2 : Familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.
- CO3 : Gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.
- CO4 : Realize with theories and applications of dielectric and ferromagnetic materials
- CO5 : Familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials and their important applications.

TEXT BOOKS:

1. W.D.Callitser and D.G.Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. V.Raghavan. Materials Science and Engineering: A First Course. PHI Learning, 2015.
3. M.F.Ashby, P.J.Ferreira and D.L.Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, 2011.

REFERENCES:

1. J.F.Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
2. D.R. Askeland and W.J.Wright. Essentials of Materials Science and Engineering, Cengage Learning, 2013.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Jean P.Mercier, G.Zambelli and W.Kurz, Introduction to Materials Science, Elsevier, 2002.
5. Yaser Dahman, Nanotechnology and Functional Materials for Engineers, Elsevier, 2017.

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	3	2	1	2	1	-	-	-	1	-	-	-
2	3	3	2	-	-	1	-	-	-	-	-	-	-	-	-
3	3	2	2	1	-	2	1	-	-	-	-	1	-	-	-
4	3	2	-	1	2	2	2	-	-	-	-	1	-	-	-
5	3	-	2	-	2	2	2	-	-	-	-	1	-	-	-
AVG	3	2.25	2	1.66	2	1.6	1.75	1				1			

1-Low,2-Medium,3-High,"-no correlation

Note: the average value of this course to be used for program articulation matrix.

BE3252**BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION
ENGINEERING****LT P C
3 0 0 3****OBJECTIVES:**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

UNIT I ELECTRICAL CIRCUITS**9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems

UNIT II MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS**9**

Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.

Domestic wiring , types of wires and cables, earthing ,protective devices- switch fuse unit- Miniature circuit breaker-moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

UNIT III ELECTRICAL MACHINES**9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

UNIT IV ANALOG ELECTRONICS**9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

UNIT V SENSORS AND TRANSDUCERS**9**

Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

TOTAL: 45 PERIODS**COURSE OUTCOMES :**

After completing this course, the students will be able to

CO1: Compute the electric circuit parameters for simple problems

CO2: Explain the concepts of domestic wiring and protective devices

CO3: Explain the working principle and applications of electrical machines

CO4: Analyze the characteristics of analog electronic devices

CO5: Explain the types and operating principles of sensors and transducers

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf's Introduction to Electric Circuits, Wiley, 2018

REFERENCES:

1. John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017
4. Muhammad H. Rashid, "Spice for Circuits and electronics", 4th Edition., Cengage India, 2019.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

CO's, PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1					1					-	-	-
2	2	1	1					1					-	-	-
3	2	1	1					1					-	-	-
4	2	1	1					1					-	-	-
5	2	1	1					1					-	-	-
Avg.	2	1	1					1					-	-	-

GE3251**ENGINEERING GRAPHICS****L T P C
2 0 4 4****COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Drawing engineering curves.

- Drawing freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- Drawing isometric and perspective projections of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination)

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

UNIT I PLANE CURVES

6+12

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE

6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING

6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES

6 +12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS

6+12

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

TOTAL: (L=30+P=60) 90 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

Publication of Bureau of Indian Standards:

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

Special points applicable to University Examinations on Engineering Graphics:

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

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2		2					3		2	2	2	
2	3	1	2		2					3		2	2	2	
3	3	1	2		2					3		2	2	2	
4	3	1	2		2					3		2	2	2	
5	3	1	2		2					3		2	2	2	
Avg	3	1	2		2					3		2	2	2	

Low (1) ; Medium (2) ; High (3)

GE3252**தமிழரும் தொழில்நுட்பமும்****L T P C****1 0 0 1****அலகு I நெசவு மற்றும் பாணைத் தொழில்நுட்பம்:****3**

சங்க காலத்தில் நெசவுத் தொழில் - பாணைத் 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 குழுவித் 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

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. பொருளை – 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) (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.

UNIT I WEAVING AND CERAMIC TECHNOLOGY**3**

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY**3**

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 - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY**3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as 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 AGRICULTURE AND IRRIGATION TECHNOLOGY**3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thooppu 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 SCIENTIFIC TAMIL & TAMIL COMPUTING**3**

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 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. பொருளை – 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.

NCC Credit Course Level 1*

NX3251	(ARMY WING) NCC Credit Course Level - I	L T P C
		2 0 0 2
NCC GENERAL		6
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		4
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		7
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1
TOTAL : 30 PERIODS		

NCC Credit Course Level 1*

NX3252	(NAVAL WING) NCC Credit Course Level - I	L T P C
		2 0 0 2
NCC GENERAL		6
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		4
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		7

PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1
TOTAL : 30 PERIODS		

NCC Credit Course Level 1*

NX3253	(AIR FORCE WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2
NCC GENERAL					6
NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2
NATIONAL INTEGRATION AND AWARENESS					4
NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1
NI 4	Threats to National Security				1
PERSONALITY DEVELOPMENT					7
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving				2
PD 2	Communication Skills				3
PD 3	Group Discussion: Stress & Emotions				2
LEADERSHIP					5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code				3
L 2	Case Studies: Shivaji, Jhasi Ki Rani				2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT					8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth				3
SS 4	Protection of Children and Women Safety				1
SS 5	Road / Rail Travel Safety				1
SS 6	New Initiatives				2
SS 7	Cyber and Mobile Security Awareness				1
TOTAL : 30 PERIODS					

COURSE OBJECTIVES:

- Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
- Wiring various electrical joints in common household electrical wire work.
- Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
- Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)**PART I CIVIL ENGINEERING PRACTICES 15****PLUMBING WORK:**

- Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- Preparing plumbing line sketches.
- Laying pipe connection to the suction side of a pump
- Laying pipe connection to the delivery side of a pump.
- Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:

- Sawing,
- Planing and
- Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

- Studying joints in door panels and wooden furniture
- Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES 15

- Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- Staircase wiring
- Fluorescent Lamp wiring with introduction to CFL and LED types.
- Energy meter wiring and related calculations/ calibration
- Study of Iron Box wiring and assembly
- Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)
MECHANICAL ENGINEERING PRACTICE****PART III 15****WELDING WORK:**

- Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- Practicing gas welding.

BASIC MACHINING WORK:

- (simple)Turning.

- b) (simple)Drilling.
- c) (simple)Tapping.

ASSEMBLY WORK:

- a) Assembling a centrifugal pump.
- b) Assembling a household mixer.
- c) Assembling an airconditioner.

SHEET METAL WORK:

- a) Making of a square tray

FOUNDRY WORK:

- a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES

15

SOLDERING WORK:

- a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

- a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

- a) Study an elements of smart phone..
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

CO2: Wire various electrical joints in common household electrical wire work.

CO3: Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

CO4: Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2			1	1	1					2	2	1	1
2	3	2			1	1	1					2	2	1	1
3	3	2			1	1	1					2	2	1	1
Avg	3	2			1	1	1					2	2	1	1
Low (1) ; Medium (2) ; High (3)															

COURSE OBJECTIVES:

- To train the students in conducting load tests electrical machines
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
- To train the students to measure three phase power and displacement

List of Experiments

1. Verification of ohms and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completing this course, the students will be able to

CO1: Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power

CO2: Analyze experimentally the load characteristics of electrical machines

CO3: Analyze the characteristics of basic electronic devices

CO4: Use LVDT to measure displacement

CO's, PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	1	2				1.5	2				-	-	-
2	2	3	1	2				1.5	2				-	-	-
3	2	3	1	2				1.5	2				-	-	-
4	2	3	1	2				1.5	2				-	-	-
Avg.	1.6	1.4	0.8	1.6				1.2	1.6						

OBJECTIVES

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

UNIT I**12**

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life-discussing past events-Writing: writing emails (formal & semi-formal).

UNIT II**12**

Speaking: discussing news stories-talking about frequency-talking about travel problems-discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

UNIT III**12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios-talking about purchasing-discussing advantages and disadvantages- making comparisons-discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

UNIT IV**12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-(example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

UNIT V**12**

Speaking: describing things relatively-describing clothing-discussing safety issues(making recommendations) talking about electrical devices-describing controlling actions- Writing: job application(Cover letter + Curriculum vitae)-writing recommendations.

TOTAL: 60 PERIODS**LEARNING OUTCOMES**

At the end of the course, learners will be able

- Speak effectively in group discussions held in a formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision
- Give appropriate instructions and recommendations for safe execution of tasks

Assessment Pattern

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

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.

- Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES:

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

	PO 01	PO 02	PO 03	PO '04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
CO1	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-

FD3301

FLUID MECHANICS AND MECHANICAL OPERATIONS

L T P C
3 1 0 4

COURSE OBJECTIVES:

To enable the students to understand the

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

COURSE OUTCOMES:

On completion of the course,

- The students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium.
- The students 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. Geankopolis, 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. Geankopolis 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, R.J., "Fluid mechanics through problems". Wiley eastern Ltd., Madras, 2002.
3. Jain A. K. "Fluid Mechanics". Khanna Publishers 1995.

FD3302

FOOD CHEMISTRY

L T P C
3 0 0 3

OBJECTIVES

The course aims to enable the students to

- develop the knowledge 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.
- effectively understand 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, its application in food industry and detergents; Shortening power of fats, chemistry of steroids, types of fat substitute.

UNIT IV FOOD COMPOSITION, WATER, MINERALS AND VITAMINS 7

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

UNIT V AROMA & IMPORTANT PHYTOCHEMICALS IN FOOD 9

Naturally occurring colours/pigments in food and impact on antioxidant level, Synthetic food grade Colours, enzymatic browning of food, flavour & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; and Naturally similar /artificial flavours, Threshold values, off flavours & food taints. Naturally occurring toxic substances, protease inhibitors, bioactive components phytates, polyphenols, saponins.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Apply the structural changes in carbohydrates during processing and predict their physiological effects in the body
2. Analyze the functional and nutritional properties of proteins
3. Evaluate the properties and physico-chemical changes of fats and oil during processing and their industrial importance
4. Justify the importance of vitamins and minerals and their physiological role in the human body
5. Assess the aroma and phytochemicals in food matrices

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2	1	3	2	-	-	-	2	2	3	2	2
2	2	3	2	3	2	2	1	-	-	-	1	2	2	2	3
3	2	3	2	2	2	3	2	-	-	-	2	3	2	3	2
4	2	1	3	2	1	3	2	-	-	-	1	3	1	1	2
5	2	2	2	3	2	2	2	-	-	-	2	2	2	1	2
Avg	1.8	2.2	2.2	2.4	2	2.6	2	-	-	-	1.6	2.3	2	1.8	2.1

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, CRC Press, 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 the 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:**

At the end of the course the students would have the knowledge to

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

C O 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	PSO 3
1	2	1	1	3	2	2	-	-	-	-	1	1	2	2	2
2	1	2	2	2	3	3	-	-	-	-	1	2	2	3	2
3	2	2	2	2	3	3	-	-	-	-	1	3	3	1	3
4	2	3	3	2	3	2	-	-	-	-	2	2	1	3	1
5	3	3	3	2	3	2	-	-	-	-	2	3	2	2	2
avg	2	2.2	2.2	2.2	2.8	2.4	0	0	0	0	1.4	2.2	2	2.2	2

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.

FD3304

FOOD PROCESS CALCULATIONS

L T P C
3 1 0 4

OBJECTIVE:

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

UNIT I

9+3

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+3

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+3

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

UNIT IV

9+3

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+3

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+15=60 PERIODS

(Use of Psychometric chart is permitted in the examination)

COURSE OUTCOMES:

At the end of the course the students would have the knowledge to

1. Explain the basic units in food processing.
2. Analyze basic humidity calculations.
3. Infer material balance for process operations.
4. Explain energy balance in food technology.
5. Explain the heat content and enthalpy in food processing.

C O 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	PSO 3
1	1	1	1	2	1	2	-	-	-	-	1	1	3	2	2
2	2	2	2	3	2	3	-	-	-	-	2	2	1	1	1
3	3	2	3	2	3	3	-	-	-	-	1	2	2	2	2

4	2	3	2	2	3	2	-	-	-	-	2	2	2	2	3
5	2	2	2	2	3	3	-	-	-	-	1	3	2	2	2
avg	2	2	2	2.2	2.4	2.6	0	0	0	0	1.4	2	2	1.8	2

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" (Stoichiometry) 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

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

UNIT I INTRODUCTION

9

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

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.

UNIT IV 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 would have the knowledge to

1. Apply the post-harvest engineering to prevent loss.
2. Infer the different cleaning, threshing and grading operations involved in food industry.
3. Utilize the conveyors in the food industry
4. Apply the storage principles in extending the shelf-life of commodity.
5. Identify the suitable pest control and management method for agricultural produce.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	2	2	3	2	-	-	-	1	2	2	2	3
2	2	1	2	3	2	3	1	-	-	-	1	2	3	3	2
3	2	3	3	2	3	3	2	-	-	-	1	3	2	1	1
4	2	2	3	2	3	2	2	-	-	-	1	2	1	2	-
5	3	2	2	2	3	2	2	-	-	-	1	3	2	3	2
avg	2	2	2.2	2.2	2.6	2.6	1.8	0	0	0	1	2.4	2	2.2	2

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. International Development Res. Centre, Ottawa, Canada. 1976.
4. Birewar, B.R., Krishnamurthy, K., Girish, G.K., Varma, B.K. and Kanjilal, S.C.. Modern Storage Structures. Indian Grain Storage Institute, Hapur.1983.
5. 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**

COURSE OBJECTIVES

The course aims to practically

- 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

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Identify the important reactions in food chemistry and their consequences.
2. Understand the methods to measure these reactions.
3. Capable of reporting the results in an appropriate format.
4. Designing and conducting an experiment to understand a simple food chemistry problem.
5. Analyze the complex interactions between the different components of foods.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	3	2	3	2	-	-	-	2	2	2	-	-
2	2	2	2	3	2	2	-	-	-	2	2	2	1	-	-
3	2	3	2	2	3	2	-	-	-	1	3	2	2	-	-
4	2	3	3	-	-	-	-	-	-	2	2	2	2	-	-
5	3	2	2	-	-	-	-	-	-	1	2	2	3	-	-
avg	2.2	2.2	2	2.6	2.3	2.3	2	0	0	0	1.6	2.2	2	0	0

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

PROGRESS THROUGH KNOWLEDGE

FD3312

FOOD MICROBIOLOGY LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES

The course aims to enable the students to understand

- Methods of isolating and characterizing various microbes associated with foods and food groups.
- Using of a 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

Course Outcomes (COs)

At the end of the course the students would have the knowledge to

1. Prepare the microbial growth media and sterilize it.
2. Isolate pure culture and preserve them.
3. Operate microscope and use it for detection of microbes.
4. Isolate and enumerate spoilage organisms.
5. Detect the presence of food borne pathogens.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	2	2	3	1	-	-	-	2	2	2	2	-
2	2	1	2	3	2	2	2	-	-	-	2	2	3	3	-
3	1	3	3	-	-	-	2	-	-	-	3	3	1	2	-
4	2	2	2	-	-	-	1	-	-	-	1	2	2	1	-
5	3	2	2	-	-	-	2	-	-	-	1	1	2	1	-
avg	1.8	2	2	2.5	2	2.5	1.6	0	0	0	1.8	2	2	1.8	0

REFERENCES

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

GE3361

PROFESSIONAL DEVELOPMENT

L T P C
0 0 2 1

OBJECTIVES:

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

MS WORD:

Create and format a document

10 Hours

Working with tables
 Working with Bullets and Lists
 Working with styles, shapes, smart art, charts
 Inserting objects, charts and importing objects from other office tools
 Creating and Using document templates
 Inserting equations, symbols and special characters
 Working with Table of contents and References, citations
 Insert and review comments
 Create bookmarks, hyperlinks, endnotes footnote
 Viewing document in different modes
 Working with document protection and security
 Inspect document for accessibility

MS EXCEL:

10 Hours

Create worksheets, insert and format data
 Work with different types of data: text, currency, date, numeric etc.
 Split, validate, consolidate, Convert data
 Sort and filter data
 Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.)
 Work with Lookup and reference formulae
 Create and Work with different types of charts
 Use pivot tables to summarize and analyse data
 Perform data analysis using own formulae and functions
 Combine data from multiple worksheets using own formulae and built-in functions to generate results
 Export data and sheets to other file formats
 Working with macros
 Protecting data and Securing the workbook

MS POWERPOINT:

10 Hours

Select slide templates, layout and themes
 Formatting slide content and using bullets and numbering
 Insert and format images, smart art, tables, charts
 Using Slide master, notes and handout master
 Working with animation and transitions
 Organize and Group slides
 Import or create and use media objects: audio, video, animation
 Perform slideshow recording and Record narration and create presentable videos

TOTAL: 30 PERIODS

OUTCOMES:

- On successful completion the students will be able to
- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
 - Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
 - Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

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

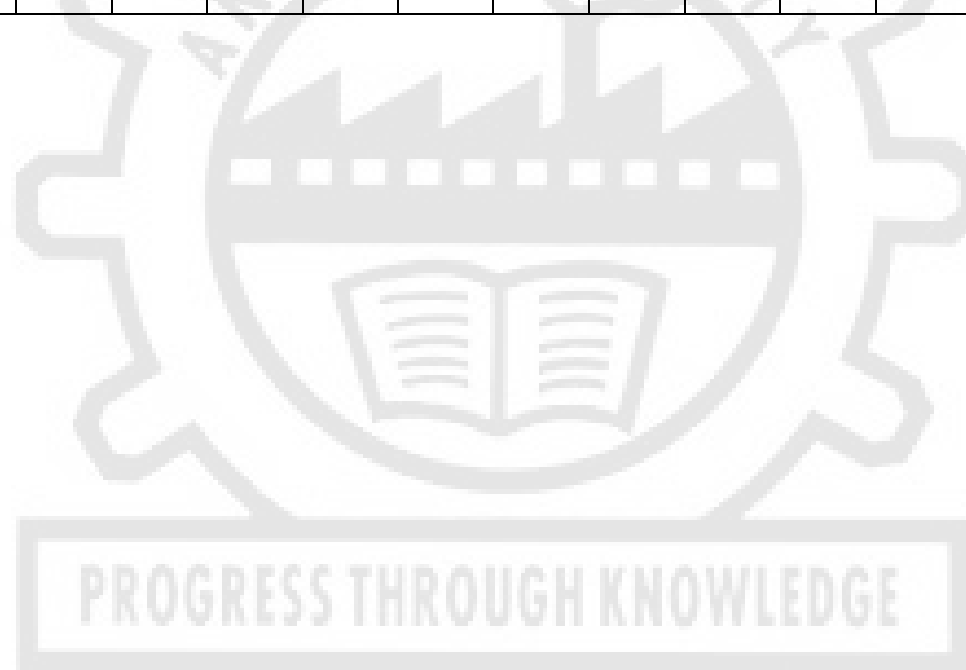
TEXT BOOKS :

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 :

4. 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 McGraw Hill, 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.

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Overall CO	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-



COURSE 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 18

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, T_m and hypochromicity, Measurement of DNA and RNA. Nucleoprotein complexes

UNIT III AN OVERVIEW OF NUTRITION AND ENERGY BALANCE 5

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 4

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 13

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 yield during oxidation of glucose and fatty acids.

TOTAL: 45 PERIODS

Course Outcomes (COs)

At the end of the course the students would have the knowledge to

1. Apply knowledge of nutrition in diet planning.
2. Analyze the dietary recommendations for non-communicable diseases.
3. Asses the quality of proteins and lipids from various sources.
4. Comprehend the physiological and toxicological effects of vitamins and minerals.
5. Apply the learnt techniques to assess the intermediate metabolism in lifestyle

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	2	2	3	2	-	-	-	1	1	2	-	1
2	2	3	2	3	2	3	2	-	-	-	1	2	1	-	2
3	2	2	2	2	3	3	3	-	-	-	2	3	3	-	2
4	2	2	3	2	3	2	2	-	-	-	1	2	1	-	2
5	3	3	2	2	3	2	2	-	-	-	1	2	1	-	1
avg	2.2	2.4	2	2.2	2.6	2.6	2.2	0	0	0	1.2	2	1.6	0	1.6

TEXT BOOKS:

1. Nelson, D.L. and M.M. Cox, "Lehninger's Principles of Biochemistry", 4th Edition, W.H. Freeman & 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. "Biochemsity", 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 SCIENCES AND SUSTAINABILITY

L T P C
2 0 0 2

OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I	ENVIRONMENT AND BIODIVERSITY	6
Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.		
UNIT II	ENVIRONMENTAL POLLUTION	6
Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .		
UNIT III	RENEWABLE SOURCES OF ENERGY	6
Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.		
UNIT IV	SUSTAINABILITY AND MANAGEMENT	6
Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.		
UNIT V	SUSTAINABILITY PRACTICES	6
Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non- conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.		
		TOTAL: 30 PERIODS

OUTCOMES:

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.

7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCE BOOKS :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
Avg.	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation

FD3402

FOOD ADDITIVES AND FLAVOURS

L T P C
3 0 0 3

OBJECTIVES:

- To expose the students to the use of different chemical additives in foods during food processing and preservation.
- To make the students understand the flavour compounds involved in development of flavor.
- To make the students 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 (COs)

At the end of the course the students would have the knowledge to

1. Comprehend the laws related to food additives for preservation of foods
2. Assess the safety level of food additives as emulsifier and thickening agents
3. Utilize the additives for novel product development.
4. Contribution of different compounds for the development of flavor and Analytical techniques involved in flavor analysis.
5. Analyze the effect of food additives on food matrix.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	2	2	3	1	-	-	-	1	1	2	2	-
2	2	2	3	1	2	3	2	-	-	-	2	3	2	1	-
3	2	2	2	2	3	3	2	-	-	-	3	2	1	2	-
4	2	2	2	1	3	2	1	-	-	-	1	2	1	3	-
5	1	2	2	2	3	2	2	-	-	-	1	2	2	2	-
avg	1.6	1.8	2	1.6	2.6	2.6	1.6	0	0	0	1.6	2	1.6	2	0

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 Flavours". 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

**L T P C
3 1 0 4**

OBJECTIVES

The course aims to enable the students 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

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Apply the basic concepts of heat flow.
2. Assess the mode of heat transfer.
3. Discuss the radiation mode of heat transfer.
4. Interpret mass transfer operations in food processing.
5. Elaborate distillation operations.

C O 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	PSO 3
1	2	1	1	2	2	2	1	-	-	-	1	2	1	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	1
3	3	2	2	2	3	3	1	-	-	-	1	3	3	-	3
4	3	3	2	3	3	2	2	-	-	-	2	2	2	-	2
5	1	3	2	2	1	2	1	-	-	-	2	3	1	-	2
avg	2.4	2.4	1.8	2.4	2.4	2.4	1.4	0	0	0	1.4	2.6	1.8	0	2

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

**L T 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

Zerth 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

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the laws, concepts and principles of thermodynamics.
2. Apply first law of thermodynamics to closed and open systems.
3. Solve problems related to cycles and cyclic devices using second law of thermodynamics.
4. Calculate the thermodynamic properties of pure substances, its phase change processes and understand the working of steam boilers.
5. Apprise the working of principles of Carnot, Vapour compression, vapour absorption and air refrigeration systems.

C O 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	PSO 3
1	2	2	2	2	2	2	1	-	-	-	1	2	2	-	2
2	3	2	3	3	3	3	2	-	-	-	1	3	1	-	3
3	3	2	3	2	3	3	1	-	-	-	2	3	3	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	1
5	2	2	3	2	1	2	2	-	-	-	1	2	1	-	2
avg	2.6	2.2	2.6	2.4	2.4	2.4	1.6	0	0	0	1.2	2.4	1.8	0	2

TEXT BOOKS:

1. Nag P. K. Thermodynamics, 2005. 5th edition, Tata Mc Graw Hill, New Delhi. 2001.
2. Ethirajan Rathakrishnan. 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 enable the students to practically understand

- Principles behind the qualitative and quantitative estimation of biomolecules.
- 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**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the basic measurement in food processing.
2. Discuss the basic chemical analysis
3. Apply the learnt basic chemistry involved in food testing.
4. Assess the nutritional anthropometry
5. Assess the clinical status of the individuals.

C O 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	PSO 3
1	1	1	1	2	2	3	1	-	-	-	1	2	-	2	2
2	2	3	1	3	2	2	1	-	-	-	1	3	-	3	1
3	1	2	2	-	-	-	1	-	-	-	1	3	-	2	1

4	2	3	2	-	-	-	1	-	-	-	1	2	-	1	2
5	3	3	2	-	-	-	1	-	-	-	2	3	-	2	2
avg	1.8	2.4	1.6	2.5	2	2.5	1	0	0	0	1.2	2.6	0	2	1.6

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 and hammer 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

Course Outcomes (COs)

At the end of the course the students would have the knowledge to

1. Interpret the application of different types of evaporators and understand the drying of principles.
2. Assess the suitable process technology such as sedimentation, filtration, cyclone and membrane for separation of different particles present in foods.
3. Select the mixing equipment for dry powders, low or high viscosity liquids and acquire knowledge to importance of size reduction and energy requirement.
4. Organize the transformation of raw materials to quality food products using different processing technologies.
5. Apply the mechanism of crystallization and distillation process in food industries.

C O 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	PSO 3
1	1	1	2	2	2	3	1	-	-	-	1	2	2	-	2
2	2	2	3	3	2	2	2	-	-	-	3	3	2	-	2
3	1	2	3	2	2	3	1	-	-	-	3	3	3	-	3
4	2	2	2	2	2	3	2	-	-	-	2	2	2	-	1
5	3	2	2	2	2	3	1	-	-	-	1	3	2	-	2
avg	1.8	1.8	2.4	2.2	2	2.8	1.4	0	0	0	2	2.6	2.2	0	2

FD3513

INDUSTRIAL TRAINING / INTERNSHIP I*

**L T P C
0 0 0 1**

OBJECTIVES:

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

No. of. Weeks: 02

OUTCOMES:

On completion of the course, the student will know about

CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute

CO2: Analysis of industrial / research problems and their solutions

CO3: Documenting of material specifications, machine and process parameters, testing parameters and results

CO4: Preparing of Technical report and presentation

FD3501

FOOD PROCESSING AND PRESERVATION

**L T P C
3 0 0 3**

OBJECTIVE:

To expose the students to the principles and different methods of food processing and preservation.

UNIT I PRINCIPLES OF MASS AND ENERGY BALANCE

9

Transport phenomena with respect to foods; Factors affecting heat and mass transfer; Study of heat transfer and its application in the design of thermal processes and freezing. Thermal processing; calculation of process time temperature-schedules.

UNIT II CANNING OF FOOD PRODUCTS 9

Newer methods of thermal processing; batch and continuous; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods.

UNIT III DRYING PROCESS FOR TYPICAL FOODS 9

Rate of drying for food products; design parameters of different type of dryers; properties of air-water mixtures. Psychrometric chart, freezing and cold storage. freeze concentration, dehydro-freezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

UNIT IV NON-THERMAL METHODS 9

Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology,

UNIT V FOOD PACKAGING 9

Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing, costs of packaging and recycling of materials.

TOTAL: 45 PERIODS**Course Outcomes (COs)**

At the end of the course the students would have the knowledge to

1. Classify the principles of food processing and preservation.
2. Interpret the role of different methods the processing of different foods.
3. Comprehend the impact on the shelf life, quality, and other physical and sensory characteristics of foods.
4. Identify the recent methods of minimal processing of foods.
5. Appraise the materials and types of packaging for foods.

C O 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	PSO 3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	2	1
2	3	3	2	3	3	3	2	-	-	-	1	3	3	3	2
3	2	2	2	2	3	3	1	-	-	-	1	3	1	1	3
4	3	3	2	3	3	2	2	-	-	-	2	2	2	2	2
5	2	3	2	2	1	2	1	-	-	-	2	3	3	3	2
avg	2.4	2.4	1.8	2.4	2.4	2.4	1.4	0	0	0	1.4	2.6	2.2	2.2	2

TEXT BOOKS:

1. Sivasankar, B. "Food Processing and Preservation". Prentice Hall of India, 2002.
2. Khetarpaul, Neelam. "Food Processing and Preservation." Daya Publications, 2005
3. Singh, M.K. "Food Preservation" Discovery Publishing, 2007.
4. Fellows, P.J. "Food Processing Technology: Principles and Practice". 2nd Edition, CRC Wood Head Publishing, 2000.
5. GopalaRao, Chandra. "Essentials of Food Process Engineering". B.S. Publications, 2006.

REFERENCES:

1. Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sorensen, Leif. "Food Preservation Techniques". CRC / Wood Head Publishing, 2003.
3. Ranganna, S. "Handbook of Canning and Aseptic Packaging". Tata McGraw-Hill, 2000.

OBJECTIVES

The course aims to

- expose the students to the principles, methods and techniques of food analysis.
- make the students to handle different chemical and instrumental methods of food analysis.

UNIT I SAMPLING METHODS FOR FOOD ANALYSIS 6

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

UNIT II LIPIDS AND PROTEINS ANALYSIS 9

Determination of Total fat in foods by different methods; Analysis of oils and fats for physical and chemical parameters, Quality standards, and adulterants. Determination of Proteins Concentration- Colorimetric methods, Determination of Total nitrogen, Spectrophotometric determination; Protein Characterization- Electrophoresis and Isoelectric focussing; Analysis of Protein quality – Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), Biological Value, Protein Digestibility- Corrected Amino acid Score (PDCAAS), In vitro Protein digestibility for C-PER; Measurement of Functional properties of proteins- Protein hydration properties, Surface properties of protein, Protein gel properties. Calculation of proximate and ultimate composition of foods.

UNIT III CARBOHYDRATE ANALYSIS, REFRACTOMETRY AND POLARIMETRY 9

Refractometry- Basic Principles and Instrumentation, and Applications-Brix Value of Fruit juices, Total soluble solids in fruit products. Carbohydrate analysis- Colorimetric Quantification methods of Mono and Di-Saccharides, HPLC of Mono and D-Saccharides using refractive index detection; Starch- Enzymatic quantification and Determination of Total amylose content; Cell wall polysaccharides-Determination of uronic acid content and β -Glucan content, Degree of Methylation and Acetylation of pectin. Polarimetry- Basic principles, Instrumentation and Applications- Determination of specific rotations of sugars; Estimation of simple sugars and disaccharides.

UNIT IV SPECTROSCOPIC AND CHROMATOGRAPHIC TECHNIQUES IN FOOD ANALYSIS 12

Spectrophotometry Basic Principles, Spectrophotometric analysis of food additives and food Components -IR Spectroscopy in online determination of components in foods; AAS and ICPAES in mineral elements and toxic metals analysis; use of fluorimeter in vitamin assay- specific use of Tintometer in Vanaspati analysis. Chromatography Basic Principles, Detection of adulterants in foods by paper chromatography and thin layer chromatography, Column chromatography for purification of pigments, Analysis of food additives, phytochemicals and aflatoxins, contaminants and other food components by HPLC, GC analysis of fatty acids, cis, trans Isomers - volatile oils, flavours and pesticides, contaminants and other volatile derivatives of food components; Significance MS detector in HPLC and GC. Ion Exchange Chromatography for amino acid purification, Affinity chromatography for protein purification, Problem solving using chromatogram.

UNIT V SENSORY EVALUATION TECHNIQUES 9

Introduction to quality attributes of food Appearance, flavour, textural factors and additional quality factors; Gustation importance of gustation, Mechanism of taste perception, Chemical dimensions of basic tastes- sweet, salt, sour, bitter and umami, Taste measurement-Electronic Tongue; Olfaction definition and importance of odour and flavour, Mechanism of odour perception, Theories of odour classification, chemical specificity of odour, Odour measurement technique- e- nose; Colour importance of colour, Dimensions of colour and attributes of colour and gloss, Perception of colour, Colour Measurement; Texture definition and importance of texture, Phases of oral processing, Texture perception, Rheology of foods, Texture classification, Texture measurement

and recent advances in texture evaluation. Sensory Evaluation Objectives, Type of food panels, Characteristics of panel member, Layout of sensory evaluation laboratory, Sensitivity tests, Threshold value, Paired comparison test, Duo trio test, Triangle test, Hedonic scale.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Assess the appropriate sampling methods for food analysis.
2. Analyse lipids & proteins for its quality & characteristics.
3. Analyse carbohydrates for its quality & characteristics.
4. Apply spectroscopic & chromatographic techniques for analysis of food components.
5. Apply sensory evaluation technique for food quality analysis.

C O 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	PSO 3
1	3	2	3	2	3	2	1	-	-	-	1	2	2	2	-
2	2	3	2	3	3	3	2	-	-	-	1	3	1	1	-
3	2	2	2	2	3	2	3	-	-	-	1	3	3	2	-
4	3	3	2	3	3	2	2	-	-	-	2	2	2	3	-
5	1	1	1	3	3	2	2	-	-	-	1	3	2	2	-
avg	2.2	2.2	2	2.6	3	2.2	2	0	0	0	1.2	2.6	2	2	0

TEXT BOOKS:

1. Pomeranz, Yeshajahu. “Food Analysis Theory and Practice” . 3rd Edition. AspenPublishers / Springer, 2000.
2. Kirk, R.S. and R. Sawyer “Pearson’s Composition and Analysis of Food”. 9th Edition. Longman, New York, 1991
3. Nielsen, S. Suzanne. “Food Analysis”. 4th Edition. Springer, 2010.

REFERENCES:

1. Ronald E. Wrolstad. “Handbook of Food Analytical Chemistry” Vol I, John Wiley & sons, 2005
2. Magdi M. Mossoba. “Spectral Methods in Food analysis” Marcel & Dekker, 1998.
3. Otlis, Semih. “Methods of Analysis of Food Components and Additives”. CRC Press, 2005.
4. Nollet, Leo M.L. “Hand Book of Food Analysis” II Rev. Edition. Vol. I, II & III, Marcel & Dekker, 2004.
5. Nollet, Leo M.L. “Food Analysis by HPLC”. II Rev. Edition, Marcel & Dekker, 2000.
6. Otlis, Semih. “Handbook of Food Analysis Instruments”. CRC Press, 2009.
7. Meilgard. “Sensory Evaluation Techniques”, 3rd ed., CRC Press LLC, 1999.
8. Maynard A. Amerine, Rose Marie Pangborn, Edward B. Roessler. “Principles of Sensory Evaluation of food”, AcademicPress, 2013.

FD3511

FOOD PROCESSING AND PRESERVATION LABORATORY

**L T P C
0 0 4 2**

OBJECTIVES:

To develop skills related to

- Preservation of foods
- Use of various techniques and additives for food processing and Preservation

EXPERIMENTS:

- 1.Heat transfer studies in a plate heat exchanger (Parallel and counter flow)
- 2.Refrigeration and Freezing of vegetables and fruits
- 3.Drying of vegetables and fruits with and without additives - Drying rate studies including, constant rate and falling rate periods and the effects of various factors on them.
- 4.Osmotic drying of foods with salt and sugar.
- 5.Canning & bottling of vegetable and fruit products
- 6.Filtration and concentration of fruit juices
- 7.Production of extruded products.
- 8.Spray drying of juices/milk
- 9.Pasteurization of milk
- 10.Retort processing of foods
- 11.Determination of Water vapor transmission rate of different packaging materials
- 12.Determination of migration characteristics of packaging materials
- 13.Determination of tensile and burst strength of given packaging material

TOTAL: 60 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Demonstrate the food processing in terms of unit operations, both conceptually and in the pilot plant.
2. Apply the mass and energy balances for food processing.
3. Operate the food processing equipment's at the pilot plant scale.
4. Analyze the effect of processing conditions on safety and quality of resulting food products.
5. Evaluate the properties of food packaging materials.

C O 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	PSO 3
1	1	1	3	2	3	2	-	-	-	1	2	3	1	2	-
2	1	2	3	3	3	2	-	-	-	2	2	3	2	3	-
3	1	2	3	3	3	2	-	-	-	2	2	3	3	2	-
4	1	2	3	3	3	2	-	-	-	2	2	3	2	2	-
5	2	2	3	3	3	2	-	-	-	2	2	3	1	1	-
avg	1.2	1.8	3	2.8	3	2	0	0	0	1.8	2	3	1.8	2	0

REFERENCES:

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

FD3512**FOOD ANALYSIS LABORATORY****L T P C
0 0 4 2****OBJECTIVES**

The course aims to

- Equip students with characterization and estimation of chemical compounds in food for
- Its compliance with standards.
- Learn the analysis of foods for the detection of adulterants in foods.

LIST OF EXPERIMENTS

1. Determination of moisture in spices powder by distillation method and Hot air oven method.
2. Determination of Total fat, protein in milk and milk products.
3. Rancidity test for fried foods to assess primary and secondary oxidative products.
4. Determination of Vitamin C in fruit juices.
 - a. Titrimetric method using dichlorophenolindophenol dye
 - b. Spectrophotometric method using dinitrophenylhydrazine
 - c. HPLC method
5. Extraction and identification of synthetic Food colour in sweets, confectioneries and beverages.
6. Determination of Iron content in foods.
7. Determination of Iodine content in iodized salt.
8. Detection and estimation of Annatto, lead, MSG, sulphur-di-oxide, Emulsifiers and stabilizers in food products.
9. Estimation of antioxidant activity in foods by DPPH assay and ORAC assay.
10. Determination of soluble and insoluble fibre in foods.
11. Detection of adulterants in edible oil and ghee.
12. Column chromatographic separation of carotenoids
13. The identification of sugars in fruit juice using TLC.

TOTAL: 60 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the analysis of foods and food products for chemical components.
2. Learn standards for food products.
3. Obtain knowledge of adulterants in foods.
4. Apply spectroscopic & chromatographic techniques for analysis of food components.
5. Apply sensory evaluation technique for food quality analysis.

C O 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	PSO 3
1	3	2	3	2	3	2	1	-	-	-	1	2	2	2	-
2	2	3	2	3	3	3	2	-	-	-	1	3	1	1	-
3	2	2	2	2	3	2	3	-	-	-	1	3	3	2	-
4	3	3	2	3	3	2	2	-	-	-	2	2	2	3	-
5	1	1	1	3	3	2	2	-	-	-	1	3	2	2	-
avg	2.2	2.2	2	2.6	3	2.2	2	0	0	0	1.2	2.6	2	2	0

TEXT BOOKS:

1. Shalini Sehgal, "A laboratory manual of food analysis", I.K. International publishing, 2016.

REFERENCES:

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

FD3601

FOOD PROCESS ENGINEERING

**L T P C
3 1 0 4**

OBJECTIVES

The course aims to

- Understand basic engineering properties of food.
- Understand different thermal and non-thermal processes used in Food Industry.

UNIT I PROPERTIES OF FOOD 11
 Engineering properties of food materials - Rheological and textural Properties, Thermal Properties, Thermodynamic Properties, surface and gas exchange properties, electric and dielectric properties Water activity and states a thermodynamic quantity, water sorption isotherms, hysteresis, theories of sorption hysteresis, water activity measurement methods, water binding, control of water activity and moisture, principles of IMF and their application

UNIT II SEDIMENTATION AND CENTRIFUGATION 7
 The velocity of particles moving in a fluid - terminal velocity - drag coefficient terminal velocity magnitude, Sedimentation - sedimentation equipment, Flotation, Sedimentation of Particles in a Gas Settling Under Combined Forces Cyclones- optimum shape, efficiency Impingement, separators Classifiers, Centrifugal separations - centrifugal force particle velocity Liquid Separation radial variation of pressure radius of neutral zone Centrifuge Equipment

UNIT III DRYING AND FREEZING 10
 Basic Drying Theory - Three States of Water phase diagram for water, Heat Requirements for Vaporization, Thermodynamics of moist air (psychrometry) - Measurement of Humidity, Air Drying, Conduction Drying, Drying under varying external condition, methods of drying, Drying Equipment, Dryer Efficiencies, calculation of drying time, Concept of Osmotic dehydration, Factors influencing osmosis.
 Freezing -Freezing curve for Homogenous and Non-homogenous food system, Freezing point depression, Freezing rate, Effect of freezing Physical and chemical changes in Foods, Enzyme activity, Microbe inactivation and Food quality sensory quality, nutritional aspects, freeze drying and freeze concentration

UNIT IV THERMAL PROCESSING 9
 Principles of Thermal Processing, Heat Transfer in Thermal Processing, Characterization of Heat Penetration Data, Retort Come-Up Time, kinetics of thermal inactivation of microorganisms and enzymes, Concept of thermo bacteriology Temperature Dependence Reaction Rates, Processes and Systems for Stabilization of Foods for Shelf-Stable Storage, Heat transfer considerations in thermal processing - In-package, In-Flow

UNIT V FOOD MATERIAL PROCESSING 8
 Membrane processes Ultra filtration, Reverse osmosis, Electrodialysis, per-evaporation and micro filtration – principles - application in food industry, Extrusion - Extrusion cookers - cold extrusion, single and twin-screw extrusion - Low pressure and high-pressure extrusion - properties of Food materials and its significance in equipment design - processing and handling application in food industry; Baking Principles, baked foods, baking equipment; Roasting Principles of roasting, roasting equipment.

TOTAL: 60 PERIODS

Course Outcomes (COs)

At the end of the course the students would have the knowledge to

1. Apply the knowledge of physical properties of foods during the processing.
2. Evaluate time temperature required to achieve desired shelf life of foods.
3. Explain the principles and current practices of mixing and the effects of processing parameters on product quality.
4. Interpret the encapsulation technology available in the field of processing.
5. Develop novel products using extrusion cooking.

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	2	2	2	2	2	-	2	-	-	-	1	2	2	2	1
2	3	3	2	3	1	-	2	-	-	-	1	3	3	3	2
3	3	2	2	2	2	-	1	-	-	-	1	2	2	2	3

4	3	3	2	3	3	-	2	-	-	-	3	2	1	1	2
5	1	3	2	2	3	-	1	-	-	-	2	3	3	2	2
avg	2.4	2.6	2	2.4	2.2	0	1.6	0	0	0	1.6	2.4	2.2	2	2

TEXTBOOKS:

1. Toledo, Romeo T. "Fundamentals of Food Process Engineering" II Edition. CBS Publishers, 2000.
2. Fellows, P J. "Food Processing Technology Principles and Practice". 3rd Edition, Woodhead, 2009.
3. Smith P. G "Introduction to Food Process Engineering". Springer, 2005
4. Earle, R.L, "Unit Operations in Food Processing". Pergamon Press. Oxford. U.K, 2013.

REFERENCES:

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

FD3611

FOOD PROCESS ENGINEERING LAB

**L T P C
0 0 4 2**

OBJECTIVES

The course aims to

- analyse applications of heat and mass transfer principles.
- enable students to develop models for optimization of process conditions for different food application.

LIST OF EXPERIMENTS

1. Material Testing and Rheology of Solid Foods.
2. Rheology of Liquid and Semisolid Foods.
3. Concepts of Heat Transfer and Thermal Death Times.
4. Canning, Retort Thermal Processing, and Lethality Computation by General Method.
5. Heat Penetration Test and Thermal Process Design Using Ball's Formula Method.
6. Blanching and Freezing of Foods.
7. Ultra-High-Temperature Processing.
8. Membrane Processing of Liquid Foods.
9. Evaporation Concentration of Liquid Foods.
10. Spray, Drum Drying, Convective Drying of Foods.
11. Osmotic Dehydration of Foods.
12. Microwave Heating of Foods.
13. Frying & Extrusion Cooking of Foods.

TOTAL: 60 PERIODS

COURSE OUTCOMES (COS)

At the end of the course the students would have the knowledge to

1. Understand heat, mass and momentum transfer analysis.
2. Validation of a thermal process
3. Analyze industrial problems along with appropriate approximations and boundary conditions
4. Interpret the encapsulation technology available in the field of processing.
5. Develop novel products using extrusion cooking.

C O 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	PSO 3
1	2	2	2	2	2	-	2	-	-	-	1	2	2	2	1
2	3	3	2	3	1	-	2	-	-	-	1	3	3	3	2
3	3	2	2	2	2	-	1	-	-	-	1	2	2	2	3
4	3	3	2	3	3	-	2	-	-	-	3	2	1	1	2
5	1	3	2	2	3	-	1	-	-	-	2	3	3	2	2
avg	2.4	2.6	2	2.4	2.2	0	1.6	0	0	0	1.6	2.4	2.2	2	2

REFERENCES

1. GustavoV. Barbosa-Canovas, Food Engineering Laboratory Manual, 2017, Technomic Publishing company Inc.
2. Shri K. Sharma, Steven J. Mulvaney, Syed S. H. Rizvi, Food Process Engineering: Theory and Laboratory LIST OF EXPERIMENTS, 1999, Wiley
3. Syed S.H. Rizvi, Gauri S. Mittal, Experimental Methods in Food Engineering, 1992, Springer

FD3711

INDUSTRIAL TRAINING / INTERNSHIP II^{##}

**L T P C
0 0 0 2**

OBJECTIVES:

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

No. of. Weeks: 04

OUTCOMES:

On completion of the course, the student will know about

CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute

CO2: Analysis of industrial / research problems and their solutions

CO3: Documenting of material specifications, machine and process parameters, testing parameters and results

CO4: Preparing of Technical report and presentation

FD3701

REFRIGERATION AND COLD CHAIN MANAGEMENT

**L T P C
3 0 0 3**

OBJECTIVES:

- To understand the underlying principles of operation in different Refrigeration & cold storage systems and its components.
- To provide knowledge on design aspects of cold storage systems

UNIT I REFRIGERATION PRINCIPLES 9

Refrigeration – principles - refrigeration effect – coefficient of performance – units of refrigeration - simple vapour compression cycle – T-S diagram – p-h chart - application of refrigeration.

UNIT II VAPOUR COMPRESSION REFRIGERATION AND COMPONENTS 9

Vapour compression system - refrigeration components – compressor and condenser – types, construction and working - expansion device and evaporators – types, construction and working.

UNIT III REFRIGERANTS AND VAPOUR ABSORPTION CYCLE 9

Refrigerants – properties – classification – comparison and advantages – chloroflouro carbon (CFC) refrigerants - effect on environmental pollution - alternate refrigerants - vapour absorption cycle – theoretical - deviation in practice - Electrolux refrigerator – construction and principles.

UNIT IV SHELF – LIFE OF FOOD PRODUCTS 9

Defining overall Shelf-life, remaining shelf life in the context of Chilled & Frozen foods; - Deterioration modes of food items; Models of quality deterioration- Kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf – life; General procedure for shelf – life testing – the 11 steps procedure.

Storage of frozen foods; - Basic design requirements of storage to uphold the shelf –life – size , insulation, entry –exit position, palletization, proper disk-space for air-circulation, automatic door – closing, proper lighting, temperature monitoring and recording facility; stacking systems, emergency exits, material handling devices like fork-lifts, pallet trucks, etc floor heaters, vapour barriers, etc.

UNIT V COLD CHAIN 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

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

C O 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	PSO 3
1	3	2	2	2	2	3	3	-	-	-	1	2	2	-	2
2	3	3	2	2	2	2	2	-	-	-	1	3	2	-	3
3	3	3	3	2	3	2	2	-	-	-	1	3	1	-	2
4	3	3	2	2	3	2	2	-	-	-	2	2	1	-	1
5	3	3	3	3	3	3	3	-	-	-	2	3	2	-	2
avg	3	2.8	2.4	2.2	2.6	2.4	2.4	0	0	0	1.4	2.6	1.6	0	2

.TEXT BOOKS:

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

REFERENCES:

1. Evans, Judith. "Frozen Food Science and Technology". Wiley-Blackwell, 2008.
2. Hui, Y.H. et al., "Handbook of Frozen Foods". Marcel Dekker, 2004.

FD3702

FOOD PLANT EQUIPMENT DESIGN

**L T P C
3 0 0 3**

OBJECTIVES

The course aims to

- understand the engineering properties of different materials for the development of food plant equipment
- understand the design of different processing requirement for food industry.

UNIT I MATERIALS AND PROPERTIES

9

Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes

UNIT II DESIGN CONSIDERATIONS

9

Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations

UNIT III DESIGN OF STORAGE VESSEL AND EXCHANGERS

9

Design of pressure and storage vessels Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories.

Design of heat exchangers Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort. Design of agitators and separators Design of agitators and baffles; Design of agitation system components and drive for agitation

UNIT IV DESIGN OF DRYER, FREEZER AND FERMENTERS**9**

Design of freezing equipment Design of icecream freezers and refrigerated display system Design of dryers Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer Design of fermenters Design of fermenter vessel, design problems

UNIT V EXTRUDERS AND EQUIPMENT SAFETY**9**

Extrusion cookers - cold extrusion, single and twin screw extrusion- Low pressure and high pressure extrusion - properties of Food materials and its significance in equipment design - processing and handling - Cold and hot extruder design, design of screw and barrel, design of twin screw extruder. Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Analyse the engineering properties of different materials for the development of food plant equipment
2. Determine the design and economic considerations
3. Design the storage vessels and exchangers
4. Design the dryers, freezers, fermenters and extruders
5. Demonstrate the hazards in process industries and safety measures in equipment design

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	2	3	3	3	-	-	-	1	2	2	2	-
2	3	2	3	2	3	3	3	-	-	-	1	3	3	1	-
3	3	2	3	2	3	3	3	-	-	-	1	3	2	3	-
4	3	2	3	2	3	3	3	-	-	-	2	2	1	2	-
5	3	2	3	2	3	3	3	-	-	-	2	3	2	2	-
avg	3	2	3	2	3	3	3	0	0	0	1.4	2.6	2	2	0

TEXTBOOKS:

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

REFERENCES:

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

FD3811

PROJECT WORK / INTERNSHIP#

L T P C
0 0 20 10

OBJECTIVES:

To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

TOTAL: 300 PERIODS

OUTCOMES:

At the end of the project, the student will be able to

CO1: Formulate and analyze problem / create a new product/ process.

CO2: Design and conduct experiments to find solution

CO3: Analyze the results and provide solution for the identified problem, prepare project report and make presentation.

GE3751

PRINCIPLES OF MANAGEMENT

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers- managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization

structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV DIRECTING

9

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNIT V CONTROLLING

9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
- CO2: Have same basic knowledge on international aspect of management.
- CO3: Ability to understand management concept of organizing.
- CO4: Ability to understand management concept of directing.
- CO5: Ability to understand management concept of controlling.

TEXT BOOKS:

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.

REFERENCES:

1. Robert Kreitner and Mamata Mohapatra, “ Management”, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, “Principles of Management”, Tata McGraw Hill, 1999.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		-	-	-	1	-	-	-	-	-	-	2	1	1
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1
AVg.	1.66	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

GE3752

TOTAL QUALITY MANAGEMENT

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
 Explain the TQM Principles for application.
 Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
 Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD,

TPM, COQ and BPR.
 Illustrate and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9
 Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9
 Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9
 The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9
 Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9
 Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: Ability to apply TQM concepts in a selected enterprise.
- CO2: Ability to apply TQM principles in a selected enterprise.
- CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
- CO5: Ability to apply QMS and EMS in any organization.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3										3	2		3
2						3						3		2	
3					3				3					2	3
4		2			3	2	3	2				3	3	2	
5			3			3	3	2							
AVg.		2.5	3		3	2.6	3	2	3			3	2.5	2	3

TEXT BOOK:

1. Dale H.Besterfield, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. Joel.E. Ross, "Total Quality Management – Text and Cases",Routledge.,2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .

GE3753

ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING

L T P C

3 0 0 3

COURSE OBJECTIVES:

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

UNIT I DEMAND & SUPPLY ANALYSIS

9

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.

UNIT II PRODUCTION AND COST ANALYSIS

9

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

UNIT III PRICING

9

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)

9

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT)

9

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students able to

CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

CO2: Evaluate the economic theories, cost concepts and pricing policies

CO3: Understand the market structures and integration concepts

CO4: Understand the measures of national income, the functions of banks and concepts of globalization

CO5: Apply the concepts of financial management for project appraisal

TEXT BOOKS:

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

REFERENCES:

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

MAPPING OF COS AND POS:

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3								2			1	3	
2		3												2	2
3		2													
4	2	3	3		2								2	3	
5	3	3	3		2								2		2
AVg.	2.5	2.4	3		2					2			1.8	2.6	2

GE3754**HUMAN RESOURCE MANAGEMENT****L T P C**
3 0 0 3**OBJECTIVE:**

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT**9**

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

UNIT II HUMAN RESOURCE PLANNING**9**

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

UNIT III TRAINING AND EXECUTIVE DEVELOPMENT**9**

Types of training and Executive development methods – purpose – benefits.

UNIT IV EMPLOYEE COMPENSATION**9**

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege

relationships.

UNIT V PERFORMANCE EVALUATION AND CONTROL

9

Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: Students would have gained knowledge on the various aspects of HRM
- CO2: Students will gain knowledge needed for success as a human resources professional.
- CO3: Students will develop the skills needed for a successful HR manager.
- CO4: Students would be prepared to implement the concepts learned in the workplace.
- CO5: Students would be aware of the emerging concepts in the field of HRM

TEXT BOOKS:

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

REFERENCES:

1. Luis R,. Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, "Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	2	2	1	2	2	2	1	1	2	1	1	1	1	1	1	1
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1	1
4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1	1
AVg.	2.8	2.8	1.8	2.6	2.6	2.2	1.8	1.8	2.4	1	1.4	1	1	1.4	1	1

GE3755

KNOWLEDGE MANAGEMENT

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

The student should be made to:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

UNIT I INTRODUCTION

9

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9
 Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9
 Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9
 Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

UNIT V FUTURE TRENDS AND CASE STUDIES 9
 Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Upon completion of the course, the student should be able to:
 CO1: Understand the process of acquiring knowledge from experts
 CO2: Understand the learning organization.
 CO3: Use the knowledge management tools.
 CO4: Develop knowledge management Applications.
 CO5: Design and develop enterprise applications.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1					1											
2					2								1			
3					2									2		
4				1	1				1					1		
5				1	1				1					1		
AVg.				1	1.4				1				1	1.33		

TEXT BOOK:

- Srikantaiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

REFERENCE:

- Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

GE3792

INDUSTRIAL MANAGEMENT

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.

- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

UNIT – I INTRODUCTION TO MANAGEMENT 9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg’s Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT – II FUNCTIONS OF MANAGEMENT - I 9

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

UNIT – III FUNCTIONS OF MANAGEMENT - II 9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mouton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT – IV ORGANIZATION THEORY 9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow’s hierarchy of needs theory; Herzberg’s motivation-hygiene theory; McClelland’s three needs motivation theory; Vroom’s valence-expectancy theory – Change Management: Concept of Change; Lewin’s Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNIT – V PRODUCTIVITY AND MODERN TOPICS 9

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- CO1 Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- CO2 Discuss the planning; organizing and staffing functions of management in professional organization.
- CO3 Apply the leading; controlling and decision making functions of management in professional organization.
- CO4 Discuss the organizational theory in professional organization.
- CO5 Apply principles of productivity and modern concepts in management in professional organization.

TEXTBOOKS:

- 1 M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
- 2 Koontz. H. and Wehrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCES:

- 1 Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.
- 2 Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
- 3 S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
- 4 Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.
- 5 S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

MAPPING OF COS AND POS:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

PROGRESS THROUGH KNOWLEDGE

VERTICALS

FD3001

DAIRY CHEMISTRY AND MICROBIOLOGY

L T P C
3 0 0 3

OBJECTIVES:

- To impart the basic knowledge on all aspects of milk components.
- To understand microbiology of dairy products, significance of different food microorganisms, their control and other related aspects.
- To Provide insights on the quality control in relation to dairy industry and impart basic knowledge on all aspects of chemical quality assurance.
- To impart the advanced knowledge on the use of analytical techniques in Dairy Chemistry and microbiology

UNIT I CHEMISTRY OF MILK PROTEINS AND LIPIDS 9

Major milk proteins: caseins (acids and micellar), methods of isolation; fractionation of casein and heterogeneity, physico-chemical properties, glycosylation, phosphorylation, amino acid composition, primary and secondary structure of different fractions; casein micelle models Distribution and fractionation of different nitrogen fractions of milk proteins, Denaturation of milk proteins, various factors affecting denaturation; casein-whey protein interactions. Milk lipids: classification, gross composition and physical properties; neutral and polar lipids and their role in milk and milk products. Fatty acids profile: composition, properties and factors affecting them. Unsaponifiable matter: composition with special reference to sterols and fat-soluble vitamins and carotenoids, chemistry, physiological functions and levels of milk.

UNIT II CHEMISTRY OF MILK CARBOHYDRATES, VITAMINS, AND MINERALS 9

Lactose: occurrence, isomers; molecular structure, Physical properties:- crystalline habits; hydrate; lactose glass; equilibrium of different isomers in solution; solubility; density sweetness; Chemical properties:- hydrolysis; pyrolysis; oxidation; reduction; degradation with strong bases; derivatives, dehydration and fragmentation browning reaction; oligosaccharides in milk Minerals: major and minor minerals; factors associated with variation in salt composition Physical equilibrium amongst milk salts; partitioning of salt constituents and factors affecting it; effect of various treatments on salt equilibrium, Salt balance and its importance in the processing of milk; protein mineral interactions; distribution and importance of trace elements in milk; Water soluble vitamins: thiamine; riboflavin; niacin; pantothenic acid; pyridoxine; biotin; folacin (folic acid) and cyanocobalamin; Molecular structure; levels in milk and milk products; biological significance; factors affecting their levels; ascorbic acid structure; relation to Redox potential (Eh) of milk and milk products.

UNIT III MICROBIOLOGY OF PROCESSED DAIRY FOODS 9

Introduction to microbes in processed dairy foods, history and development of processed foods. Microorganisms important in processed foods: spoilage and pathogens, Food borne new emerging pathogens, Microbial ecology of processed foods and food ecosystem, biofilm formation, Factors influencing microbial growth in foods: Intrinsic factors, Extrinsic factors. Rapid assessment of dairy food for microbial and non-microbial contaminants; Enumeration principles in detection methods of predominant spoilage organisms, pathogens and indicator organisms like, E.coli, Salmonella, Shigella, Staphylococcus aureus, Bacillus cereus.

UNIT IV ANALYTICAL TECHNIQUES IN DAIRY CHEMISTRY AND MICROBIOLOGY 9

Electrophoresis: principle and types, isoelectric focussing. Column Chromatography, TLC, GLC, HPLC, gel-permeation, ion-exchange, affinity chromatography Spectrophotometry: UV, visible, IR and flame photometry; potentiometry: principle, various electrodes; buffers. Immunobased analytical techniques such as ELISA & Lateral flow assay Separation of bio-molecules using membranes; ultracentrifugation.

UNIT V CHEMICAL QUALITY ASSURANCE IN DAIRY INDUSTRY 9

Concept of quality assurance and quality control in relation to dairy industry; quality management

systems - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP); role of international organisations such as ISO; IDF; CAC; AOAC; WTO and national organisations like BIS; CCFS; Good laboratory practices (GLP), laboratory Accreditation PFA and Agmark; significance of milk and milk products order (MMPO) and APEDA (Agricultural and Processed Foods Export Development Authority) in dairy industry; Instrumentation in analysis of milk and milk products; detection of adulterants in milk and milk products; Quality of packaging material for dairy products, Chemical contaminants /residues: pesticides; antibiotics; heavy metals; radionuclides etc. in dairy products.

TOTAL:45 PERIODS

Course Outcomes (COs)

At the end of the course the students would have the knowledge to

1. Describe the composition of milk, physicochemical characteristics of the main components and identify the beneficial and spoilage microorganisms.
2. Apply advanced analytical techniques to understand the various chemical and microbiological components.
3. Integrate the knowledge of food chemistry/engineering/microbiology and physical properties of foods with processing of dairy products.
4. Apply the analytical techniques in Dairy Chemistry and microbiology

CO No	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO1 2	PS O1	PSO 2	PS O3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	2
3	3	2	2	2	3	3	1	-	-	-	1	3	3	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	1	-	1
avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.75

TEXTBOOKS/REFERENCES

1. Nielsen, S. Suzanne 1994. Introduction to the Chemical Analysis of Foods, Jones and Barlett Publishers, Boston, London.
2. Cooper, T.G. 1977. The Tools of Biochemistry, John Wiley & Sons, U.S.A.
3. Williams, P.A. and Phillips, G.O. 2000. Gums and Stabilizers for the Food Industry. Royal Society of Chemistry
4. Dairy Chemistry and Biochemistry (1998) by P.F.Fox and P.L.H McSweeney
5. Textbook of Dairy Chemistry by M.P.Mathur, D.D.Roy and P.Dinakar.
6. ISI Handbook of Food Analysis S.P. 18 (Part II) Dairy Products. 1981 ISI Specifications (concerned) (ISI)

FD3002

PROCESSING OF DAIRY PRODUCTS

L T P C

3 0 0 3

9

UNIT I EVAPORATION & MIXING

Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators.

Mixing and agitation: Theory and purpose of mixing. Equipments used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

UNIT II DRYING

9

Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and

drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers.

UNIT III PROCESSING EQUIPMENTS 9

Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. Packaging equipments: Packaging machines for milk & milk products. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

UNIT IV MECHANICAL SEPARATION 9

Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers. Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers.

UNIT V THERMAL PROCESSING 9

Pasteurization:Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers. Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance.

TOAL: 45 PERIODS

Course Outcomes (COs)

At the end of the course the students would have the knowledge to

1. Understand the composition of milk and 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 equipments used for the manufacturing of ice-cream and milk powder production

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	1	1	1	-	-	-	-	1	1	2	2	2
2	2	3	2	3	2	1	-	-	-	-	1	3	3	1	3
3	2	2	1	2	1	1	-	-	-	-	1	3	2	2	2
4	3	3	1	3	1	1	-	-	-	-	1	2	3	1	2
5	2	3	2	2	3	1	-	-	-	-	3	3	2	1	2
avg	2	2.4	1.4	2.2	1.6	1	0	0	0	0	1.4	2.4	2.4	1.4	2.2

TEXT BOOK

1. De Sukumar Outlines of Dairy Technology, Oxford University press, New Delhi, 2002.

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

FD3003

VALUE ADDED DAIRY PRODUCTS

**L T P C
3 0 0 3**

OBJECTIVE

- To project the significance and status of traditional and value added dairy products in Indian dairy industry.
- To explain the current status of traditional milk products in India. Place of milk products in the dietary regime in Indian population.

UNIT I NATIVE DAIRY PRODUCTION

9

Introduction of Traditional dairy products in India, definition – present status and market potential of traditional dairy products – globalization of traditional dairy products – classification of traditional milk products. fermented traditional dairy products. plans and policies of the Government and developmental agencies.

UNIT II HEAT ACID COAGULATED PRODUCTS

9

Chhana- definition- composition- methods of manufacture, Chhana based sweets-packaging and preservation methods- yield and cost analysis. Paneer: definition mechanization of paneer manufacturing - paneer based products – storage and packaging and preservation methods – Latest development in paneer processing. Advances in industrial production of ghee, flavour and texture simulation. New products based on fruits, vegetables and cereals, Application of membrane technology; Microwave heating for industrial production of traditional dairy products.

UNIT III THERMALLY PROCESSED MILK COMMODITY

9

Khoa – Classification- methods of manufacture – Factors affecting yield of khoa- yield and cost analysis of khoa. Processing of khoa –burfi, peda, milk cake, kalakand, gulab jamun, rabri, malai, khurchan, basundhi- composition – manufacturing technicalities. UHT flavoured milk processing and adulterations, Cost of manufacture and storage of traditional flavoured milk products.

UNIT IV MILK CHEESE CURD-BASED BY-PRODUCTS

9

Chhana – Product description, methods of manufacture, packaging and preservation. Chhana based sweets – Rasogolla, Sandesh, Rasmalai, and Chhanapodo - manufacturing practices, compositional profile and mechanization of manufacturing process. Kheer and Payasam – Product description, production and processing, sensory estimation, In-can sterilization of Kheer

UNIT V CONVENIENT TRADITIONAL DAIRY PRODUCTS & NEW PACKAGING TECHNOLOGIES

9

Packaging processes (canning) – interaction between milk and cereal constituents- yield and cost benefit analysis. Convenience traditional dairy products; use of natural and permitted synthetic preservatives with new packaging systems. Techno-economic aspects for establishing commercial units for traditional products. Manufacture of convenience dairy foods, Use of natural preservatives in traditional dairy foods, Use of permitted synthetic preservatives in traditional dairy foods, Scope for packaging of traditional dairy foods.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand common terminology used in packaging of milk and milk products.
2. Assess how to increase the selling of milk and milk products by attractive packages.
3. Analyse how to increase products claim in market by using different package techniques, and legal requirements.
4. Discuss methods sterilization and traditional way of processing the value-added milk products
5. Distinguish the importance of coding and labelling of packages.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	2	-	-	1	-	-	-	1	2	2	-	2
2	3	3	2	3	-	2	2	-	-	-	1	3	2	-	2
3	3	2	2	2	-	2	1	-	-	-	1	3	3	-	3
4	3	3	2	3	-	1	2	-	-	-	1	2	2	-	2
5	1	3	2	2	-	2	1	-	-	-	2	3	2	-	1
avg	2.2	2.4	1.8	2.4	0	1.4	1.4	0	0	0	1.2	2.6	2.2	0	2

TEXTBOOKS/REFERENCES

1. Aneja.R.P, B.N Mathur, R.C Chandra and A.K. Banerjee 2002, Technology of Indian Milk and Milk Products, Dairy India Publication
2. Dairy India year book 2007 & 2017, A- 25 Priyadarshinivihar, Delhi 110092, India.
3. David.J, 2009 "Technologies advanced in indigenous milk products" published by KitabMahal, 22-A, Sarojini Naidu Marg, Allahabad (2nded).
4. Eeckless C.H, W.B Combs and H.Mecy (1955), Milk and Milk Products, Tata McGraw Hill Publishing Co.Pvt.Ltd. New Delhi.
5. Sukumar De (1980), Outlines of Dairy Technology, Oxford University Press, New Delhi.
6. Achaya KT & Rangappa KS. 1975. *Indian Dairy Products*. 2nd Ed. Asia Publ. House.
7. Aneja RP, Mathur BN, Chandhan RC & Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publ., Delhi.
8. De S. 1980. *Outlines of Dairy Technology*. Oxford Univ. Press Publ., New Delhi.
9. Gould GW. 1995. *New Methods of Food Preservation*. Blackie.
10. NDRI. 1998. *Advances in Traditional Dairy Products*. Lecture Compendium, Dairy Technology Division, NDRI, Karnal.
11. NDRI. 2006. *Developments in Traditional Dairy Products*. Lecture Compendium, Dairy Technology Division, NDRI, Karnal.

FD3004 PRECISION FERMENTATION FOR DAIRY ALTERNATIVES

L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basics of fermentation for plant based ingredients.
- To give insights on precision fermentation

UNIT I FERMENTATION BASICS

9

Fermentative products - enzymes, flavoring agents, vitamins, natural pigments, and fats. Benefits of precision fermentation based dairy alternatives over plant based dairy alternatives

UNIT II DAIRY & FERMENTED DAIRY PRODUCTS

9

Dairy products, texture, physico-chemical property, functional properties, Probiotic delivering

ability, Sensorial features, geography specific dairy products.

UNIT III CRITICAL CONSIDERATIONS IN PRECISION FERMENTATION 9

Critical considerations in precision fermentation, Target selection and design, strain development, feedstock optimization strategies, Applications of food bio-informatics, AI, ML for food ingredient discovery, bio-mimicry strategies in precision fermentation.

UNIT IV PRE-REQUISITES IN PRECISION FERMENTATION 9

Bioprocess design, feed stock identification for commercial application, Safety and standard regulations, Regulatory approval bodies, Ethical considerations.

UNIT V PRECISION FERMENTATION PRODUCTS AND APPLICATION IN ALTERNATE DAIRY PRODUCT DEVELOPMENTS 9

Chymosin, Vitamin B12, Riboflavin, Whey protein, casein, collagen, fibronectin, soy leghemoglobin, DHA, EPA, Microbial exopolysaccharides. Dairy analogues, Benefits of dairy analogues over conventional dairy products, Need for dairy alternates.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the concepts, principles and procedures involved in the fermentation of plant based products.
2. Acquire knowledge to fermented dairy products
3. Examine the precision fermentation technology.
4. Assess the basics of fermentation for plant based ingredients and insights on precision fermentation

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	PS O1	P S O 2	PS O3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	1
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	2
3	3	2	2	2	3	3	1	-	-	-	1	3	2	-	1
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	1
avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.25

TEXTBOOKS/REFERENCES

1. Microbiology and Technology of Fermented Foods by Robert W. Hutkins, Blackwell Publishing TP371.44 .H88 2006eb ebook
2. Wood, Brian J. B. "Microbiology of Fermented Foods" Volume 1 and 2. II Edition. Blackie Academic and Professional, 1998.

OBJECTIVE

- To impart knowledge on different types of cheese production
- To provide insight of both pre and post coagulation techniques in cheese production.
- To impart knowledge about the cheese ripening metabolism

UNIT I INTRODUCTION**9**

Introduction – origin of cheese production, scope & status of cheese manufacturing in India, types of cheese, milk and starter culture quality in cheese production. Additives used in cheese processing. Nutritional aspects of cheese.

UNIT II PRETREATMENT OF CHEESE MILK**9**

Introduction Acidification, Enzymatic coagulation process, Acid/ heat-coagulation process, factor affecting coagulation, post – coagulation techniques – membrane filtration, ultrafiltration techniques and their applications.

UNIT III CHEESE RIPENING CHEMISTRY**9**

Introduction – Ripening agents, Metabolism of residual lactose, lactate, & citrate. Citrate metabolism. Lipolysis, Proteolysis, Catabolism of amino acids and their functions. Cheese Flavor – development of cheese flavor, Accelerated cheese ripening Aroma compounds in specific cheeses.

UNIT IV CHEESE PRODUCTION**9**

Manufacture of Mozzarella, Cheddar, Gouda, Swiss, Cottage, Blue, & Processed cheese, cheese spread and processed cheese foods. Cheese from different milk sources – goat, Ewe, buffalo. Mechanization and automation in cheese processing.

UNIT V MICROBIAL PATHAGEN AND MYCOTOXIN IN CHEESE**9**

Introduction – growth and survival of bacterial pathogens, Production of toxins in cheese, growth and survival of mold. Factor influencing the microbial spoilage of cheese. control measure for microbial contamination in cheese.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the concepts, principles and procedures involved in the fermentation of plant-based products.
2. Acquire knowledge to fermented dairy products
3. Assess the precision fermentation technology.
4. Evaluate the insights coagulation techniques in cheese production and cheese ripening metabolism

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	PS O1	PS O2	PS O3
1	2	1	1	2	2	2	1	-	-	-	1	2	1	2	-
2	3	3	2	3	3	3	2	-	-	-	1	3	2	2	-
3	3	2	2	2	3	3	1	-	-	-	1	3	1	1	-
4	3	3	2	3	3	2	2	-	-	-	1	2	2	2	-
avg	2.7 5	2.2 5	1.7 5	2.5	2.7 5	2.5	1.5	0	0	0	1	2.5	1.5	1.7 5	0

TEXTBOOKS/REFERENCES

1. McSweeney, P. L. H., Guinee, T. P., Fox, P. F., Cogan, T. M., McSweeney, P. L. H., Guinee, T. P., Fox, P. F., Cogan, T. M. (n.d.). Fundamentals of Cheese Science. United States: Springer US.
2. Handbook of Cheese in Health: Production, Nutrition, and Medical Sciences. (2013). Netherlands: Wageningen Academic Publishers.
3. Cheese: Chemistry, Physics and Microbiology. (2017). United Kingdom: Elsevier Science.

FD3006

INNOVATIVE PACKAGING OF DAIRY PRODUCTS

L T P C

3 0 0 3

UNIT I INTRODUCTION

9

Importance of Packaging, History of Package Development, Packaging materials, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information.

UNIT II

9

working principles of various type batch type filling machine, working principles of FFS machine, Identification of packaging materials; Flame Hot wire test, Testing of papers/ paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength, Testing of glass bottle – resistance to thermal shock, Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance

UNIT III

9

Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeades, concentrated and dried milks including baby foods. Packaging of functional dairy/food products.

UNIT IV

9

Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP

UNIT V

9

Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food

TOTAL:45 PERIODS

TEXTBOOKS/REFERENCE BOOKS

- Patel, H.G., Modha, H. and Ranganadham, M. , Packaging of dairy Products, Agrimoon.com
- Ahvenainen, R. (2003). Novel Food Packaging Techniques. Woodhead Publ. Ltd., Cambridge, England.
 - Engineers India Research Institute. (2005). Handbook of Packaging Technology. EIRI, Delhi.
 - Han, J. (2005). Innovations in Food Packaging. Elsevier Science & Technology Books.
 - Yam, K. L. (2009). Encyclopedia of Packaging Technology. 3rded. John Wiley and Sons, Inc. Publ., USA.

OBJECTIVES:

- To familiarize the concepts of quality control and safety management in dairy processing.
- To impart knowledge on the microbiological risk analysis specific to dairy products.
- To explain the role of biosensors in the quality control of dairy industry.
- To brief the dairy plant and equipment hygiene practices.

UNIT I INTRODUCTION**9**

Consumer Awareness about Microbiological Quality and Safety of Dairy Foods: Changing scenario; Concepts of quality control, quality assurance and food safety; Global quality and food safety standards, integrated food law, its main features and functions.

UNIT II FOOD SAFETY MANAGEMENT SYSTEM IN DAIRY INDUSTRY**9**

Introduction to Food Safety Management System: Concepts of Quality Management System (QMS)–ISO: 9000:2000; Principles of QMS; Standard requirements for QMS; HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools and techniques.

UNIT III MICROBIOLOGICAL RISK ANALYSIS**9**

Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria and two and three class sampling plan / guidelines; Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant. Rapid Enumeration Techniques: Enumeration principles and procedure for rapid detection of predominant hygiene indicator organisms and pathogens like E. coli (E. coli 0157:H7), Salmonella, Shigella, Staphylococcus aureus, Bacillus cereus and Listeria monocytogenes.

UNIT IV BIOSENSORS IN DAIRY QUALITY ANALYSIS**9**

Role of Biosensors for monitoring hygiene and safety of dairy foods: Detection of antibiotic residues in milk – Delvo SP, MDR test, penzyme test, charm assay, lateral flow assay (ROSA test) etc. Detection of aflatoxins, pesticides other inhibitors etc. and their public health importance in dairy foods.

UNIT V PLANT AND EQUIPMENT HYGIENE**9**

Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of waste water and effluents.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the concepts of quality control and safety management in dairy processing
2. Appraise the microbiological risk analysis of dairy products
3. Conceive the role of biosensors in the quality control of dairy industry
4. Apply the dairy plant and equipment hygiene practices

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	PS O1	PS O2	PS O3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	2	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	3	1
3	3	2	2	2	3	3	1	-	-	-	1	3	1	2	2
4	3	3	2	3	3	2	2	-	-	-	1	2	2	2	1
avg	2.7 5	2.2 5	1.7 5	2.5	2.7 5	2.5	1.5	0	0	0	1	2.5	1.75	2.25	1.5

TEXTBOOKS/REFERENCES

1. Griffiths, M. ed., 2010. Improving the safety and quality of milk: Milk production and processing. Elsevier.
2. Motarjemi, Y., Moy, G.G., Jooste, P.J. and Anelich, L.E., 2013. Food Safety Management: Chapter 5. Milk and Dairy Products.
3. World Bank, 2020. Food Safety Handbook: A Practical Guide for Building a Robust Food Safety Management System. The World Bank.
4. Papademas, P. ed., 2014. Dairy Microbiology: A Practical Approach. CRC Press.
5. Gandhi, K., Sharma, R., Gautam, P.B. and Mann, B., 2020. Chemical quality assurance of milk and milk products. Singapore: Springer.

FD3008

INTRODUCTION TO FOOD BIOTECHNOLOGY

L T P C
3 0 0 3

OBJECTIVES

The course aims to

- acquaint with the fundamentals of biotechnology in relation to raw materials for food processing.
- enable the students to learn about food fermentations, waste utilization and use better genetic resources in food industry.

UNIT I FOOD BIOTECHNOLOGY

9

Fermentative production of enzymes used in food industry; solid state fermentation; recovery of enzymes from natural sources; cheese making and whey processing, impact of enzyme technology (bioethanol, protein hydrolysates, bioactive peptides); enzymatic processing of fruit juices. Role of enzymes in baking, meat and meat processing; comparative methods of toxicity test in (novel) foods; biosensors; enzymatic approach to tailor made fats; catabolic processes and oxygen-dependent reactions in food; use of lipases and reactions in organic solvents and two phases

UNIT II OVERVIEW OF GENETICS

9

Chemical structure of nucleic acids, proteins; introduction to Genetics, DNA replication, transcription and translation; cell division, cell cycle, mitosis, meiosis; introduction to human genetics; Mendelian genetics; single cell disorders; complex traits; mutation, types of mutations DNA repair mechanism; modifying enzymes; mutation and polymorphism and their detection; family based and case control study designs; pedigree analysis; linkage analysis and association studies.

UNIT III GENETIC ENGINEERING

9

Overview of recombinant DNA technology and its applications. Characteristics and importance: Cloning vector and expression vector, Transformation, Transfection and Transduction – Principle and differences. Plasmid vector: Cloning site, Selection, Screening, PCR, RT-PCR, electrophoresis, electro blotting and capillary blotting, applications to produce genetically modified foods

UNIT IV CELL CULTURE TECHNOLOGY

9

Introduction to plant and animal tissue cultures and cell cultures in general. Cell culture lab design and equipment, Media and reagents. Animal, mammalian, and other cell lines for in-vitro testing of drugs, toxicity of environmental pollutants, production of vaccines and therapeutic proteins & production of stem cells. Principles of cryobiology and molecular diagnostics, Technological aspects for commercial utilization of cell cultures: Reactor studies, scale up and biosafety.

UNIT V TRANSGENIC TECHNOLOGY & APPLICATIONS IN FOODS

9

DNA microinjection, Retroviral vectors, Transgenic animals – Knock in and knock out animals, Transgenic plants – Ti plasmid. Genetically engineered proteins Bovine Somatotropin in Milk;

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

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Apply the principles of biotechnology in Food processing industries to improve the quality of foods
2. Execute the production of commercially important metabolites
3. Apply the principle of downstream processing and explain various stages involved in downstream processing
4. Evaluate the diagnostic techniques for food borne pathogens and toxins
5. Assess the safety aspects and social issues related to applications and implications of genetically modified foods

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	2	2	1	-	-	-	1	2	2	-	2
2	3	2	3	3	3	3	2	-	-	-	1	3	3	-	2
3	3	2	3	2	3	3	1	-	-	-	2	3	2	-	1
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	2
5	2	2	3	2	1	2	2	-	-	-	1	2	1	-	1
avg	2.6	2.2	2.6	2.4	2.4	2.4	1.6	0	0	0	1.2	2.4	2	0	1.6

TEXTBOOKS

1. B.D. Singh. "Biotechnology - Expanding Horizons", Kalyani Publishers, 2014.
2. Meenakshi Paul. "Biotechnology and Food Processing Mechanics", Gene-Tec Books, 2007.
3. James D. Watson. "Molecular Biology of the Gene", 7th Edition. Benjamin Cummings, 2013.
4. Oliver Brandenburg, Zephaniah Dhlamini, Alessandra Sensi, Kakoli Ghosh and Andrea.
5. Sonnino. "Introduction to Molecular Biology and Genetic Engineering". FAO, 2011.
6. S.B. Primrose and R.M. Twyman. "Principles of Gene Manipulation and Genomics", 7 thEdition. Blackwell Publishing, 2006.
7. Ashok Agarwal and Pradeep Parihar. "Industrial Microbiology Fundamentals and Applications" Agrobios, 2005.

REFERENCES

1. Bains W. "Biotechnology from A to Z", Oxford Univ. Press., 2004, 3rd Edition
2. Joshi VK & Pandey A. "Biotechnology Food Fermentation"., Vols. I, 2nd Edition. Education Publ. 1999.
3. Knorr D. "Food Biotechnology"., Marcel Dekker., 1985.
4. Lee BH. "Fundamentals of Food Biotechnology"., VCH., 1996.
5. Perlman D. "Annual Reports of Fermentation Processes"., 1979.

FD3009

ENZYMES IN FOOD AND FEED INDUSTRY

**L T P C
3 0 0 3**

OBJECTIVE:

- To highlight the action and mechanism of microbial enzymes and fermentative production of enzymes followed by isolation and purification
- To analyze the role of specific enzymes in the processing of dairy, bakery, brewery, fruit and vegetable products, plantation crops.
- To analyze the role of specific enzymes in starch industry, confectionary, protein hydrolysis,

- extraction of oil.
- To analyze the role of specific enzymes in processing of meat, seafood and poultry products, waste management, animal feed industry.
- To analyze the role of specific enzymes as biosensors, additives, in packaging, and describe the concept of recombinant enzymes and safety of enzymes.

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation. Kinetics of single substrate reactions; estimation of Michaelis – Menten parameters, multisubstrate reactions- mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product.

UNIT II ENZYMES IN FOOD INDUSTRY 9

Introduction to enzymes used in Food industry, Objectives of using enzymes in food processing and in food product development, Merits and demerits of using enzymes, Sources of enzymes, Microbial enzymes and their advantages/ disadvantages, Commercially important enzymes used in Food industry and their mode of action, Overview of applications of enzymes in the Food industry, Newer enzymes and their actual and potential applications, Fermentative production of enzymes used in food industry by SSF or SmF, Recovery and purification of enzymes.

UNIT III ENZYME APPLICATIONS IN FOODS 9

Use of enzymes in: Dairy, Bakery, Brewery, Fruit and Vegetable Processing, Plantation Products, Starch industry and confectionery, Protein hydrolysis for protein hydrolysate and bioactive peptides, Oilseeds processing, formation of TAGs, extraction of fish oil, meat, seafood (surimi product), poultry, eggs, treatment of wastes from food industry, flavor biotransformations.

UNIT IV APPLICATIONS OF ENZYMES IN FEED INDUSTRY 9

The benefits of supplementation of exogenous enzymes to feed. Use of enzymes in poultry and animal feed.

UNIT V ADVANCES IN UTILIZATION OF ENZYMES 9

Enzymes in biosensors, Enzymes as additives e.g. antioxidant or antimicrobial, Novel food applications of enzymes, Enzymes in active packaging and in edible coatings and films, safety of enzymes used in foods, food grade enzymes, Immobilization of enzymes for food applications, Recombinant enzymes from GMO.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

- Highlight the action and mechanism of microbial enzymes and fermentative production of enzymes followed by isolation and purification.
- Analyze the role of specific enzymes in the processing of dairy, bakery, brewery, fruit and vegetable products, plantation crops.
- Analyze the role of specific enzymes in starch industry, confectionary, protein hydrolysis, extraction of oil.
- Analyze the role of specific enzymes in processing of meat, seafood and poultry products, waste management, animal feed industry.
- Analyze the role of specific enzymes as biosensors, additives, in packaging, and describe the concept of recombinant enzymes and safety of enzymes.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	2	2	1	-	-	-	-	2	2	2	1
2	3	2	3	-	3	3	2	-	-	-	-	3	2	2	2
3	3	2	3	-	3	3	1	-	-	-	-	3	1	1	1
4	3	3	2	-	3	2	2	-	-	-	-	2	2	2	2

5	2	2	3	-	1	2	2	-	-	-	-	2	1	1	2
avg	2.6	2.2	2.6	0	2.4	2.4	1.6	0	0	0	0	2.4	1.6	1.6	1.6

TEXTBOOKS

1. Robert Rastall., (2007), Novel Enzyme Technology for Food applications, 1st ed, CRC Press, U.S.
2. Marwaha, (2002). Food Processing: Biotechnological Applications, Asiatic Publishers, New Delhi

FD3010

FOOD FERMENTATION TECHNOLOGY

**L T P C
3 0 0 3**

OBJECTIVES

The course aims to

- impart knowledge and skills related to process technologies in fermented food products
- learn about the different equipment used for the production of various fermented food products.

UNIT I HISTORICAL PERSPECTIVE OF FOOD FERMENTATION 9

History of food fermentations; types of fermented foods and substrates/raw materials used, traditional fermented foods, biotransformation of raw materials

UNIT II FERMENTING ORGANISMS AND THEIR ROLE 9

Principles of food and industrial fermentations; microorganisms of importance in food fermentations, Biochemistry of fermentations/fermentation pathways. Lactic Acid Bacteria and starter cultures (Taxonomy, ecology, physiology, genetics and biotechnology, phage control) Brewers and Bakers yeasts, Yeast starter culture maintenance, Moulds used in food fermentations; Genetic manipulation of fermenting microbes, Strain specific traits

UNIT III TECHNOLOGY OF FERMENTED FOODS 9

Dairy fermentations - Yeast fermentations - Wine and beer fermentations, bread making, Mould fermentations – soy based fermented foods – miso, tempeh, soy sauces Manufacture of cheese, yoghurt, wine, beer, bread, soy sauce; processes and equipment used for manufacture; bottling / packaging, aging, storage and shelf life of fermented foods; Prevention of spoilage of fermentations.

UNIT IV PRODUCTS OF MIXED FERMENTATIONS 9

Meats, sausages, fish sauces, sauerkraut, idli, Manufacture of different types of sausages, fish sauces, sauerkraut, idli batter- processes and equipment used for manufacture; packaging, aging, storage and shelf life of the products; Prevention of spoilage of fermentations.

UNIT V OTHER PRODUCTS FROM FERMENTATION 9

Fermentation production of flavor components, acids, alcohol, enzymes, pigments/colours.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 Understanding concepts, principles and procedures involved in the area of fermented food production.

CO2 Familiarizing with different fermenter types and their design criteria.

TEXT BOOKS

1. Joshi, V. K. "Biotechnology: Food Fermentation" Volume 1. Educational Publishers & Distributors, 2004.

- Hui Y. H "Handbook of Food and Beverage Fermentation Technology". Marcel Dekker, 2004.
- Wood, Brian J. B. "Microbiology of Fermented Foods" Volume 1 & 2. II Edition. Blackie Academic & Professional, 1998.

REFERENCES

- Farnworth, Edward R. "Handbook of Fermented Functional Foods" II Edition. CRC Press, 2008.
- Lea, Andrew G. H & John R. Piggott "Fermented Beverage Production" II Edition. Kluwer Academic/ Plenum Publishers, 2010.

FD3011

BIOLOGICAL INSTRUMENTATION AND PROCESS CONTROL

L T P C

3 0 0 3

OBJECTIVE

The course aims to

- Introduce the dynamic response of open and closed loop systems, control loop components and stability of control systems.
- Learn instrumentation for the measurement of key process variables in food processing
- Update the applications of sensors in food processing Industry

UNIT I OPTICAL SPECTROSCOPY

9

Design of Experiments – Error Analysis – S/N ratio – Limit of Detection – UV –VIS Spectroscopy, Applications, Instruments – single beam, double beam and Photo-diode array – applications – IR & Raman – Uses – Design – FT-IR, Raman.

UNIT II CHROMATOGRAPHY

9

Distribution coefficients – solid-liquid, liquid-liquid and gas chromatography – theory of chromatography-normal phase & reverse phase chromatography – gel permeation – ion exchange & affinity chromatography – HPLC- Instrumentation & case studies.

UNIT III STRUCTURAL ELUCIDATION

9

Nuclear Magnetic Resonance – Introduction-spin states – ¹H, ¹³C NMR – Instrumentation-use in structural elucidation. Electron Paramagnetic Resonance-concept & instrumentation – use in metal containing proteins & membrane studies. X-Ray : X-ray spectroscopy –Auger – EELS Instrumentation & applications in Biology- X-ray diffraction- Instrumentation –small molecule & macromolecular crystallography.

UNIT IV MASS SPECTROMETRY

9

Introduction – Instrumentation – CI, EI-Methods of Ionization- Methods for separation of Ions – Method for Detection. MALDI- TOF, ESI and FT-MS.

UNIT V ELECTROCHEMICAL MEASUREMENTS

9

Different types of electrochemical apparatus – Measuring Electrode potentials- Red-Ox proteins – Porous Silicon.

TOTAL: 45 PERIODS

COURSE OUTCOME:

CO1 To provide to the students the fundamentals of instrument knowledge and their applications in biology.

TEXTBOOKS

- Skoog, D.A. et al., "Principles of Instrumental Analysis". VI Edition, Thomson/Brooks/ Cole, 2007.
- Willard, Hobart H, "Instrumental Methods of Analysis".VII Edition, CBS Publishers, 2008.
- Braun, R.D. "Introduction to Instrumental Analysis". McGraw-Hill, 1987.

OBJECTIVES

The course aims to

- familiarize with hazards, and toxicity associated with food and their implications for health.
- know the various kinds of allergens and basis of allergic reactions • familiarize with various natural toxins in food.

UNIT I INTRODUCTION**9**

Definition and need for understanding food toxicology; Hazards - Microbiological, nutritional and environmental. Basics of immune resources - humoral and cell media resources. Allergen and mechanism of allergic resources.

UNIT II FOOD ALLERGY AND SENSITIVITY**9**

Chemistry of food allergens, celiac disease, food disorders associated with metabolism, lactose intolerance, and asthma

UNIT III PRINCIPLES OF TOXICOLOGY**9**

Natural food toxicants - toxicity of mushroom alkaloids, seafood, vegetables, fruits, pulses, and antinutritional compounds. Biological factors that influence toxicity, toxin absorption in the G.I.tract, Industrial microflora, blood, brain barrier, storage and excretion of toxins

UNIT IV DETERMINATION OF TOXICANTS IN FOOD SAMPLING**9**

Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagen city and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.

UNIT V TOXICANTS FORMED DURING FOOD PROCESSING**9**

Intentional direct additives, preservatives, nitrate, nitrite, and N- nitroso compound flavour enhancers, food colours, indirect additives, residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N - nitrosamines, Acrylamide and their mode of action

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Find the hazards and the toxicity associated with food and their implications for health
2. Analyse the chemistry of food allergens and disorders associated with food
3. Assess the risk and exposure of toxins in food sampling
4. Determine the toxicants in foods by the qualitative and quantitative analysis
5. Critique the formation of toxins during post harvest processing or else during storage

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	2	2	1	-	-	-	1	2	2	-	1
2	3	2	3	3	3	3	2	-	-	-	1	3	2	-	2
3	3	2	3	2	3	3	1	-	-	-	2	3	1	-	1
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	2
5	2	2	3	2	1	2	2	-	-	-	1	2	2	-	2
avg	2.6	2.2	2.6	2.4	2.4	2.4	1.6	0	0	0	1.2	2.4	1.8	0	1.6

TEXTBOOKS

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

REFERENCES

1. Labbe, Ronald G. and Santos Garcia "Guide to Food Borne Pathogens" John Wiley & Sons, 2001.
2. Cliver, Dean O. and Hans P. Riemann "Food Borne Diseases" II Edition., Academic Press/Elsevier, 2002.
3. Riemann, Hans P. and Dean O. Cliver "Food Borne Infections and Intoxications" III Edition., Academic Press/Elsevier, 2006.

FD3013 GENETIC ENGINEERING AND GENETICALLY MODIFIED FOODS L T P C 3 0 0 3

OBJECTIVES:

Introduction to GM foods and their methods of production, advantages

- To study genetically modified plants which are commercially available
- To study transgenic animals and their engineering method
- To understand genetically modified microorganisms and their applications in foods
- To know about Pharmaceutical applications of genetically engineered plants
- To understand Risk and safety assessment of the GM foods and their labeling

UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 9

Manipulation of DNA and RNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for insect, yeast and mammalian system, Prokaryotic and eukaryotic host systems, Introduction of recombinant DNA in to host cells and selection methods.

UNIT II DNA LIBRARIES 9

Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Screening of DNA libraries using nucleic acid probes and antisera.

UNIT III SEQUENCING AND AMPLIFICATION OF DNA 9

Maxam Gilbert's and Sanger's methods of DNA sequencing. Inverse PCR, Nested PCR, AFLPPCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

UNIT IV TRANSGENIC TECHNOLOGY 9

DNA microinjection, Retroviral vectors, Transgenic animals – Knock in and knock out animals, Transgenic plants – Ti plasmid.

UNIT V APPLICATIONS OF RDNA TECHNOLOGY IN FOODS 9

Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered bacteria: Chymosin Lite beer; Tryptophan; Transgenic plants: Calgene Flavr Savr™ tomato, Monsanto Round-Up™ Ready, Ciba Geigy Basta™ resistant crops; Edible vaccines: Cholera vaccine in potatoes; Transgenic Fish: Atlantic salmon.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Better understanding of genetically modified plants, animals and modified microorganisms
2. Familiarize in Pharmaceutical applications of genetically engineered plants

3. Obtain knowledge in Risk and safety assessment of the GM foods and their label.
4. Apply the genetically modified microorganisms and their applications in foods

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	2	2	-	2	1	-	-	-	1	2	1	2	2
2	3	1	3	3	-	3	2	-	-	-	1	3	2	1	1
3	1	2	1	3	-	3	1	-	-	-	1	3	2	2	2
4	3	2	2	3	-	2	2	-	-	-	1	2	2	2	2
avg	2.25	1.5	2	2.75	0	2.5	1.5	0	0	0	1	2.5	1.75	1.75	1.75

TEXTBOOKS

1. Rees, Andy "Genetically Modified Food: A Short Guide for the Confused". Pluto Press, 2006.
2. Ahmed, Farid E. "Testing of Genetically Modified Organisms in Food". Food Products Press, 2004.

REFERENCE

1. Halford, Nigel G. "Genetically Modified Crops". Imperial College Press, 2003.

FD3014

FUNCTIONAL FOODS AND NUTRACEUTICALS

**L T P C
3 0 0 3**

OBJECTIVES:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease

UNIT I INTRODUCTION AND SIGNIFICANCE

9

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoo chemicals and microbes in food, plants, animals and microbes.

UNIT II ANALYSIS OF PHYTOCHEMICALS

9

Qualitative and quantitative methods: phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, Chitin; Carotenoids - Factors affecting bioavailability, chemical and histochemical characterization of cell wall polysaccharides in almond seed in relation to lipid bioavailability.

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY

9

In vitro and In vivo methods for the assessment of antioxidant activity, Comparison of different In Vitro methods to evaluate the antioxidant, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

UNIT IV ROLE IN HEALTH AND DISEASE

9

Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and symbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

UNIT V SAFETY ISSUES

9

Health Claims, regulations and safety issues- International and national.

TOTAL: 45 PERIODS**Course Outcomes (COs)**

At the end of the course the students would have the knowledge to

1. Understand the basics of nutraceuticals and phytochemicals
2. Analyse the soluble component of food products using qualitative and quantitative methods
3. Evaluate the methods used for assess the activity of antioxidants
4. Apply and analyse the role of Nutraceuticals and Functional foods in health aspects
5. Apply the suitable food safety regulations in food industry sector for getting healthy food

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	2	2	-	-	-	-	1	2	2	-	2
2	3	2	3	3	3	3	-	-	-	-	1	3	2	-	2
3	2	2	3	3	3	3	-	-	-	-	2	3	3	-	3
4	3	3	1	2	3	2	-	-	-	-	1	2	2	-	2
5	2	2	3	2	1	2	-	-	-	-	2	2	1	-	3
avg	2.4	2.2	2.4	2.4	2.4	2.4	0	0	0	0	1.4	2.4	2	0	2.4

TEXT BOOKS

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

REFERENCES

1. Shi, John, FereidoonShahidi 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. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003

FD3015**INTRODUCTION TO MEAT, MARINE , POULTRY****L T P C****3 0 0 3****UNIT I INTRODUCTION TO MEAT INDUSTRY****9**

Scope of meat & meat products industry in India, Sources of meat and meat products in India, its importance in national economy; Effect of feed, breed and management on meat production and quality

UNIT II INTRODUCTION TO POULTRY**9**

Definition of Poultry, Importance of Poultry Farming, and Poultry development in India. Present status and future prospectus of poultry Industry. Origin of the chicken and Classification of Poultry based on Genetics utility. Classification of chicken as per international standards. Commonly Occurring Anti-Nutrients, and Antibiotics in Poultry Feed Ingredients and its Effect on Egg and

Meat Nutrition.

UNIT III INTRODUCTION TO SEA FOOD 9

Introduction, Seafood spoilage, Seafood hazards, Pre-mortem handling, Post-mortem handling.

UNIT IV SLAUGHTERING OF ANIMALS AND POULTRY 9

Common and commercially important meats; pre and post slaughter handling, meat inspection and grading; animal welfare and safety in slaughter plant; Factors affecting post-mortem changes, properties and shelf-life of meat; Meat quality evaluation; Mechanical deboning, meat tenderization.

UNIT V RECENT TRENDS IN MEAT PROCESSING 9

Types of Meat and its sources, composition, structure, of meat and meat products. Ante mortem handling, slaughtering of animals, Mechanical deboning, inspection and grading of meat. Post-mortem changes of meat. Color, flavors, microbiology and spoilage factors of meat and meat products.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand different variety of meats and its handling.
2. Familiarize with the concept of meat processing.
3. Get insights into basics of marine food processing.
4. Understand the basics of poultry processing.
5. Discuss egg processing and its related aspects.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	-	2	1	-	-	-	1	2	2	-	2
2	3	1	2	1	-	3	2	-	-	-	1	3	2	-	2
3	1	1	2	1	-	3	1	-	-	-	2	3	1	-	3
4	1	2	2	2	-	2	2	-	-	-	1	2	2	-	2
5	2	2	3	2	-	2	2	-	-	-	1	2	2	-	2
avg	1.8	1.6	2.2	1.6	0	2.4	1.6	0	0	0	1.2	2.4	1.8	0	2.2

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi, 1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology , Second Edition, AVI, Westport, 1977.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing , Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products, John Wiley & Sons Publishers, New York. 1985.

UNIT I INTRODUCTION

Types of Meat and its sources, composition, structure, of meat and meat products. Definition of muscle and Composition of muscle. Different types of stunning methods. Different types of slaughtering methods, Chemical and biochemical constitution of muscle - Factors reflected in specialized muscle function and constitution, The conversion of muscle to meat - Preslaughter handling, Death of the anima, ageing.

Introduction, Types and characteristics of poultry products, composition, nutritive value, calculation of nutritive value of poultry products, Poultry Meat Tenderness, Pale, Soft, and Exudative Poultry Meat. Poultry dressing - ante and postmortem examination. Transportation to slaughterhouse.

UNIT II SLAUGHTERING AND CUTTING

9

MEAT: Basic preparatory procedures (culmination, emulsification, pre-blending). Cured and smoked meats. Ante mortem handling, slaughtering of animals, modern abattoirs, Abattoir – Definition and construction. Slaughter house and its features. Mechanical deboning, inspection and grading of meat. Post-mortem changes of meat. Meat tenderization – natural and artificial.

POULTRY: Slaughterhouse Building and Facility Requirements, Slaughtering Equipment and Operations, Poultry Carcass Evaluation and Cutting, Official Control of Slaughterhouses and Processing Plants, Poultry Packaging, Food Production from the Halal Perspective.

UNIT III DIVERSIFIED POULTRY

9

Ducks and Geese – Introduction, Advantages, classification, Ducks rearing system; Quails – Origin and domestication, Advantages of Quail farming; Guinea fowls – Varieties and importance of Guinea fowl farming in India; Turkeys – Turkey farming in India, Varieties.

UNIT IV SPOILAGE AND TEST METHODS OF MEAT

9

Colour, microbiology and spoilage factors of meat and meat products, Factors affecting post-mortem changes, properties and shelf-life of meat. The spoilage of meat by infecting organisms – TEST METHODS: Physical, Chemical and microbiological testing of meat, Sensory evaluation

UNIT V EGGS

9

Structure, composition, nutritive value, calculation of nutritive value and functional properties of eggs, Reasons for dirty eggs — Remedies, Nutritional and Health Attributes of Eggs, Functional Properties of Egg Components in Food Systems; Estimation of External and Internal Quality of Chicken Egg — Factors affecting the quality of Eggs.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand and identify the specific processing technologies used for meat and marine products.
2. Familiarize with quality evaluation techniques of rmeat and marine products..
3. Interpret the changes in the composition of foods with respect to the type of processing technology used.
4. Aware of Feed, Breed Management on production and quality Get through Pre and Post slaughter handling techniques
5. Capable of detailed understanding the detailed process flow of value added products from poultry species.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	-	2	1	-	-	-	1	2	2	-	2
2	3	1	2	1	-	3	2	-	-	-	1	3	3	-	3
3	1	1	2	1	-	3	1	-	-	-	2	3	2	-	2
4	1	2	2	2	-	2	2	-	-	-	1	2	2	-	2

5	2	2	3	2	-	2	2	-	-	-	1	2	2	-	1
avg	1.8	1.6	2.2	1.6	0	2.4	1.6	0	0	0	1.2	2.4	2.2	0	2

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi,1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. Isabel Guerrero- Legarreta, “Handbook of Poultry Science and Technology”, Wiley, 2010.
4. Jhari Sahoo, “Textbook on Meat, Poultry and Fish technology”, Daya Publishing House, 2016.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processingll, Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.

FD3017

BYPRODUCTS IN MEAT PROCESSING

L T P C
3 0 0 3

UNIT I MEAT PRODUCTS

9

Flavours and Flavour Generation of Meat Products, Dried and Cured meat. Canned meat, Frozen meat, Cooked and Refrigerated meat, Meat Fermentation, Developments in Meat Bacterial Starters. By product utilization in meat industries.

UNIT II FISH BY PRODUCTS

9

Fish byproducts - production of fish meal, fish protein concentrate, fish protein hydrolyzate fish liver oil and fish silage; Production of chitin, chitosan; Production of non-food items from fish processing wastes.

Fishery by-products - Surimi- Introduction, fish muscle proteins, the surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products. Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysis (FPH)

UNIT III EGG PRODUCTS

9

Physical and Chemical changes in the stored Egg — Self life duration; Functional Properties of Egg; Egg Products — Egg Powder — Liquid Eggs — Restaurant Products; Industrial use of Eggs and Egg Products.

UNIT IV INGREDIENTS: PAST & FUTURE ROLE IN PROCESSED MEAT MANUFACTURE

9

PAST ROLE: Scientific modelling of blended meat products; Blood by-products as ingredients in processed meat, Utilisation of hydrocolloids in processed meat systems, Use of cold-set binders in meat systems.

FUTURE ROLE: Using natural and novel antimicrobials to improve the safety and shelf-life stability of processed meat products, The use of nutraceuticals in processed meat products and their effects on product quality, safety and acceptability Use of probiotics and prebiotics in meat products.

UNIT V MEAT ALTERNATIVES

9

History of meat alternatives, Plant based meat, Market for plant-based alternatives, Meat alternatives health benefits.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the different by-products in different meat industries.
2. Explain about the waste product utilization in meat industry.
3. Assess the process technology for different meat by-products.

4. Develop plant based meat and meat alternatives.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	1	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	1	2
3	3	2	2	2	3	3	1	-	-	-	1	3	3	1	3
4	3	3	2	3	3	2	2	-	-	-	1	2	1	1	2
avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	1	2.25

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi, 1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology , Second Edition, AVI, Westport, 1977.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing , Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products, John Wiley & Sons Publishers, New York. 1985.

FD3018

PRESERVATION TECHNOLOGY OF EGGS, MEAT, POULTRY AND SEAFOOD

**L T P C
3 0 0 3**

UNIT I MEAT PRESERVATION

9

The storage and preservation of meat: Preservation of meat- chilling, freezing, curing, smoking, canning, dehydration, irradiation, freeze drying, antibiotics, microwave, chemicals. Moisture control, Direct microbial inhibition.

UNIT II FISH PRESERVATION

9

Canning - Principles of canning, classification based on pH groupings, effect of heat processing on fish, storage of canned fish, pre-process operations, post process operations, cannery operations for specific canned products.(Tuna,Mackerel,Sardine).

Curing- Salting , Marinating and Smoking (smoke production , smoke components, quality, safety and nutritive value of smoked fish, processing and equipment, pre-smoking processes, smoking process control) operations.

UNIT III POULTRY PRESERVATION I - REFRIGERATION AND FREEZING

9

Biochemical Changes During Onset and Resolution of Rigor Mortis Under Ambient Temperature, Physicochemical Changes During Freezing and Thawing of Poultry Meat, Low-Temperature Storage of Poultry, Engineering Principles of Freezing, Quality of Frozen Poultry, Quality of Refrigerated Poultry, Refrigeration Equipment and Operations, Freezing Equipment and Operations, Refrigeration and Freezing in Industrial Food Facilities (Hospitals, Restaurants, Factories).

UNIT IV POULTRY PRESERVATION II – HEATING, DRYING, CHEMICALS AND IRRADIATION **9**

Heating, Drying, and Chemicals, Irradiation.

UNIT V EGG PRESERVATION **9**

Preservation of eggs - Refrigeration and freezing, thermal processing, dehydration, coating.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the different by-products in different meat industries.
2. Explain about the waste product utilization in meat industry.
3. Assess the process technologies for different meat by-products.
4. Develop plant-based meat and meat alternatives.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	2
3	3	2	2	2	3	3	1	-	-	-	1	3	1	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	3	-	1
avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.75

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi, 1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology , Second Edition, AVI, Westport, 1977.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing , Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products, John Wiley & Sons Publishers, New York. 1985.



FD3019

MARINE FOODS PROCESSING

L T P C

3 0 0 3

9

UNIT I INTRODUCTION

A history of seafood industry; Types of fish – major cultured species, underutilized fishery species; Composition, Major and minor nutrients present in sea food, nutrient intake recommendations, nutrition labelling for sea food , structure and spoilage factors of fish. Techniques for harvesting fish; Post harvest quality changes, post-harvest losses, methods for assessing and preventing losses.

UNIT II FISH PROCESSING

9

Post-mortem changes in fish. Handling and transportation of fish. Bacteriology of fish, Shellfish Handling and primary processing ; Chilling of fish, Freezing and Individual quick freezing, Heat processing of Fish; Radiation processing of fish and fish products. Drying - Traditional chimney kiln, modern mechanical fish smoking kiln of fish.

Overview on – Crabs, Lobsters, Prawns, Shrimps.

UNIT III FISH FERMENTATION**9**

Introduction to fermentation in Food Technology; ;Lactic Acid Fermentation; Traditional salt/fish fermentation; Classification of fermented fish; Future trends in fish fermentation technology.

UNIT IV FISH WASTE MANAGEMNET**9**

Introduction , Treatment methods – Hydrolysis, Bioremediation, Anaerobic treatment, Filtration/Screening. Uses of fish waste – Animal feed, Biogas, Natural pigments, In food industry, Inputs and outputs in fisheries.

UNIT V SEaweEDS AND ITS APPLICATION**9**

Introduction to seaweeds, Chemical composition; Saccharification of seaweeds; Lactic Acid fermentation of sea weeds; Applications of fermented products in food; Future prospects of seaweed fermentation.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Able to be aware of Feed, Breed Management on production and quality Get through Pre and Post slaughter handling techniques
2. Capable of detailed understanding the detailed process flow of value added products from marine species
3. Explain about the waste product utilization in fish industries.
4. Assess the process technologies for different fish by-products.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	2
3	3	2	2	2	3	3	1	-	-	-	1	3	3	-	3
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	2
avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2.25	0	2.25

TEXTBOOKS:

1. Venugopal, V. "Seafood Processing: Adding Value through Quick Freezing, Retort able Packaging and Cook-Chilling & other methods" (Food Science and Technology Vol. 13) , CRC press, 2006.
2. Se-Kwon Kim, "Seafood Science-Advances in chemistry, technology and its applications", CRC press, 2015. Ioannins S boziaris, "Seafood Processing – Technology, Quality and Safety", Wiley Blakwell, 2014.

FD3020 TECHNOLOGY OF PACKING MEAT AND MARINE PRODUCTS**L T P C
3 0 0 3****UNIT I INTRODUCTION****9**

Introduction, Packaging materials and its functions – Metal containers, Ethylenic and Non – ethylenic Thermoplastic, Package design and packaging equipment's, Packaging safety,

UNIT II PACKAGING OF COOKED MEATS AND MUCLE BASED PROCESSED FOODS**9**

Cooked meats, Packaging requirements for muscle-based cooked food products, Consumer trends in food packaging, choosing packaging materials for cooked meat products, Packaging materials and forms used on cooked meat and muscle-based , convenience-style food products – Wrapping, Film packing, Tray packing, Vacuum packaging, MAP.

UNIT III PACKAGING OF FISH AND FISHERY PRODUCTS**9**

MAP principles and importance for packaging fresh fish, Non-microbial effects of MAP, Effects of MAP on - fish spoilage, microbial safety of fish products, Application of MAP on fish and fishery products.

UNIT IV PACKAGING OF POULTRY PRODUCTS**9**

Packaging of Egg and Egg Products, Over-wraps, Tray with over-wraps, Shrink flim with over-wraps. Vacuum packaging, MAP.

UNIT V DEVELOPMENTS AND RECENT ADVANCES IN THE USE OF PACKAGING MATERIALS FOR MEAT, FISH AND POULTRY**9**

Over-wrapping / stretch-wrapping, Vacuum packaging, MAP, Boil and steam cooking packaging, Retort sterilized packaging, Smart packaging, Packaging with enclosed free-oxygen scavenging agent – Future trends.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Demonstrate the packaging functions and evaluate its performance in food preservation of meat products.
2. Utilize the various food grade packaging materials in meat industries.
3. Comprehend the functions of advanced packaging methods for meat, fish and poultry by-products.
4. Apply the packaging and labelling regulations while designing the packaging system for meat, marine and poultry products.

C O 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	PSO 3
1	2	1	2	2	2	2	1	-	-	-	1	2	2	2	-
2	3	2	2	3	3	3	2	-	-	-	1	3	2	2	-
3	3	3	2	2	3	3	1	-	-	-	1	3	1	2	-
4	3	2	2	3	2	2	2	-	-	-	1	2	2	2	-
avg	2.75	2	2	2.5	2.5	2.5	1.5	0	0	0	1	2.5	1.75	2	0

TEXTBOOKS:

1. J.P.Kerry and J.F.Kerry., Processed meats – Improving, safety, nutrition and quality., Woodhead Publishing Limited., 2011.
2. Ioannis S.Bozaris., Seafood Processing – Technology, Quality and Safety. IFST Advances in Food Science, Wiley., 2014.
3. Jhari Sahoo., Textbook on Meat, Poultry and Fish Technology, Astral International Private Limited., 2016.

FD3021 QUALITY, LAWS AND REGULATIONS IN MEAT INDUSTRIES**L T P C
3 0 0 3****UNIT I MEAT****9**

Physical Sensors for Quality Control during Processing, Sensory Evaluation of Meat Products, Detection of Chemical Hazards, Microbial Hazards in Foods: Food-Borne Infections and

Intoxications, Assessment of Genetically Modified Organisms (GMO) in Meat Products by PCR, HACCP: Hazard Analysis Critical Control Point, Quality Assurance. Effects of feed, breed and environment on production of meat animals and their quality Meat Quality-color, flavor, texture, Water-Holding Capacity(WHC),Emulsification capacity of meat

UNIT II FISH 9

National and International Regulations, Standards, Quality Control and Marketing of Fish and Fish Products; Grading Standards of Fish; Quality assessment by Chemical, Physical and sensory methods. Risk characterization.

UNIT III POULTRY 9

Chemical Residues: Pesticides and Drugs (β -Agonists and Antibiotics), Factors Affecting Microbial Growth in Fresh Poultry, Basic Principles of the HACCP System in the Poultry Industry, HACCP in Poultry Slaughterhouses, Online Inspection Poultry-Related Foodborne Disease, Overview of Poultry Processing and Workers' Safety, Poultry-Processing Industry and eTool. GRADING OF POULTRY MEAT - Grade — I, Grade — II

UNIT IV EGGS 9

The Nutritive value of Eggs after cooking ; Quality identification of shell eggs; Factors affecting egg quality and measures of egg quality. Selection of types of Detergents and Sanitizers for controlling Egg Quality and Poultry Products

UNIT V LAWS AND REGULATIONS 9

Need and various aspects of food testing and notified NABL, referral and reference labs; List of notified reference laboratories, referral laboratories and state/ public food laboratories in India; Food safety regulations and certifications; International organization for standardization (ISO); Codex alimentarius commission; Food safety and standards authority of India (FSSAI); Good manufacturing practices and standard operating procedures.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Aware of the handling of sample from processing till packaging.
2. Aware of all the laws and regulations in supply chain.
3. Understand the food safety regulations and standards for different meat products.
4. Apply the suitable food safety regulations in meat industry sector for getting quality food product.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	2	1	-	-	-	-	2	2	-	2
2	3	3	2	3	-	3	2	-	-	-	-	2	2	-	2
3	2	2	3	2	-	3	1	-	-	-	-	3	3	-	3
4	3	3	2	3	-	2	2	-	-	-	-	2	2	-	2
avg	2.5	2.25	2	2.5	0	2.5	1.5	0	0	0	0	2.25	2.25	0	2.25

TEXTBOOKS:

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi,1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. The food safety information handbook by Cynthia A. Robert, 2009

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat ProcessingII, Woodhead Publishing Limited, England (CRC Press), 2002.

2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979.

FD3022

FAT AND OIL TECHNOLOGY

**L T P C
3 0 0 3**

COURSE OBJECTIVE

- To understand the physicochemical properties of fats and oils
- To study the different methods of extractions and refining processes of various fats and oil in food processing industries.

UNIT I PHYSICAL AND CHEMICAL PROPERTIES 9

Introduction of fat and oils, chemical composition; physico-chemical properties; functions of oil human body-fatty acids -double bond and their position in oil-Geneva type classification-sources-vegetable oils-productions -oil content-coconut, palm, peanut, rice bran, sesame, mustard and sunflower seeds oils-physical and chemical properties of fats and oils-chemical reactions of oil-hydrolysis -hydrogenation, oxidation and polymerization.

UNIT II EXTRACTION METHODS 9

Oil extraction methods-mechanical expression-ghani, power Ghani, rotary, hydraulic press, screw press, filter press- principle of operation and maintenance-solvent extraction process-steps involved, batch and continuous-continuous solvent extraction process, oil quality and standard quality regulations, shelf life and oxidative stability of oil.

UNIT III REFINING OF OILS 9

Scope and importance of oil refining; characterization- degumming, deacidification, bleaching of oil, decolourising agents, deodorization process and winterization process. Hydrogenation of oil-selectivity-catalyst-vanaspati, ghee and margarine. Characterization and types of fat replacers and their specific uses. Processing of other sources of edible oils and fats like rice bran, maize germ etc.

UNIT IV PHYSIOCHEMICAL PROPERTIES OF FATS AND OILS 9

Physiochemical properties of fats and oils. Instrumental analysis of fats and oils – Gas chromatography, FTIR, GC-MS, NMR & NIR spectroscopy. Edible use of fat and oils in food industry.

UNIT V INDUSTRIAL APPLICATIONS AND QUALITY STANDARDS 9

Industrial applications of fats and oils-quality regulations-manufacture of soap, candle =, paints and varnishes-ISI and Agmark standards-site selection for oil extraction plant -safety aspects -HACCP standards in oil industries.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the processing technologies used for fats and oils
2. Identify the edible use of fats and oils in food industries.
3. To apply knowledge to manufacture of designer fats.
4. Analysis the fatty acid components by using various instrumentation.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	1	2	2	1	-	-	-	1	2	1	2	-
2	3	3	2	2	3	3	2	-	-	-	1	3	2	3	-

3	3	2	2	2	3	2	1	-	-	-	2	3	2	1	-
4	3	3	2	1	3	1	2	-	-	-	3	2	3	2	-
avg	2.75	2.25	1.75	1.5	2.75	2	1.5	0	0	0	1.75	2.5	2	2	0

TEXTBOOKS/ REFERENCES:

1. Harry Lawson, "Food oils and Fats - Technology, Utilization and Nutrition", CBS Publishers and Distributors, New Delhi, 1997.
2. Gunstone F.D., "Oils and Fats in Food Industry", Blackwell Publishing, United Kingdom, ISBN – 13: 9781405171212, 2008.
1. Gunstone F.D., "Vegetable Oils in Food Technology: Composition, Properties and Uses", 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681, 2011.

FD3023 PROCESSING OF CEREALS, OIL SEEDS AND PULSES

L T P C
3 0 0 3

COURSE OBJECTIVE

- To provide the basic understanding of cereals, oilseeds and pulses after harvesting.
- To impart knowledge about the new technologies in oil seed processing.
- To make students able to implement their knowledge about detailed manufacturing technologies of cereals, oilseeds and pulses consumed in daily life in food industries.

UNIT I OIL SEED AND NUTS

9

Chemical composition and characters of oil seed and nuts. Anti-nutritional factors, removal of anti-nutritional methods. Post-harvest technology of oils seeds. Handling, drying, storage, grading, pre-treatments, cleaning, dehulling, solving problems in size reduction and flaking.

UNIT II OIL SEED PROCESSING

9

Oil seeds processing, Sesame, Coconut, Groundnut, Mustard, Soyabean, Sunflower, Safflower. Oil seeds extraction traditional methods, New Technologies in oil seed processing, Calculation of extraction efficiency, new technologies in oilseed processing, Modification of oil seed process- Hydrogenation, chemical process- interesterification, dry fractionation, utilizations of oil seed meals of different food use. Desolventization and refining of oils; degumming, neutralization bleaching, filtration, deodorization.

UNIT III PROCESSING OF WHEAT AND RICE

9

Wheat-types, milling, flour grade, flour treatments-bleaching, maturing, types of flour for baking technology of dough development, Marconi products. Oil extraction- mechanical expression of oil-Ghani, power, Ghani, rotary, hydraulic press, screw press expellers, filter press.; solvent extraction process. Other source of edible oil like rice bran, corn germ oil.

UNIT IV PROCESSING OF CEREALS

9

Corn-milling (wet and dry), cornflakes. Barely-Milling, Malting, Processing of beer. Oats- Milling (oatmeal, oat flour & oat flakes). Sorghum, Pearl Millet, finger millet-Milling.

UNIT V PROCESSING OF MAIZE

9

Structure-composition of maize-milling methods-Pre-cleaning-cleaning equipment -degermination and dehushing -Dry milling of maize-wet milling -flow chart-Products of milling-Flour-Semolina-Brewer' grits etc and their applications.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Explain the structure of the cereal grain, and the components of commercial flour
2. Demonstrate the cereal grain production and quality categorisation systems
3. Interpret the chemical and biological structure of pulses.
4. Comprehend different processing of legumes and its by product
5. Identify chemical composition of oilseed and demonstrate the oil extraction process

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	-	-	-	1	2	2	-	2
2	3	3	3	3	3	3	3	-	-	-	1	3	2	-	2
3	3	2	2	2	2	3	3	-	-	-	2	3	3	-	3
4	3	3	3	3	3	3	3	-	-	-	1	2	2	-	2
5	2	3	3	3	3	3	3	-	-	-	1	2	2	-	2
avg	2.6	2.6	2.6	2.6	2.6	3	3	0	0	0	1.2	2.4	2.2	0	2.2

TEXTBOOKS/REFERENCE

1. Kent, Technology of Cereal, 5th ED. Pergamon Press, 2003.
2. Chakraborty., Post-Harvest Technology of Cereals, Pulses and oilseeds, revised ed., Oxford & IBH Publishing Co. Pvt Ltd, 1988.
3. Marshall, Rice Science and Technology, Wadsworth Ed., Marcel Dekker, New York, 1994.

FD3024

ENRICHMENT AND FORTIFICATION OF CEREALS AND OILS

**L T P C
3 0 0 3**

COURSE OBJECTIVE

- Impart the knowledge on the importance of enrichment and fortification of cereals and oils.
- To understand the role of micronutrients on human health.

UNIT I INTRODUCTION

9

Food fortification; Rationale and methods, advantages, disadvantages of food fortification, large scale food fortification, Biofortification, point of use or home fortification.

UNIT II RICE

9

Enrichment-need -methods; processed foods from rice- breakfast cereals, flakes, puffing, canning, instant rice and other processed rice products.

UNIT III MAIZE PROCESSING

9

Machinery and equipment -Acid Hydrolysis, Enzyme Hydrolysis-Processing for value added products -dextrose, maltodextrin and other products. Value addition and food fortification of cereals- Exploring food fortification potential of neglected legume and oil seed crops for improving food nutrition security- among smallholder farming communities. Protein fortification of corn tortillas with oilseeds flours.

UNIT IV BIOFORTIFICATION IN PULSES

9

Introduction; Role of micronutrients on human health; Nutritional composition of pulse; Health Benefits of pulses; Interventions for Biofortification of pulses- Breeding Nutritional Enrichment in pulse crops through Biofortification; Advantages; Future challenges in Biofortification.

UNIT V**9**

Bread enrichment with oilseeds; Novel breads fortified through oilseed and nut cakes; Protein fortification of corn tortillas with oilseed flours; Effect of oilseed flour addition on the chemical characteristics of wheat chapati; Fortification of cereals and cereal products with proteins and amino acid.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Learn about food fortification of cereals and its applications.
2. Understand the need and methods of food enrichment
3. To improve the nutritional quality of the food and provide a community health benefit with minimal risk to health.
4. Aware of the role of micronutrient fortification in human health.

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	PSO 3
1	2	1	2	2	-	2	2	-	-	-	2	2	2	2	-
2	3	3	2	3	-	3	3	-	-	-	3	3	1	1	-
3	2	2	3	2	-	3	1	-	-	-	1	3	2	2	-
4	3	3	2	3	-	2	2	-	-	-	2	2	3	3	-
Avg.	2.5	2.25	2.25	2.5	0	2.5	2	0	0	0	2	2.5	2	2	0

TEXTBOOKS/REFERENCES

1. Unmed Sing, C S Praharaj, S S Singh, N P Singh , Biofortification of food crops, ISBN; 8132227166, Technology & Engineering
2. De Lamo, B., & Gómez, M. (2018). Bread enrichment with oilseeds. A review. *Foods*, 7(11), 191.

FD3025**MILLING AND FRACTIONATION TECHNOLOGIES****L T P C
3 0 0 3****OBJECTIVE**

The course aims to

- To create awareness about the processing of major cereals and pulses.
- To gain knowledge on milling process and fractionation technologies.

UNIT I PROCESSING METHODS**9**

Concept of primary, secondary and tertiary processing; methods and types of milling – dry and wet milling; rice, wheat, maize and millet. Cereal Processing & milling -dry milling (wheat and rye), pearling (rice, oat & barely), Wet milling (corn and wheat) & malting (Barely, corn and wheat).

UNIT II RICE PROCESSING**9**

Paddy processing and rice milling; conventional milling; modern milling; milling operations, milling machines, milling efficiency. Quality characteristics influencing final milled products. Milling of rice types; huller mill, sheller-cum-cone polisher mill. Modern rice milling unit operation-dehusking, paddy separating, polishing and grading. Factors affecting rice yield during milling.

UNIT III CORN**9**

Corn milling – dry and wet milling, starch and gluten separation, milling fractions and modified starches. Criteria in assessment of milling process.

UNIT IV WHEAT PROCESSING**9**

Wheat milling process-flour milling -soft and durum wheat processing. Milling of legumes- home

scale, cottage scale and modern milling methods, milling quality, efficiency and factors affecting milling, problems in dhal milling industry.

UNIT V PULSE MILLING

9

Need for pulse milling -unit operations of pulse milling-domestic and commercial scale pulse milling methods -Dry and wet milling, Improved milling method. Pulse milling machineries-dehusking in pulse pearler-splitting of pulse in pulse splitter-Mini dhal mill -working principle-advantage and disadvantage-pulse milling efficiency- Grinding of split pulses-pulse flour products - their applications and equipments used. Cereal bran fractionation: Processing techniques for the recovery of functions components and their applications to the food industry.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Know about paddy processing and rice milling equipment which will help them entrepreneurial skills.
2. Study the processing and milling of corn & wheat which will promote gainful employment.
3. Develop skills needed in the milling of pulses.
4. Apply the knowledge of primary, secondary and tertiary processing methods of cereals, pulses and millets.

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	PSO 3
1	2	1	2	2	-	2	1	-	-	-	-	2	2	-	2
2	3	2	2	3	-	3	2	-	-	-	-	3	3	-	2
3	3	2	3	2	2	3	1	-	-	-	-	3	2	-	3
4	3	3	2	3	1	2	2	-	-	-	-	2	2	-	1
Avg.	2.75	2	2.25	2.5	0.75	2.5	1.5	0	0	0	0	2.5	2.25	0	2

TEXT BOOKS

1. KM. Sahay and KK. Singh. Unit operations of Agricultural Processing, Vikash Publishing house PVT Ltd. Delhi, 2014.
2. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 2014.

REFERENCE BOOKS

1. Samuel A .Matz: "The Chemistry and Technology of Cereals as Food and Feed", Chapman and Hall, 1992.
2. Bernard Godon and Claude Willm, "Primary Processing of Cereals" Berns and Noble Publishers, 1994.
3. Karel Kulp and Joseph P Pante, "Handbook of Cereal Science and Technology", Marcel Dekkar, USA, 2000.

FD3026

TECHNOLOGY OF MALTING AND BREWING

L T P C
3 0 0 3

COURSE OBJECTIVE

The course aims to

- To provide information about importance of malting and brewing in food industry.
- To impart knowledge about the changes occurring during processing of non-alcoholic beverages.

UNIT I INTRODUCTION

9

Introduction to malting. Scope and significance of food processing; malting production:

Introduction to brewing, history of brewing; Scope and importance of food processing; raw materials barely; hops; water, yeast. Adjuncts for beer production; maize, rice, millet, wheat sugar.

UNIT II BARELY 9

Barely production and trade, composition and structure of barely. Preparation and storage of barely for malting, suitability of different cereals for malting, characteristics of barely for malting and brewing, steeping techniques, germination of barely, structural characteristics, enzymatic and chemical changes during malting, role of gibberellic acid in malting, Techniques of malting composition of malt, malting of wheat and other cereals.

UNIT III QUALITY CONTROL 9

Quality evaluation of malt, special malts, significance of water quality in brewing process mashing; changes during mashing, methods of mashing, treatment of cereals used as adjuncts, properties and complications of using adjuncts of different sources.

UNIT IV APPLICATIONS OF MALT IN FOOD 9

Baking, infant food etc. Brewing operations, constituents of hops, brewing adjuncts. Beer quality-flavor, taste, alcohol content, chemical constituent etc.

UNIT V 9

Applications of Brewery-By Products in the food industry. Advantages and Disadvantages of Malting and brewing technology. Applications of enzymes in the malting process.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the technology of production of alcoholic beverages.
2. Assess the knowledge about quality control techniques of beverages.
3. Apply the malting process in food processing industry.
4. Implement the food laws and regulations of beverages

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	PSO 3
1	2	3	2	2	2	2	1	-	-	-	1	2	2	2	-
2	3	3	2	3	3	3	2	-	-	-	2	3	3	3	-
3	2	2	3	1	2	3	1	-	-	-	2	3	2	2	-
4	1	2	1	3	3	2	2	-	-	-	1	2	1	1	-
Avg.	2	2.5	2	2.25	2.5	2.5	1.5	0	0	0	1.5	2.5	2	2	0

TEXTBOOKS:

1. M.J. Lewis and T.W. Young 'Malting and Brewing Science Vol. I', Springer Science & Business Media, Germany.
2. M.J. Lewis and T.W. Young 'Malting and Brewing Science Vol. II', Springer Science & Business Media, Germany.

FD3027

BY PRODUCTS MANAGEMENT

**L T P C
3 0 0 3**

COURSE OBJECTIVE

- To study about the by products obtained during processing along with their uses.
- To acquire the skills of manufacturing for making food products.
- To gain knowledge about future developments in food products.

UNIT I INTRODUCTION**9**

Supply chain of food grains, Hydrothermal treatment of grains; Products and By-products of cereals and millets: infant foods from cereals and millets, cereal based fermented products, breakfast cereal foods -flaked, puffed, expanded, extruded and shredded products etc.

UNIT II SPECIALITY OIL PRODUCTS**9**

Margarine, mayonnaise, salad dressing, fat substitutes etc. chemical adjuncts: lecithin's and GMS; Nutritional food mixes from oilseeds; processing of oilseeds for food use, protein rich foods, protein enriched cereal food.

UNIT III**9**

Food applications of by-products of pulses and oils milling and their value addition. Packing of pulses and their products. Utilization of oil seed meals for food uses i.e., high protein products like concentrates, isolates. Processing of deoiled cakes in to proteins concentrates and isolates. Textured protein products, Functional protein preparations.

UNIT IV**9**

Cereal, pulses and oilseeds Technology

Rice milling, pulse milling, wheat milling-oil extraction-Methods of manufacture of Bread -different processes of manufacture-type of breads-buns, biscuits, cakes and cookies -Pasta Products-Tortilla-Method of manufacture. Innovative products from pulses and oilseeds.

UNIT V**9**

Utilization of by -products-chemical composition and nutritional value, consumption, value addition-suitability of flour required for different products; Traditional process technique-parching, puffing, popping, roasting, frying, flaking, fermentation, extraction process. Processed corn products (popped, corn, cornflakes). Parched and snack products. Future developments in products and processes.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand utilization of by products from cereals
2. Get exposure to the preparation of products from cereals, pulses and oilseeds.
3. Application of practical knowledge of pulse milling and oil extraction techniques.
4. Explain about future developments in food products.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	2	-	2	1	-	-	-	1	2	2	-	2
2	3	3	3	3	-	3	2	-	-	-	1	3	3	-	2
3	2	2	2	2	-	2	1	-	-	-	1	3	2	-	2
4	3	3	2	3	2	2	2	-	-	-	2	2	1	-	1
Avg	2.5	2.5	2	2.5	0.5	2.25	1.5	0	0	0	1.25	2.5	2	0	1.75

TEXTBOOKS/REFERENCES

1. N.L. Kent and A.D.Evans: Technology of Cereals (4th Edition) Elsevier Science (Pergaman), Oxford, UK, (1994).
2. George E Inglett: Maize-Recent Progress in Chemistry and Technology Academic Press, London (1982).
3. Ruth H. Matthews: Pulses – Chemistry, Technology and Nutrition Mercel Dekkar USA (2000).
4. Edible oil processing, 2nd Edition, Wolf Hamm (Editor), Richard J. Hamilton (Editor), Gijs Calliauw (Editor), ISBN:978-1-4443-3684-9, 2013.

5. Technology of oilseeds processing, Oils & Fats and Refining, by EIRI Board (Author), 2011.
6. The Chemistry and Technology of Edible Oils and Fats and their High Fat products, By G. Hoffmann, Academic Press, 2013.

FD3028 QUALITY, LAWS AND REGULATIONS IN GRAIN PROCESSING INDUSTRIES L T P C 3 0 3

UNIT I 9
Objectives, importance and functions of quality control, Importance of safety in marketing of grain and grain products - domestic and export markets. International organizations: ISO, CAC, WTO, USFDA, Codex, EIC. National organizations: FSSAI, BIS, CCFS, Agmark and APEDA, Good Laboratory Practices.

UNIT II 9
Regulations of food safety and quality - Food laws - Food Safety and Standards Act (FSSAI) and standards of foods, Packaged Commodities Rules, QA Audit, HACCP, GMP, standard sanitary procedures- GAP, GFSI; function and roles of USFDA, USDA and EPA, ASTA

UNIT III 9
Quality Control Measures - International standards for export and quarantine requirements for export of food products (raw and processed). Adulteration and its types, sensory and instrumental analysis, rules and regulations for waste disposals. Sampling and specification of raw materials and finished products. Statistical quality

UNIT IV 9
Assessing Grain Quality - Physical Aspects, Variety, Growth and Storage Conditions, Chemical Composition. Managing Grain Quality - Grain Receival, Segregation and Storage, Processing, Nutrition and Intolerances. Sampling Devices, Human Visual Analysis, Bulk Density (Test Weight) ,Moisture Content , Sieves and Dockage Tester, Protein Content, Wheat Hardness, ELISA Test Kits for Mycotoxins.

UNIT V 9
Falling Number , NIR Spectroscopy, Digital Imaging, Hyperspectral Imaging, ELISA Test Kits for Insect Activity ,PCR-Based Detection Methods ,Electronic Noses,X-ray Imaging for Internal Insects.

TOTAL :45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. At the end of the course the students will be able to understand the importance of quality control of grain
2. Understand the various national and international laws & regulations involving in grain quality control
3. Understand the traditional and new technologies in involving in quality control
4. Implement the food laws and regulations of beverages

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	2	2	2	1	-	-	-	1	2	-	1	2
2	3	3	2	3	3	3	2	-	-	-	2	3	-	2	3
3	2	2	3	1	2	3	1	-	-	-	2	3	-	3	2
4	1	2	1	3	3	2	2	-	-	-	1	2	-	2	1
Avg	2.5	2	2.25	2.5	2.5	1.5	0	0	0	1.5	2.5	0	2	2	2.5

TEXTBOOKS:

1. Inteaz. A, Food Quality Assurance: Principles and Practices, Taylor and Francis, 2014
2. Andres V J, Quality Assurance for the Food Industry: A Practical Approach, CRC Press, 2004
3. Manoranjan K, Food analysis and Quality control, Kalyani Publishers, 2002
4. David K, Sensory Analysis for Food and Beverage Quality Control: A Practical Guide, Woodhead Publishing Ltd, 2010

FD3029

HIGH PERFORMANCE COMPUTING

L T P C
3 0 0 3

OBJECTIVES

- This course will facilitate students to understand parallel processing, parallel programming and languages.

UNIT I PARALLEL PROCESSING FUNDAMENTALS 9

Parallel Processing Concepts - Levels of parallelism - task, thread, memory, function; Models (SIMD, MIMD, Dataflow Models etc), Architectures- multi-core, multi-threaded.

UNIT II PARALLEL PROGRAMMING MODELS 9

Parallel Programming and Multiprogramming, Programming Models in high performance computing architectures – Shared memory and Message passing paradigms - Fundamental Design Issues in Parallel Computing – Synchronization - Interconnect, Communication, Memory Organization Memory hierarchy and transaction specific memory design - Thread Organization.

UNIT III PARALLEL PROGRAMMING LANGUAGES 9

Parallel Programming Languages – Overview, OpenMP, History of GPUs leading to their use and design for HPC, Introduction to the GPU programming model and CUDA, host and device memories, Basic CUDA program structure, kernel calls, threads, blocks, grid, thread addressing, predefined variables

UNIT IV CUDA 9

CUDA - example code: vector and matrix addition, matrix multiplication, Using Windows and Linux environments to compile and execute simple CUDA programs, Linux make files, Timing execution time, CUDA events, Host synchronization

UNIT V BIOINFORMATICS AND PARALLEL COMPUTING 9

Bioinformatics and Parallel Computing- Bioinformatics Applications, Recent developments in Computational Biology and Nanotechnology and its impact on HPC

TOTAL : 45 PERIODS

COURSE OUTCOME

At the end of this course students would be expected to learn parallel computing

REFERENCES

1. Highly Parallel Computing", by George S. Almasi and Alan Gottlieb
2. Advanced Computer Architecture: Parallelism, Scalability, Programmability, by Kai Hwang, McGraw Hill 1993
3. CUDA by Example- An Introduction to General-Purpose GPU Programming by Jason Sanders and Edwards Kandrot Addison-Wesley, 2011.
4. "Parallel Computer Architecture: A hardware/Software Approach", by David Culler Jaswinder Pal Singh, Morgan Kaufmann, 1999.
5. Jeffrey S. Vetter (Editor), Contemporary High Performance Computing: From Petascale toward Exascale (Chapman & Hall/CRC Computational Science) CRC Press, 2013
6. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing, CRC Press, 2011
7. Wagner, S., Steinmetz, M., Bode, A., Müller, M.M. (Eds.), High Performance Computing in Science and Engineering, Garching/Munich, Springer Verlag, 2010

OBJECTIVES

The course aims to

- Impart an understanding on the microstructural and molecular basis of food materials.
- Emphasize the formation and structure of food biopolymers.
- Deliver the technologies for characterization of engineered/ structured food materials

UNIT I INTRODUCTION**9**

Fundamentals of food materials, Molecular basis of food materials, Observation of materials at various size ranges and size-property relationship, The Composite Structure of Biological Tissue, Amorphous and crystalline structures of materials, Gel structures of food materials, Interfacial properties of the food materials.

UNIT II MICRO TO MACRO LEVEL STRUCTURES OF FOOD MATERIALS**9**

Microstructure definitions, Measurement of microstructures/nanostructures, The relationship between structure and quality, Microstructure and emulsions, Fibrous Composites, Visualisation of surface structures, Interfacial assembly of food materials, The dynamic interface, Phase and state transitions.

UNIT III FOOD GELS**9**

Introduction to food biopolymers, Rheology of food gels: yielding and gelling soft matter, Formation and structure of biopolymer network gels, Formation and structure of micro- and nano-gel particles, Structure–rheology relationships of food gels and food gel structures.

UNIT IV FOOD MATERIAL CHARACTERIZATION**9**

Introduction, Material Characterization Techniques; Nuclear Magnetic Resonance (NMR), Fourier Transform Infra-Red (FT-IR), X-ray powder diffraction, Small angle neutron & X-ray scattering (SANS and SAXS), Confocal microscopy, Scanning electron microscopy, Atomic Force Microscopy (AFM).

UNIT V FOOD MATERIAL ENGINEERING**9**

Food structure and bio-accessibility of nutrients, Effects of Processing Technologies on Food Material, Properties, Technologies for protection and delivery of nutrients, State Diagrams of Food Materials, Probing food structure, Food design based on the supplemented diagram, Design of foods and encapsulation systems, Food Nanoparticles: Formation, Properties and Applications.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Explain the basic terms in food material engineering.
2. Understand the microstructural and molecular basis of food materials.
3. Acquire knowledge to the formation and structure of food biopolymers.
4. Interpret the technologies for characterization of engineered/ structured food materials

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	2	-
2	3	3	2	3	3	3	2	-	-	-	1	3	2	2	-
3	3	2	2	2	3	3	1	-	-	-	2	3	1	2	-
4	3	3	2	3	3	2	2	-	-	-	1	2	2	2	-
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1.25	2.5	1.75	2	0

TEXTBOOKS/REFERENCES

1. Bhesh Bhandari & Yrjö H. Roos. "Food Materials Science and Engineering" Wiley-Blackwell Publishing, 2012.
2. José Miguel Aguilera & Peter J. Lillford, "Food Materials Science - Principles and Practice", Springer New York, 2008.
3. Alexandru Mihai Grumezescu & Alina Maria Holban, "Handbook of food bioengineering" Elsevier Science, 2018.
4. Charis Michel Galanakis, "Food Structure and Functionality" Elsevier Science, 2020.

FD3031

FOOD STRUCTURING TECHNIQUES

L T P C
3 0 0 3

OBJECTIVES

The course aims to

- Introduce the techniques of developing structured food products.
- Comprehend the structure development in various food matrices.
- Evaluate the technical and functional performance of structured food materials.

UNIT I INTRODUCTION

9

Nature of food structure, Food structure development, Role of hydrocolloids and proteins in food structure development, making of structured foods, Destruction, destabilization and deformation of food matrix, Application of materials science in food design and development of engineered food materials, the systematic approach to food engineering systems (SAFES), Complex Disperse System (CDS) formalism, Top-down and Bottom-up strategies of constructing food matrix. Modelling and Computer Simulation Approaches to Understand and Predict Food Structure Development.

UNIT II TECHNIQUES FOR FIBROUS STRUCTURE FORMATION

9

Cultured meat, Mycoprotein, Wet spinning, Electrospinning, Extrusion, Mixing of proteins and hydrocolloids, Freeze structuring, Shear cell technology.

Food Printing: 3D food printing; Approaches, Technologies in food printing, Printability of food components, Factors affecting the printability, 4D Printing; Concept and Functionality, smart food materials, shape memory effect in 4D food printing, Deformation and breakup, Coalescence and alignment, Applications of 3D and 4D food printing.

UNIT III FOOD STRUCTURE DEVELOPMENT IN EMULSION SYSTEMS

9

Emulsions: Principles and Preparation, Basic constituents of Food emulsion, Emulsion architecture, Microstructure design and performance. Food Structure Development in Oil and Fat Systems; nanoscale crystals and the structures of lipids and fat, fat crystal network. Role of bubbles in food structure development; Formation of foam/bubble microstructures, Rheological behaviour, Characteristics of bubble-containing structures.

UNIT IV STRUCTURING POLYPHASIC FOOD SYSTEMS

9

Structuring Dairy Products by means of Processing and Matrix Design, Processing of Food Powders, Structured Cereal Products, Structured Meat Products, Structured Chocolate Products, Edible Moisture Barriers for Food Product Stabilization. Encapsulation of food materials; Micro and nano encapsulation, selection of wall and core materials, structural characterization of encapsulates.

UNIT V PERFORMANCE OF STRUCTURED FOOD

9

Food Structure Development for Rheological/Tribological Performance; structure-property-oral process relationships. Developing Food Structure for Mechanical Performance; structure and bulk behavior of soft solid foods, particulate composites and gels, cellular solid foams, and short fiber-reinforced foods. Design Structures for Optimal Sensory Performance, Development of Food Structures for the Encapsulation and Delivery of Bioactive Compounds.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Aware techniques of developing structured food products.
2. Understand the concepts and principles of food structuring.
3. Assimilate the modern techniques of food structure development.
4. Evaluate the technical and functional performance of structured food materials.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	3
3	3	2	2	2	3	3	1	-	-	-	3	3	3	-	2
4	3	3	2	3	3	2	2	-	-	-	2	2	1	-	1
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1.75	2.5	2	0	2

TEXTBOOKS/REFERENCES

1. Fotis Spyropoulos, Aris Lazidis & Ian Norton, "Handbook of Food Structure Development" Royal Society of Chemistry, 2020.
2. Bhesh Bhandari & Yrjö H. Roos. "Food Materials Science and Engineering" Wiley-Blackwell Publishing, 2012.
3. José Miguel Aguilera & Peter J. Lillford, "Food Materials Science - Principles and Practice", Springer New York, 2008.
4. Alexandru Mihai Grumezescu & Alina Maria Holban, "Handbook of food bioengineering" Elsevier Science, 2018.

FD3032

CONCEPTS ON EXPERIMENTAL DESIGN AND MODELLING

L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to

- Introduce students to Experimental Design Fundamentals, Single Factor, Multifactor Experiments and Taguchi Methods.
- Describe how to design experiments, carry them out, and analyze the data they yield.
- Gain an understanding of how the analysis of experimental design data is carried out using the most common software packages.

UNIT- I INTRODUCTION TO EXPERIMENTAL DESIGN

9

Importance of experiments- experimental strategies, basic principles of design, terminology. Concepts of random variable, probability, density function cumulative distribution function. Sample and population. Measure of Central tendency- Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions- Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size, normal probability plot, linear regression model.

UNIT -II: DESIGN OF EXPERIMENTS -SINGLE AND MULTIFACTOR EXPERIMENTS

9

Types of Design of experiments- Completely randomized design, Randomized block design, Latin square design, Two and three factor full factorial experiments, 2K factorial Experiments, Confounding and blocking designs, Plackett- Burman design.

UNIT -III: SPECIAL EXPERIMENTAL DESIGNS

9

Fractional factorial design, Nested designs, Split plot design, Response Surface Methodology (RSM), Experiments with random factors, rules for expected mean squares, approximate F- tests.

UNIT- IV: ANALYSIS AND INTERPRETATION METHODS**9**

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments- one way ANOVA, two way ANOVA and multi way ANOVA, Pairwise comparison- Tukey's test and Fisher LSD test, Regression analysis, Statistical analysis, estimation of model parameters, model adequacy checking, Forming mathematical models from experimental data- First order, second order models.

UNIT- V: DESIGN OF EXPERIMENTS**9**

Design using Orthogonal Arrays, Data analysis, Robust design- control and noise factors, S/N ratios, parameter and tolerance design concepts, case studies.

TOTAL:45 PERIODS**COURSE OUTCOMES:**

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

CO1 Understand the basic concepts related to experimental design

CO2 Understanding the different types of design and its relevance to real time experiments.

CO3 Gain knowledge in analyzing the design and developing appropriate models

TEXTBOOKS/REFERENCES

1. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons 2003.
2. Nicolo Belavendram/Quality by Design; Taguchi techniques for industrial perimentation / Prentice Hall, 1995.
3. Phillip J.Rose/**Taguchi techniques for quality engineering**/McGraw Hill, 1996.
4. Zar, J.H., 1999. Biostatistical analysis. Pearson Education India.
5. Pruzan, P., 2016. Research methodology: the aims, practices and ethics of science. Springer.

FD3033**STATISTICAL TOOL IN DATA ANALYSIS****L T P C
3 0 0 3****OBJECTIVE:**

The course aims to

- Provide an insight into various statistical tools in data analysis.
- Provide an insight into the real-life and varied application of the subject.
-

UNIT I INTRODUCTION TO SCIENCE OF STATISTICS**9**

Fundamental Elements of Statistics, Qualitative and Quantitative Data Summaries, Statistical Inference, Stating Hypotheses, Test Statistics and p-Values, Evaluating Hypotheses, Equation of multiple linear regression, Interpretation of multiple linear regression, Cautions about Regression.

UNIT II DATA MANAGEMENT AND ANALYSIS**9**

Quantitative analysis, descriptive statistics, inferential statistics: Uses and limitations Summation sign and its properties, Proportions, percentages, ratios, Measures of central tendency-mean, median, mode arithmetic mean and its uses, mid – range, geometric mean, weighted mean, measures of dispersion /variability- range, variance, standard deviation, standard error, coefficient of variation, Kurtosis, Sleekness (practical aspects of grouped data-frequency distribution, histogram, frequency polygons, percentiles, Data Management and Analysis, Frequency distributions, Measures of central tendency, measures of dispersion, variability).

UNIT III STATISTICAL DATA ANALYSIS USING SPSS**9**

Data handling: open SPSS data file – save – import from other data source – data entry – labeling for dummy numbers - recode in to same variable – recode in to different variable – transpose of data – insert variables and cases – merge variables and cases. Testing of Hypothesis: Parametric – One sample – Two sample independent t – test – Paired t – test. Non – parametric: One sample KS test- Mann-Whitney U test – Wilcoxon Signed Rank test - Kruskal Wallis test – Friedman test-

Chi- square test.

UNIT IV DATA ANALYTICAL MODELS 9

Reducing Data Complexity (Principal Component Analysis (PCA) and Exploratory Factor Analysis (EFA)), Additional Linear Model Topics (Collinearity, Logistic, Hierarchical Linear Models (HLM)), Confirmatory Factor Analysis and Structural Equation Modeling (SEM).

UNIT V DATA ANALYTICS: SOFTWARES AND TOOLS 9

SQL, Tableau, QlikView, R language, Python, RapidMiner, OpenRefine, SAS.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1- Collect, store, process and analyze data according to high standards

CO2- conduct empirical research in food science and technology using modern analytic software tools

CO3- develop and apply new research methods

CO4- solve problems using best practices of data analysis using modern computational tools.

TEXTBOOKS/REFERENCES

1. Gupta, S. (2001) "Research Methodology and Statistical Techniques", Deep and Deep, New Delhi.
2. Heumann, C., Schomaker, S., Introduction to Statistics and Data Analysis: with Exercises, Solutions and Applications in R. Springer, 2016
3. Teetor, P. (2011). R cookbook: Proven recipes for data analysis, statistics, and graphics. O'Reilly Media, Inc.

FD3034

FOOD INFORMATICS

**L T P C
3 0 0 3**

OBJECTIVE

The course aims to

- Impart knowledge on structural interaction between organic molecules and their interaction.
- Provide a knowledge about the various types of sequence database
- Impart knowledge on both *Insilco* and *Invitro* studies

UNIT I INTRODUCTION 9

Role of functional foods against metabolic syndrome like diabetics, celiac diseases. Potential benefits (like antioxidant, anticancer activity) of active compounds present in the food materials (herbs, fruits, & vegetables) – proteins and phytochemicals like – Carotenoids, Lycopene, Xanthophylls, lutein, Sulfides, Polyphenolics, Flavonoids, Naringin, Quercetin, Anthocyanidins, catechins, Flavones, Prebiotics / Probiotics, Fructo oligosaccharides, Lactobacillus, Phyto estrogens: Isoflavones, daidzein, Geebustin, lignans, Tocopherols, etc.

UNIT II SEQUENCE DATABASE 9

Introduction to bioinformatics tools: Sequence database – Nucleotide, protein, Literature Databases, Composite Databases (NRDB), Genome Databases- (Viral genome database (ICTV db)), Bacterial Genome database (GOLD, MBGD), Organism specific database. file formats, Introduction to sequence alignment (only general ideas, not algorithm) - Local and global, pair wise and multiple, BLAST. Small compound database – PubChem, ChemSpider, ZINC, ChEMBI, Drug Bank, Flavornet (Volatile compounds from the literature based on GC-MS), SuperSweet (Database – Carbohydrates & artificial sweeteners).

UNIT III STRUCTURE PREDICTION 9

Extraction of active compounds from food materials. Screening of active molecules using chromatography techniques. ChemsSketch – conversion of 2-D structure into 3D structure. X-ray crystallography & NMR techniques: Protein 3D structure, Collecting X-ray Data, Diffraction,

Coordinate systems in crystallography, Electron Density maps, obtaining a model, Judging the molecular models, other diffraction methods for model building, Tools for studying macromolecules.

UNIT IV IN Silico Models 9

Introduction to Molecular docking, Structure Based methods to identify lead components, Energy minimization tool, Denovo ligand design, molecular docking and molecular simulation case studies.

UNIT V NVITRO Models 9

Introduction – preparation of cell culture media and its requirements. Preservation cell line cultures – cryopreservation. Facts of cell line contamination; cell line studies: Anti-diabetic, Anti-Cancer, and Anti-inflammation activity. cytotoxicity by MTS assay. Case studies.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the facts and importance's of phytochemicals.
2. Evaluate the structural prediction and refinement of organic molecules.
3. Able to discuss about the various types of sequence database
4. Apply the fundamental conceptual of both *In-silico* and Invitro methods.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	3
3	3	2	2	2	3	3	1	-	-	-	2	3	3	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	1	-	2
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1.25	2.5	2	0	2.25

TEXTBOOKS/REFERENCES

1. Foodinformatics: Applications of Chemical Information to Food Chemistry. (2014). Germany: Springer International Publishing.
2. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
3. Arthur K. Lesk, "Introduction to Bioinformatics", Oxford University Press, 4th edition, 2014.

PROGRESSTHROUGH KNOWLEDGE

FD3035

APPLIED GENOMICS AND PROTEOMICS

**L T P C
3 0 0 3**

OBJECTIVES

The course aims to,

- provide advanced theoretical knowledge on the organization and function of genomes,
- functional genomic analyses, and advanced methods and approaches in proteomics.

UNIT I STRUCTURE OF GENOMES, MAPPING AND SEQUENCING 9

Organization and structure of genomes in prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion); Genome mapping methods (genetic and physical); RAPD, RFLP, SNP analyses; Fluorescence In-Situ Hybridization (FISH) techniques; Advances in gene finding and functional prediction; Chain termination and chemical degradation sequencing methods.

UNIT II LARGE SCALE GENOMICS/ FUNCTIONAL GENOMICS ANALYSES 9
Genome-wide association (GWA) analysis; Comparative Genomic Hybridization (CGH); Massively Parallel Signature Sequencing(MPSS); Whole genome shot-gun sequencing and its applications. Introduction of Next Generation Sequencing (NGS).

UNIT III TRANSCRIPTOMICS ANALYSES 9
Gene expression analysis by cDNA and oligonucleotide arrays; Microarray experimental analysis and data analysis.Methylome analysis using microarray; ChIP-on-Chip analysis.Bioinformatic analysis of large-scale microarray data for comparative transcriptomics.

UNIT IV SEPARATION AND PROCESSING OF PROTEINS FOR PROTEOMICS 9
Overview of strategies used for the identification and analysis of proteins; Protein extraction from biological samples (Mammalian Tissues, Yeast, Bacteria, and PlantTissues); 2-DE of proteins for proteome analysis; Liquid chromatography separations in proteomics (Affinity, Ion Exchange, Reversed-phase, and size exclusion); Enzymatic cleavage of proteins. Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis.

UNIT V MASS SPECTROMETRY AND COMPARATIVE PROTEOMICS 9
Common ionization methods for peptide/protein analysis; Introduction to Mass spectrometers; MALDI-TOF and LC-MS analyses; Comparative proteomics based on global in-vitro and in-vivo labeling of proteins/peptides followed by Mass-spectrometry. Analysis of posttranslational modification (PTM) of proteins; Characterization of protein interactions using yeast two-hybrid system and Protein microarrays; Proteomics informatics and analysis of protein functions.

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course students will be able to,
CO1 have advanced theoretical knowledge on the organization and function of genomes CO2 know functional genomics analyses
CO3 understand advanced methods and approaches in proteomics.

TEXTBOOKS AND REFERENCES

1. S.P. Hunt and F. J. Livesey, (2000) Functional Genomics
2. N. K. Spur, B. D. Young, and S. P. Bryant (1998) ICRF Handbook of Genome Analysis Volume 1 & 3. G. Gibson and S. V. Muse (2002) A primer of Genome Science
4. R. J. Reece (2004) Analysis of Genes and Genomes
5. Rinaldis E. D. and Lahm A (2007)DNA Microarrays. Horizon bioscience.
6. Simpson R. J.“ Proteins and Proteomics - A Laboratory Manual” .Cold Spring Harbour Laboratory Press, 2002.
7. Twyman R. M. “ Principles of Proteomics” . Taylor & Francis. 2004
8. O’ Connor C. D. and Hames B. D. “ Proteomics” . Scion, 2008.
9. Schena M. “ Protein Microarrays” . Jones and Bartlett, 2005.
10. Smejkal G. B. and Lazarev A. V. “ Separation methods in Proteomics” . CRC Press, 2006.

FD3036 TECHNOLOGY OF FRUIT AND VEGETABLE PROCESSING L T P C
3 0 0 3

OBJECTIVES

The course aims to

- develop the knowledge of students in the area of vegetable and fruit processing and technology.

- enable students to appreciate the application of scientific principles in the processing of fruits and vegetables.

UNIT I BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS 8

Ability to identify all commercially important fruits and vegetables with their names in important Indian languages, important regions, season, Production and processing scenario of fruits and vegetable India and World. Scope of Fruit and Vegetable Preservation Industry in India. Present status, constraints and prospectus. Problem solving in post-harvest quality of fruits and vegetables

UNIT II FRESH FRUITS AND VEGETABLES 8

Physical, Textural characteristics, structure and composition. Maturity standards; Importance, methods of Maturity determinations maturity indices for selected fruits and vegetables. Harvesting of important fruits and vegetables. Fruit ripening- chemical changes, regulations, methods. Calculation of respiration rates, Spoilage of fruits, vegetable and their processed products.

UNIT III PRESERVATION OF FRUITS AND VEGETABLES 9

Preservation by fermentation- Definition, Advantages, disadvantages, Types of fermentation, equipments; Fruit wine. Irradiation applications for fruits and Vegetable. Minimally processed fruits and vegetables, solving problems with respect to natural resistance of fruit, General pre processing, drying and freezing of fruits and vegetables - problems associated with specific fruits and vegetables, problem solving in Post- cutting treatments to extend the shelf-life of fresh-cut products.

UNIT IV CANNING, PUREES AND JUICES 12

Canning- General pre-processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality assurance Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance Vegetable Purees/pastes - General and specific processing, different packing including aseptic. Technology for juice pressing, juice extraction and clarification, methods of bottling, enzymatic clarification and debittering of juices, fruit juice powders- preparation and packaging

UNIT V FRUIT AND VEGETABLE PRODUCTS 8

Ready to eat fruit and vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres- General and specific processing, different packing including aseptic, Dried Onion, Powder. Garlic Dried Garlic, Powder, Oil. Potato Wafer; starch, Papad, Carrot Preserve, candy, Pickle, Jam. Cauliflower and cabbage Dried cauliflower and cabbage, Sauerkraut, Pickle Leafy vegetables; Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Bitter gourd Pickle, Dried bitter gourd. Indian Food Regulation and Quality assurance, Case studies- Improving the nutritional quality of processed fruits and vegetables, Waste management in fruit and vegetable processing industries

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

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

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	2	3	3	-	-	-	1	2	2	-	2
2	3	3	3	3	3	3	3	-	-	-	1	3	2	-	2

3	3	3	3	2	3	2	2	-	-	-	1	3	3	-	2
4	3	3	3	2	3	2	2	-	-	-	1	2	2	-	1
5	3	3	3	3	3	3	3	-	-	-	2	3	2	-	2
Avg	3	2.8	2.8	2.4	2.8	2.6	2.6	0	0	0	1.2	2.6	2.2	0	1.8

TEXT BOOKS:

1. Fellows, P J. "Food Processing Technology Principles and Practice". 3rd Edition, Woodhead, 2009.
2. Salunke, D . K and S. S Kadam "Hand Book of Fruit Science and Technology Production, Composition, Storage and Processing". Marcel Dekker, 2005.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.

FD3037

FRUITS AND VEGETABLES AS NUTRACEUTICAL

**L T P C
3 0 0 3**

OBJECTIVES

The course aims to

- Understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- Understand the role of Nutraceuticals and functional food in health and disease

UNIT I

9

Introduction to major class of bioactives in fruits and vegetables, present scenario of nutraceutical market, food and nutrient intake behavior in Indians, classification of plant derived bioactives, interaction of functional food with medicine, Vitamins and Minerals of fruits and Vegetables, Flavonoid, Isoflavone, and Carotenoid Contents in Raw fruits and Vegetables, Fibre – dietary fibre, plant tissue and type of cell walls, cell wall polysaccharide, effects of cooking or processing on cell wall composition, health benefits

UNIT II

9

Pharmacological properties of fruits and vegetables; nutritional indicators and health aspects of fruits and vegetable consumption in adults; diabetes, diabetic complication and flavonoids; curcumin – epigenetic therapy; Nutraceuticals as therapeutic agent for inflammation – flavonoids, anthocyanin; diet and nutrition in prostate health, Antioxidants in fruits & vegetables – factors that affect antioxidant response to ingestion of fruit - health properties.

UNIT III

9

Role of fruit and vegetable nutrients in Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc. Sports foods – ingredients, components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition. Formulations for meeting normal and special needs of infants, current status of infant foods, additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods

UNIT IV

9

Concept of new health food product development from fruits and vegetables. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods from fruits and vegetables, Prebiotic substances from fruits and vegetables and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and symbiotic

UNIT V**9**

Nutraceutical delivery vehicles, Role of bioactives from fruit and vegetables for human health – plant parts and chemistry, mechanism of action - case studies, recovery of valuable bioactives from residues of fruit and vegetable processing industry, stability and bioaccessibility of fruit and vegetables bioactives in food – food component interaction and matrix effect.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the concepts of physiological characteristics of fruits and vegetables.
2. Aware of the basic concepts of nutraceuticals and its role in health and disease
3. Examine the chemical nature of nutraceuticals and methods of extraction
4. Evaluate the role of Nutraceuticals and functional food in health and disease

TEXTBOOKS

1. Anumala, V., Phurailatpam, A., Sarma, P., Anumala, V., Phurailatpam, A., Sarma, P. (2021). Fruits and Vegetables as Nutraceutical: Nature's Medicine. United States: Taylor & Francis.
2. Functional Foods, Nutraceuticals, and Degenerative Disease Prevention. (2011). Germany: Wiley.
3. Li, T. S. C., Li, T. S. C. (2008). Vegetables and Fruits: Nutritional and Therapeutic Values. United States: CRC Press.
4. Nutritional Composition and Antioxidant Properties of Fruits and Vegetables. (2020). Netherlands: Elsevier Science.

**FD3038 ADVANCES IN FRUIT AND VEGETABLE PROCESSING TECHNOLOGIES L T P C
3 0 0 3****OBJECTIVES**

The course aims to

- Familiarize students with advanced fruit and vegetable processing techniques and its applications
- Understand the effect of Novel non thermal methods on quality and safety of fruit and vegetable products.

UNIT I**9**

Ultraviolet light for processing of fruit and vegetable products, high pressure processing of fruit and vegetable, ultrasound application of fruit and vegetable products, minimal processing

UNIT II**9**

Membrane application in fruit and vegetable processing technologies, high intensity pulsed electric field applications, applications of ozone in fruit and vegetable processing, irradiation application in fresh fruit and vegetable produce processing

UNIT III**9**

Enzyme maceration, fruit and vegetable juices as vehicle for probiotic microorganism and prebiotics oligosaccharides, vacuum frying of fruit and vegetable application in processing, role of canning in preservation of fruits and vegetables,

UNIT IV**9**

freeze concentration applications in fruit and vegetable processing, refrigeration and cold chain effects on fruit and vegetable product shelf life, edible coatings.

UNIT V**9**

Thermal treatment effects in fruit and vegetable juices, effect of fruit and vegetable processing on product aroma, sensory evaluation in fruit and vegetable product development, ohmic heating,

microwave dielectric heating recent trends in drying

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand different non thermal processing of food and its application in fruit and vegetable processing
2. Familiarize students with Novel non thermal methods for sterilization of fruit and vegetable
3. Discuss about the quality evaluation of fruit and vegetable products.
4. Understand the effect of Novel non thermal methods on quality and safety of fruit and vegetable products

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	2	3	3	-	3
3	2	2	3	2	2	3	1	-	-	-	1	3	2	-	1
4	3	3	2	1	3	2	2	-	-	-	2	2	2	-	2
Avg	2.5	2.25	2	2	2.5	2.5	1.5	0	0	0	1.5	2.5	2.25	0	2

TEXTBOOKS

1. Advances in Fruit Processing Technologies. (2012). United Kingdom: Taylor & Francis.
2. Technological Interventions in the Processing of Fruits and Vegetables. (2018). United States: Apple Academic Press.

FD3039

BEVERAGE TECHNOLOGY

**L T P C
3 0 0 3**

OBJECTIVE

- To impart knowledge on scope and importance of beverage industries.
- To impart knowledge on the processing aspects of beverage production.
- To understand the principal facts behind non-alcoholic beverage production

UNIT I

INTRODUCTION

9

Classification of beverages and their importance. Scope of food beverages & its processing units in India. Ingredients details in carbonated beverages, History of Soft Drinks, Findings and Development of carbonation apparatus, Transformation of health drinks to common beverages, Product timeline and marketing. Non-carbonated beverages.

UNIT II

ALCOHOLIC & NON-ALCOHOLIC BEVERAGES

9

Brewing techniques, nutritional value of alcoholic beverages, Processing aspects (Distillation techniques) of beer, wine, and other non – alcoholic beverages like vodka, rum, gin, whisky, brandy, & toddy. Distilled spirits.
Tea - Processing of different types of tea and its importance, coffee processing – introduction, biological activity of coffee, flavored milk, cereal-based non-alcoholic beverages.

UNIT III

FRUIT AND VEGETABLE BASED BEVERAGES

9

Nutritional properties and health benefits of fruit-based beverages. Nutritional composition and functional activity of vegetables-based beverages, Cereal based beverages. Indigenous beverages: Processing of coconut water, sugarcane juice, cashew apple extract, Neera – coconut palm sap.

UNIT IV CARBONATED SOFT DRINKS- MANUFACTURING**9**

Source of carbon dioxide, chemical and physical properties of carbon dioxide, carbonating process, Machineries and equipment used. Preparation of syrups; Dilution systems; Filling system; Packaging-containers and closures; Effective application of quality controls, brix, acidity to brix ratio, single strength of product- sanitation and hygiene in beverage industry.

UNIT V HEALTH AND REGULATORY ISSUES**9**

Quality control of beverage: Quality standards for beverages, chemical, microbial and sensory evaluation, product shelf life. FSSAI, CODEX, FDA and EU regulations- Labelling and packaging; Ingredients according to PFA, EFSA and FDA – Absolute requirements of soluble solids and titrable acidity in beverages.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Formulate the beverages using selected ingredients
2. Apply Unit operations involved in the carbonated beverage manufacturing
3. Explain the various production techniques in non-carbonated beverages
4. Evaluate the quality parameters of fermented beverages
5. Implement the food laws and regulations of beverages

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	-	-	-	1	2	2	-	2
2	3	2	1	3	3	3	2	-	-	-	1	3	3	-	3
3	3	3	3	1	3	3	1	-	-	-	2	3	2	-	2
4	2	3	2	3	3	2	2	-	-	-	1	2	2	-	1
5	2	2	1	2	1	2	2	-	-	-	1	2	2	-	3
Avg	2.4	2.4	1.8	2.2	2.4	2.4	1.8	0	0	0	1.2	2.4	2.2	0	2.2

TEXTBOOKS/REFERENCES

1. Varnam, A., Sutherland, J. (2012). Beverages: Technology, Chemistry and Microbiology. United Kingdom: Springer US.
2. Trends in Non-alcoholic Beverages. (2019). United Kingdom: Elsevier Science.
3. Non-alcoholic Beverages: Volume 6. The Science of Beverages. (2019). United Kingdom: Elsevier Science.
4. Natural Beverages: Volume 13: The Science of Beverages. (2019). United Kingdom: Elsevier Science.
5. Ashurst, P.R, Chemistry and technology of Soft drink and fruit juices, 2nd edition, Blackwell Publishing Ltd. 2005.
6. Steen, D.P and Ashurst, P.R, Carbonated soft drinks – Formulation and manufacture, Blackwell Publishing Ltd. 2000.
7. Shankunthala Manay, N. and Shadakdharaswamy, M, Foods – Facts and Principles, New Age International Pvt. Ltd, 2000.

FD3040**FRUIT AND VEGETABLE STORAGE****L T P C
3 0 0 3****OBJECTIVES**

The course aims to

- Provide In-depth knowledge on safe storage of food materials.
- Enable design of storage Structures for various categories of food product

UNIT I**9**

Introduction – storage operation, harvest and pre-harvest factors, traditional and modern storage methods, changes during storage, factors influencing storage, genetic effects on storage, humidity and temperature – measurement and control technology, store design and methods, pre-storage treatments

UNIT II**9**

Pre-cooling of fruits and vegetables – methods, estimation of cooling time, ventilation & forced system, combined forced and extraction system, low cost cold room, storehouse – layout of floor duct, air distribution, packaging icing, cooling load calculations, vacuum cooling – principle, process, mechanism, equipment, advantages, limitations, Commercial forced air cooling methods, product moisture loss and produce cooling pattern with forced air cooling; heat load; hydrocooling of fruits and vegetables – hydrocooling rate, methods; evaporative cooling (EC) – thermodynamics and psychrometric of EC process, types of EC system, limitations, maintenance and design

UNIT III**9**

Hypobaric storage – mode of action, transport, effect on fruits and vegetables, case studies on raw horticultural commodities and processed products, vacuum infiltration and cooling, hyperbaric storage – mode of action, effect on fruits and vegetables, case studies on raw horticultural commodities and processed products

UNIT IV**9**

Controlled atmosphere (CA) – changes during storage, biochemical considerations, gas exchange mechanism, equipment for producing and regulation CA, design, construction and operation - on raw horticultural commodities and processed products, gas measurement and control technology, effect of gas atmosphere and interactions, MAP – techniques, polymeric film properties, gas and vapour applied to MA process operation, effect on shelf life of fruits and vegetables, MAP design with O₂ modeling, chilling injury, control of temperature, absorbers

UNIT V**9**

Handling of common fruits and vegetables – recommended storage conditions for various fruits and vegetables, storage and transportation of fruits - citrus, sub tropical, pears, grapes, plums, cherries, peaches, apricot and berries. Vegetables – artichokes, asparagus, corn, cucumber, eggplant, garlic, lettuce, melon, mushroom, okra, onion, parsnip, parsley, peas, pepper, potato, spinach, canned foods, transport. – sea, CA, hypobaric, MA – case studies.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand trends and development storage technologies aiming at assuring the safety and quality of fruits and vegetables.
2. Explain the design, construction, operation, control and maintenance of commercial refrigeration systems and cold storages for fruits and vegetables
3. Assess basic in storage of fruits and vegetables
4. Examine the design of storage Structures for various categories of food product

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	PSO 3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	1	2
2	3	3	2	3	3	3	2	-	-	-	2	3	3	1	2
3	2	2	3	2	2	3	1	-	-	-	1	3	1	1	2
4	3	3	2	1	3	2	2	-	-	-	2	2	2	1	1
Av g	1	0.9	0.8	0.8	1	1	0.6	0	0	0	0.6	1	0.8	0.4	0.7

TEXTBOOKS

1. Thompson, A. K., Thompson, A. K. (2015). Fruit and Vegetable Storage: Hypobaric, Hyperbaric and Controlled Atmosphere. Germany: Springer International Publishing.
2. Puttongsiri, T., Prange, R. K., Thompson, A. K., Bancroft, R. D., Puttongsiri, T., Prange, R. K., Thompson, A. K., Bancroft, R. D. (2018). Controlled Atmosphere Storage of Fruit and Vegetables. United Kingdom: CABI.
3. Packaging and Storage of Fruits and Vegetables: Emerging Trends. (2021). (n.p.): Apple Academic Press.
4. Rao, C. G., Rao, C. G. (2015). Engineering for Storage of Fruits and Vegetables: Cold Storage, Controlled Atmosphere Storage, Modified Atmosphere Storage. India: Elsevier Science.

FD3041

INNOVATIVE PACKAGING OF FRUIT AND VEGETABLES

L T P C
3 0 0 3

OBJECTIVES

The course aims to

- Understand the different methods involved in development of fruit and vegetable packaging systems.
- Understand the different packaging system available for fruit and vegetable packaging

UNIT I

9

Bio-based packaging of fruits and vegetables, MAP of fresh produce, shrink packaging of fruits and vegetables, NMBP, antimicrobial packaging – basic concepts and applications in fresh and fresh-cut fruits and vegetables, cushioning materials for fruits and vegetables

UNIT II

9

Active packaging of fresh and fresh-cut fruits and vegetables, Intelligent packaging applications of fruits and vegetables, Edible coating and their effect on their effect on post-harvest quality of fruits and vegetables, nano-enabled packing of food products

UNIT III

9

Engineering properties of packaging film for raw and processed fruits and vegetable products, predictive modeling for packaged fruits and vegetables, mathematical modeling for micro-perforated films in fruits and vegetables packaging

UNIT IV

9

Smart packaging technologies for fruit and vegetable beverage products – gas release, flavour release, nutrient release, enzyme release, thermochromic labelling, smart branding, odour removal packaging, anti-counterfeit beverage packaging, tamper-proof packaging.

UNIT V

9

Improving convenience in product use and for on-the go food and drink consumption, self heating and self cooling systems, smart packaging of fruit and vegetable beverages with aerosol

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the concepts, types of food packaging systems for fruits and vegetables
2. Analyse complex systems of food packaging and logistics in packaging of fruits and vegetables.
3. Understand the different packaging system available for fruit and vegetable packaging
4. Explain the advances involved in processing of fruits and vegetables

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	2	2	2	2	1	-	-	-	-	2	3	-	2
2	3	3	2	3	3	3	2	-	-	-	-	3	2	-	2
3	2	1	2	2	1	1	1	-	-	-	-	3	3	-	2
4	3	3	2	2	1	2	2	-	-	-	-	2	2	-	2
Avg	2.5	2	2	2.25	1.75	2	1.5	0	0	0	0	2.5	2.5	0	2

TEXTBOOKS

1. Innovative Packaging of Fruits and Vegetables: Strategies for Safety and Quality Maintenance. (2018). Canada: Apple Academic Press.
2. Innovations in Food Packaging. (2013). Netherlands: Elsevier Science.
3. Packaging and Storage of Fruits and Vegetables: Emerging Trends. (2021). (n.p.): Apple Academic Press.

FD3042 FRUIT AND VEGETABLE INDUSTRY SAFETY AND LAWS L T P C
3 0 0 3

OBJECTIVES:

- To study various food laws, importance and functions of food safety management systems
- To impart knowledge on food laws and safety in food processing.

UNIT I NECESSITY OF LAW IN FRUIT AND VEGETABLE PROCESSING INDUSTRY 9

Establishment of US Pure Food Law in early 1900s and of Food & Drug Administration to enforce safety of food products; Urbanisation of population and necessity of processed and preserved foods and the necessity of ensuring quality of food to prevent adulteration. PFA; Various aspects of defining adulteration, taking samples of food for analysis by public analyst, prosecution for adulteration and punishment; Standards of various food products; FPO; Use of permitted additives like colours, preservatives, emulsifiers, stabilisers, antioxidants etc. Food Safety & Standards Act 2006 and the provisions therein; Integrated Food Law - Multi departmental - multilevel to single window control system, consumer protection Act.

UNIT II FOOD SAFETY IN PROCESSING 9

Fruit and vegetable processing industry - Building and equipment design; microbiological quality of fruit and vegetable products, air; Safety in food procurement, storage, handling and manufacture; Food safety in retail fruit and vegetable product businesses; international food service operators, institutional food service operators; application of the principals of modern hygiene; Food handlers, habits, clothes, illness;

UNIT III KEY SAFETY PRINCIPLES 9

Fruit and vegetable processing industry - Training & Education for safe methods of handling fruits and vegetables; cleaning and sanitization of processing plants; principles of cleaning and sterilization; sterilization & disinfection- different methods used-detergents, heat, chemicals; selecting and installing equipment; Cleaning of equipment and premises. Safety limits of sanitizers; pest control; management and disposal of waste.

UNIT IV FOOD SAFETY MANAGEMENT SYSTEM 9

Fruit and vegetable processing industry - Physical, chemical and Microbial hazards and their control in food industry; Quality systems standards including ISO; - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP);

UNIT V MANAGEMENT 9

Good Manufacturing Practice and HACCP; Surveillance networks, Consumer and food service

operator education; GM Foods, safety and labeling; International Food Standards ISO 9000 and related standards; Impact of food safety on global trade. Concepts and trends in food legislation, Information-Domination in the European Food Industry, Agriculture, Ethics and Law, WHO in Global Food Safety Governance, The Right to Food in International Law with Case Studies. Intellectual Property and Food Labelling: Trademarks and Geographical Indications, Agricultural Innovation: Patenting and Plant Variety Rights Protection, Cross-Contamination, Genetic Drift, and GMO Co-existence with Non-GM Crops, Legal Barriers to International Food Trade, food policies

TOTAL : 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Identify the Agency responsible for legislation & implementation when facing a problem concerning fruits and vegetables
2. Elaborate on the relevant legislation/standard for a fruits and vegetables based product
3. Assess the meaning of what is written in the relevant legislation when facing a problem concerning fruits and vegetables
4. Propose to pertinent Authorities amendments to existing legislation/standard whenever it seems justifiable

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	3	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	3
3	3	2	2	2	3	3	1	-	-	-	1	3	1	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	1
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	2

TEXT BOOKS:

1. Rees, Naomi and David Watson —International Standards for Food Safety□, Aspen Publication, 2000.
2. Schmidt, Ronald H. and Rodrick, G.E. —Food Safety Handbook□, Wiley Interscience, UK, 2005.

REFERENCES

1. Mehta, Rajesh and J. George —Food Safety Regulations, Concerns and Trade : The Developing Country Perspective□, Macmillan, 2005.
2. The Prevention of Food Adulteration Act, 1954□, Commercial Law Publishers India) Pvt. Ltd.,

PROGRESSTHROUGH KNOWLEDGE

FD3043 PACKAGING DESIGN AND SUSTAINABLE DEVELOPMENT

L T P C
3 0 0 3
9

UNIT I

Introduction to Packaging Design Concepts : Introduction to design, 2D & 3D dimensional Design, Study of Visual Elements, Principles of Typography, Introduction to visual ergonomics, understanding the relationship between consumer & communication Design

UNIT II

9

Application of Computers in Packaging Design Setting drawing requirement, Commands and systems variables, to co-ordinate a system, creating objects, editing methods, Layers and object properties, Creating 3D objects etc. Auto CAD/CAM.

UNIT III **9**
 Concept of Packaging Design and Sustainable Package Design: Sustainable Packaging, No Touch and Antiviral/Antimicrobial Packaging, Nano Packaging System , Biodegradable and Biocompatible Packaging

UNIT IV **9**
 Sustainability & Circular Economy in Packaging Concept of Sustainability – Principles & Concepts, Design Guidelines for Sustainable Packaging, Concept of Compostable, Biodegradable & Bio based Packaging Materials,

UNIT V **9**
 Source Reduction –Various Waste Disposing Techniques, Environmental policies of India, Case Studies of Life Cycle Assessment in Packaging.

TOTAL – 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand basic concept of Packaging Design and Sustainable Package Design
2. Able to develop the knowledge of students in the area of food packaging designs and the technologies used in packaging design.
3. Explain latest food packaging technologies for adoption of sustainability in food industry.
4. Elaborate Hazards and toxicity associated with packaging materials, labelling of foods.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	2	-	3
3	3	2	2	2	3	3	1	-	-	-	1	3	3	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	2	-	2
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2.25	0	2.25

TEXTBOOKS:

1. Robertson, G.L. “Food Packaging: Principles and Practice” (2nd Edition), Taylor & Francis, 2006.
2. Ahvenainen, R (Ed.) “Novel Food Packaging Techniques”, CRC Press, 2003.
3. Mathlouthi, M. “Food Packaging and Preservation”, Aspen Publisher 2013.
4. Han, J.H. (Ed.) “Innovations in Food Packaging”, Elsevier /Academic Press, 2013.
5. Douglas Riccardi, “Food Packaging Design”, Design Media Publishing Limited, 2015.
6. Marianne R. Klimchuk and Sandra A. Krasovec, “Packaging Design: Successful Product Branding from Concept to Shelf”, Wiley, 2006.
7. Walter Soroka, “Fundamentals of packaging technology”, 3rd Edition, Institute of packaging professionals, Naperville, Illinois, USA, 2002
- 8) Klimchuk & Krasovec, “Packaging Design: Successful Product Branding from Concept to Shelf”

FD3044

PACKAGE PRINTING INKS AND COATINGS

L T P C
3 0 0 3
9

UNIT I

Introduction Packaging printing, more than just putting ink on substrate - Origination: Conventional, originals, Digital originals. Printing Inks. PACKAGING EMBELLISHMENT AND PRINTING a) Graphic design – Preparation and reproduction of art work. b) Printing Techniques – Letterpress. Flexography, Lithography, Gravure, Silkscreen. c) Printing inks and Print evaluation. d) Ink-Jet Printing in Bar Coding

UNIT II **9**
 Basic Concept of Printing on Packaging - Linking various printing processes to package design formats. Designing, Manufacturing & Application of Labels & Sleeves-Design Innovations in Labels. Direct Printing Techniques on Packaging Substrates & Case Studies of Hot Foil & Cold Foil Stamping, Embossing & Engraving, Holography & Other Techniques-Design Criteria for Specialty & Premium Products

UNIT III **9**
 Advances in Printing on Packaging with special reference to the Digital Printing Printing and embossing, Decoration and printing of corrugated board containers, The choice of printing process at different levels of packaging: primary, secondary and tertiary packaging materials.

UNIT IV **9**
 Introduction, Light and colour, the description of colour, Colour vision, Additive and subtractive colour mixing, other factors affecting colour, Colour printing, Graphic design, reprographics and pre-press, E-marketing-traditional marketing vs. e-marketing-internet marketing-e advertising new trends in internet marketing-e branding - e-payment systems and security features in internet

UNIT V **9**
 Proofing options and approval processes, Technological aspects of printing processes, other processing techniques, Quality control in packaging, s, holograms on labels, printing inks and adhesives, Packaging and Branding: Brand Loyalty and Brand Equity-Labeling-Product Life Cycle-New Product Development

TOTAL – 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the

1. Aware to develop food packaging designs and the technologies used in packaging printing.
2. Understand the Basic Concept of Printing on Packaging.
3. Assess latest food Printing technologies for adoption in food industry.
4. Evaluate the chemical hazards and toxicity with packaging materials and regulations.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	2
2	3	3	2	3	3	3	2	-	-	-	1	3	3	-	2
3	3	2	2	2	3	3	1	-	-	-	1	3	2	-	1
4	3	3	2	3	3	2	2	-	-	-	1	2	1	-	2
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	1.75

TEXTBOOKS:

- (1) Giles, "Design and Technology of Packaging Decoration for the Consumer Market", Blackwell, 2001.
- (2) Yam K. L., "The Wiley Encyclopedia of Packaging Technology", Third Edition, Wiley, 2009
- (3) Klimchuk & Krasovec, "Packaging Design: Successful Product Branding from Concept to Shelf".

UNIT I**GLASS TECHNOLOGY**

1. Different Types of Glass 2. Manufacture, 3. Properties, 4. Users, 5. Different Methods of Production, 6. Quality Control and Instrumentation. 7. Special Glasses. 8. Refractories: Additives and their Effects. Basic processes of glass making, Batch process, Continuous process, Raw materials selection, Batch house & mixing, Batch transportation, Tank furnace, Batch feeding, Melting & refining,

UNIT II

Concept and Advanced Processing of Glass Packaging Bottle glass, Sheet glass, Glass Containers, Other glasses, Annealing, Thermal treatment, Chemical treatment, Production control & planning- Bottle Forming Process & Designs. Quality control & testing of finished glass bottles - USP Types of Glass and Properties and its applications and testing.

UNIT III**METAL CONTAINERS**

Metals in Packaging & their properties - Aluminium based: Conversion processes for Sheets - Aluminium Foil, properties & their applications. Aluminium cans/ Containers: Impact extruded containers. Collapsible tubes, definitions, manufacture – materials. Closing and sealing, annealing, internal coating, marking – decorating, sizes, dimensions, descriptions, nozzles, caps. Decoration, printing of metal containers

UNIT IV**CONCEPT AND ADVANCEMENT IN METAL PACKAGING**

Steel based: Stainless & Galvanized Steel - Coated steels like Tinplate, Tins and cans: Tin coating, black plate, Tin free Steel - Polymer coated - properties & their applications. Metal Cans – Two-piece Cans - Draw & redraw, Draw & iron, Walled iron Cans - Welded & Seamless Cans - Collapsible Tubes – Aerosol Containers- Quality control & testing of Metal Packaging. Steel Drums General, classification, materials, manufacturing process, internal lacquering/external painting, closure, liners. Metal crates & Trays: Aerosols. Aerosols valves. Lacquers and coating for tin cans. Testing of cans – water, vacuum Filling and closing of cans, vacuum packaging.

UNIT V**WOODEN CONTAINERS**

Classification of wood species identification, quality control in wood. Properties of wood, preservation of timber, principles of construction of box and crates, styles of box and crates, choice of thickness, width of planks, battens. Nails-types of nails, skid base and sill base packages, reinforcements, reinforcements, determining cross section of skids. Formulae for calculating thickness of sides, tops and bottom of nailed boxes. Case closures – captive screw closures, palm bolts, strap bolts. Plywood containers: Wire bound boxes, large frame wooden cases, wooden casks, Wooden based Packaging, Pallet and Palletization.

TOTAL – 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Develop food packaging designs in Glass and the technologies used in packaging industries.
2. Aware about the latest technologies in glass, design packaging of foods in relation to laws and regulations
3. Understand basic concepts of metals in packaging and their characteristics.
4. Improved knowledge in wood and glass materials adoption in food industry.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	2	2	-	2	1	-	-	-	-	2	2	-	2
2	3	3	2	3	-	3	2	-	-	-	-	3	2	-	2
3	2	1	1	2	-	2	1	-	-	-	-	3	1	-	1
4	3	3	2	2	-	2	2	-	-	-	-	2	3	-	1
Avg	2.5	2	1.75	2.25	0	2.25	1.5	0	0	0	0	2.5	2	0	1.5

TEXTBOOKS:

1. Glasses and the Vitreous State – J. Zarzycki
2. Handbook of Glasses – R. H. Doremus
3. Handbook of Glass Manufacture - F.V. Tooley
4. Handbook of Glass Properties – G. W. Morey.
5. J. F. Hanlon, Handbook of Package Engineering, CRC Press
6. F. A. Paine, The Packaging User's Handbook, Springer

FD3046

PLASTICS AND POLYMERS IN PACKAGING

L T P C
3 0 0 3

UNIT I INTRODUCTION TO PLASTICS, POLYMERS AND DIFFERENT PROCESS AND PACKAGING 9

Polymeric materials – Definitions, Classification types, properties and applications. Crystalline in polymers. Polymer degradation Polymer blends, alloys and composites – Basic concepts Selection of materials. Additives for plastics – Basic need for incorporating additives. Classifications of additives. Types and applications. Incorporation of additives (Elementary concepts only).

UNIT II 9

Injection moulding of thermoplastics materials. Constructional features of moulding equipment. Technical specifications of the injection moulding machine Moulding cycle. Various process parameters and their influence on the quality of the moulded products. Trouble shooting in injection moulding. FRP process - Ancillaries used in FRP. Processes like hand layup, spray up & filament winding techniques

UNIT III 9

Extrusion – Constructional features of extruded equipments, blown film, cast films, multiplayer films, Biaxially oriented films, Extrusion of sheets, tapes, box strapping and monofilaments. Extrusion coating/ lamination Aspects to be covered are auxiliary equipment, plant layouts, process parameters and their effect on the quality of the extruded products and trouble shooting.

UNIT IV CONCEPT AND ADVANCED PROCESSING OF PLASTICS AND POLYMER PACKAGING 9

Blow moulding – Constructional features of a blow moulding equipment. Materials for blow moulding. Classification – Extrusion blow moulding () Injection blow moulding & Stretch blow moulding (injection & extrusion) Comparison of the above processes Trouble shooting in blow moulding. Calendaring – plant layout – calender roll construction & configuration. Process parameters and their influence. Trouble shooting in calendaring.

UNIT V 9

Thermoforming - Male mould forming, female mould forming, plug assist forming & continuous forming lines. Trimming device and techniques. Rotational moulding – Materials used. Principle of biaxial drives & moulding plants. Foam plastics – Moulding of expandable polystyrene material. Preparation of expandable PS beads - Preparation, stabilisation & moulding stages.

TOTAL – 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the importance of food polymers
2. Explain the concept of selection of packaging materials.
3. Understand the effect of various methods of processing on the structure and texture of food materials with relate to plastics
4. Understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation of food materials.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	2	2	-	2	1	-	-	-	-	2	3	-	1
2	3	3	2	3	-	3	2	-	-	-	-	3	2	-	2
3	2	1	1	2	-	2	1	-	-	-	-	3	2	-	1
4	3	3	2	2	-	2	2	-	-	-	-	2	2	-	2
Avg	2.5	2	1.75	2.25	0	2.25	1.5	0	0	0	0	2.5	2.25	0	1.5

TEXTBOOKS:

1. Pye R. G. W., "Injection Mould Design: A Design Manual For The Thermoplastics Industry", Longman Scientific And Technical.
2. Dubois J. H. & Pribble W. I., "Plastics Mold Engineering Handbook", Springer
3. Peter Jones, "The Mould Design Guide", Rapra.
4. Fisher E. G., "Extrusion Of Plastics", Wiley.
5. Joshi M. V., "Dies For Plastic Extrusion", Macmillan.
6. Miller Edward, "Plastic Product Design" Part A&B, CRC Press.
7. Norman Lee, "Blow Moulding Design Guide", Hanser Publication

FD3047

PAPER, CFB AND PAPER BOARD BASED PACKAGING

L T P C
3 0 0 3

UNIT I

9

Paper and board manufacture. Pulp characterization for the manufacture of paper and board. Stock preparation mechanism for paper and board manufacture. Types of papers and boards and their Grades and characteristics, Speciality papers: Wrapping, kraft, brown, creep, reinforced, greaseproof, glassine, vegetable parchment, sack kraft paper, tissue paper, waxed paper, coated paper, Bituminised paper and others.

UNIT II

9

Folding board cartons. Standard industry terminology. General nomenclature, usual consideration, styles, dimensions, materials, coating structure, printing, crease quality, packing and storage, multipacks, Corrugated Fibre Board, Box Style & Their Economics.

UNIT III

9

Composite Containers: General consideration, construction, types, materials, manufacture, economy, applications, composites for liquids, Multiwall paper Sacks.

UNIT IV

9

Cellulosic Film, Cellulosic Materials, Processes in Cellulose Industries, Paper and Board Manufacture, Testing of Cellulose and Paper Materials, Speciality Papers, Folding Cartons, Multiwall Paper Sacks, Composite Containers.

UNIT V

9

Application of paper and paper board in packaging., Concept and Advanced Processing of Paper and Paperboard Packaging, Concept and Automation in Corrugated Fibre Board Boxes Packaging,

Testing.

TOTAL – 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Interpret development and designs of different packaging products.
2. Able to develop models for various food products in paper-based materials.
3. Understand the importance of packaging applications for all food groups
4. Familiarize to use packaging instruments and analytical techniques.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	1	1	-	-	-	1	2	2	-	2
2	2	3	2	3	-	2	2	-	-	-	1	3	1	-	2
3	2	2	2	2	-	1	1	-	-	-	1	3	2	-	1
4	1	3	2	3	-	2	2	-	-	-	1	2	2	-	2
Avg	1.75	2.25	1.75	2.5	0	1.5	1.5	0	0	0	1	2.5	1.75	0	1.75

TEXTBOOKS:

1. F. A. Paine, The Packaging User's Handbook, Springer2.
2. Handbook of Paper and Paperboard Packaging Technology, Second Edition, by Mark J Kirwan

FD3048

PACKAGING LAWS AND REGULATIONS

L T P C
3 0 0 3
9

UNIT I

STANDARD AND QUALITY CONTROL. 1) Basic concepts. 2) Standard for packaging material - rigid, non – rigid and ancillary material. 3) Standard for export packages – labelling and marketing regulations. 4) Packaging quality control criteria. 5) Sampling, variables and attributes, AQL. 6) Implication of ISO-9000. 7) Eco Packaging and regulation. 8) Recycling and Disposal of Packaging Waste.

UNIT II

9

LAWS & REGULATIONS

a) Food Safety & Standards Act, 2006 b) The Legal Metrology Act, 2009 (Packaged Commodities Rules, 2011) c) UN certification code for packaging of Dangerous goods. d) Packaging laws and regulations – legal requirements

UNIT III

9

Packaging Laws and Regulations Standards, Bureau of Indian standard, standardization, Quality standards Legal Meteorology Act, FDA/ AGMARK rules and regulations, Eco- regulations, eco labeling, Pollution control related to packaging, IMDG, ICAO, Life Cycle Analysis, Export Regulations, recent FSSAI act, RFID, Barcode Markings & Labeling on Transport packaging.

UNIT IV

9

Packaging Laws & Regulations Standards, Bureau of Indian standard, standardization, Quality standards. Legal Meteorology Act, Weights and measures Acts, FDA/ AGMARK rules and regulations, Eco- regulations, eco labeling, Counterfeiting, IMDG, ICAO, Life Cycle Analysis, Export Regulations,

UNIT V

9

Governing laws and regulations involved in packaging of products FSSAI Rules and Regulations, Packaging Standards, Laws and Regulation, Role of BIS, FSSAI, MoFI and NABL, IATA, ILAC,

IMDG, ASTM, TAPPI, IMDG with reference to the Packaging Industry.

TOTAL – 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the various laws and associated Authorised bodies and functions and responsibilities.
2. Analyze the testing and labeling regulatory requirements with respect to food packaging
3. Maximize knowledge to FSSAI, associated with and laws, regulations and the monitoring agencies involved food safety, labelling of foods, and international bodies.
4. Elaborate registration and obtaining license from FSSAI, Packaging laws and regulations.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	2	1	-	-	-	1	2	2	-	1
2	3	3	2	3	3	3	2	-	-	-	1	3	3	-	2
3	3	2	2	2	3	3	1	-	-	-	1	3	2	-	2
4	3	3	2	3	3	2	2	-	-	-	1	2	1	-	3
Avg	2.75	2.25	1.75	2.5	2.75	2.5	1.5	0	0	0	1	2.5	2	0	2

TEXTBOOKS:

- 1) Yam K. L., “The Wiley Encyclopedia of Packaging Technology”, Third Edition, Wiley, 2009

FD3049

PACKAGING PERFORMANCE TESTING AND PROCESS, MACHINERY AND EQUIPMENT

**L T P C
3 0 0 3**

UNIT I

9

Introduction to Food Preservation/ Packaging Technology, Method of Storage. - Speciality packages a) Aerosols, easy opening devices, carry home packs, Strip packaging, shrink packaging, blister packaging, skin packaging and stretch wrapping. Systems packaging – Lined cartons, Form Fill Seal (FFS), Stand – up pouches, etc. Controlled Atmosphere packaging (CAP) and Modified Atmosphere packaging (MAP). Aseptic packaging.

UNIT II

9

Product Packaging (Food / Pharmaceuticals / Cosmetics / Chemicals etc. Packaging of food products a) Agriculture produce. b) Processed and dehydrated food. c) Milk and milk products. d) Meat and poultry products. e) Marine products – Shrimps. f) Spices. Packaging of other specific items a) Pharmaceuticals. b) Tea. c) Cosmetics and Perfumery. d) Soaps, detergents and shampoos. e) Chemicals and fertilizers. f) Petroleum products. g) Pesticides. h) Light Engineering Goods and domestic appliances. i) Heavy machinery and equipment. j) Textiles and Garments. k) Handicrafts and other products

UNIT III

9

Packaging processes and machinery – types, characteristics and specialties; selection and specification. Equipments for canning, paper / board carton, flexible packaging, etc. Packaging Machinery: Types, merits, demerits of the process Filling of dry and liquid products Gravimetric filling, volumetric filling, filling of still liquids, Filling of carbonated liquids and other packaging techniques.

UNIT IV

9

In line check weighing Equipment for filling tubes, packaging of counts, automatic capping machinery, form-fill seal machinery for liquids, non-liquids, rigid preformed container machinery, bag handling-filling-sealing machinery, Cartoning, Labelling, Thermoforming. In plant plastic bottle making; Laminating, Hot melt – use, method, equipment; Vacuum and gas packaging, method,

application, equipment. Latest developments in packaging machinery.

UNIT V

9

1) Shrink and stretch wrapping equipment. 2) Blister packaging equipment 3) Strip packaging 4) Lined cartons 5) Standi pack 6) Labelling machinery 7) Cartoning machinery 8) Wrapping, multipack wrapping and bundling 9) In plant plastic bottle making 10) Laminating – slitting – sheeting 11) Code marking and imprinting 12) Tape dispensers 13) Hot melt – use, method, equipment 14) Vacuum and gas packaging, method, application, equipment 15) Packaging of pottery and ceramics 16) Latest developments in packaging machinery

TOTAL – 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand and identify the specific processing technologies used for foods and the various products derived from the materials.
2. Well equipped with skills on handling food equipment's.
3. Prove knowledge to instruments working, calibration.
4. Understand and apply advanced preservation and packaging techniques for all food products.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	2	1	2	1	-	-	-	1	1	2	2	-
2	3	3	2	1	3	3	2	-	-	-	2	3	2	2	-
3	3	2	2	2	3	3	1	-	-	-	1	3	3	1	-
4	3	3	2	3	2	2	2	-	-	-	2	2	1	3	-
Avg	2.5	2.5	1.75	2	2.25	2.5	1.5	0	0	0	1.5	2.25	2	2	0

TEXTBOOKS:

- 1) Yam K. L., "The Wiley Encyclopedia of Packaging Technology", Third Edition, Wiley, 2009
- 2) F. A. Paine, The Packaging User's Handbook, Springer
- 3) Pharmaceutical Packaging Handbook By Edward Bauer
- 4) Textbook of Pharmaceutical Packaging Technology by Kaushik

FD3050

INTRODUCTION TO BAKING AND BAKERY PRODUCTS

L T P C

3 0 0 3

UNIT I

INTRODUCTION

9

Historical development and status of bakery industry in India; Introduction and definition of bakery products as per FSSAI – bread, biscuit, cake, pastries, rusk, crackers, bun and their specifications. present status and future prospectus

UNIT II

BAKERY INGREDIENTS

9

Classification of bakery products. Bakery ingredients and their functions-Essential ingredients. Flour, yeast and sour dough, water, salt- Other ingredients Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants.

UNIT III

TRADITIONAL AND SPECIALITY PRODUCTS

9

Cakes, biscuits, pastries, pretzels production and quality control, Enriched Bakery Products - Bakery goods with soya flour, groundnut flour, whole wheat meal etc., bakery products of unconventional flours, dietetic bakery products. Specialities from All Over the World ; Bakery

Products of China ; Italian Bakery Products ; Mexican Bakery Products ; Bakery Products of Turkey.

UNIT IV BAKERY INGREDIENTS AND ADDITIVES 9

Water, leavening agents, Salt, Sweeteners, Eggs, Milk, Proteins, Enzymes, Lipids, Starch – Role of ingredients in baking. Functionality of minor ingredients - Functions of milk and milk products, malt and malt products, yeast food, vital gluten, redox agents in bakery systems - Introduction, basics of dough development, redox requirements in bread making process. Surfactants and anti-microbial agents, hydrocolloids, colors, flavour and flavouring materials.

UNIT V BAKERY PLANT LAYOUT 9

Plant layout and maintenance for bakery and confectionery processing: Introduction to food plant design - plant location - location factors, site selection - layout - objectives, classical and practical layout – preparation of process chart and machinery layout – product layout and process layout - repair and maintenance of equipment – preventive and breakdown maintenance – replacement of equipment

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

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

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	-	2	2	-	-	-	1	2	2	1	1
2	3	2	3	3	-	3	2	-	-	-	1	3	3	1	2
3	3	2	2	2	-	3	1	-	-	-	2	3	2	1	2
4	2	3	2	3	-	2	2	-	-	-	1	2	2	2	1
5	2	1	2	1	-	2	2	-	-	-	1	2	1	2	2
Avg	2.4	2	2.2	2.2	0	2.4	1.8	0	0	0	1.2	2.4	2	1.4	1.6

TEXT BOOKS:

1. Matz, Samuel A., —Bakery Technology and Engineering, 1992, 3rd Edition, Chapman & Hall, London.
2. Cauvain, Stanley P, and Young, Linda S., —Technology of Bread Making, 2007, springer

REFERENCES:

1. Edwards W.P. — Science of bakery products, RSC, UK, 2007
2. Samuel A. Matz., —Equipment for Bakers, Pan Tech International Publication. 1988.

FD3051 FLOUR CHEMISTRY AND RHEOLOGY

**L T P C
3 0 0 3**

UNIT I FLOUR 9

Flour: Refined, composition, nature of gluten and its functions in bread making and baking. Simple tests for flour quality, colour, gluten and water absorption. Blended flours and their suitability for use in different types of baked products. Flour improvers.

UNIT II WHEAT FLOUR**9**

Wheat grain structure and composition, classification and grading, dry milling of wheat, flour characteristics, optimization, chemistry & biochemistry – wheat proteins, adverse reactions to wheat proteins, polysaccharides, interaction within components and interaction with other components

UNIT III PHYSIOCHEMICAL TESTS & FUNCTIONAL TESTS**9**

Principles and methods of estimation of moisture, protein, ash, minerals, fats, diastatic activity, starch damage content, maltose value, flour colour grade value and flour particle size distribution. Principles and methods of estimation of gluten quantity, SDS -Sedimentation volume, falling number, dough raising capacity and alkaline water retention test. Significance of above tests in relation to bread, biscuits and cakes.

UNIT IV BASIC APPROACHES TO DOUGH RHEOLOGY**9**

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. Bakery ingredients and dough rheology: Effects of water, yeast, oxidation and compounds with disulfide and thiol groups, sugar and emulsifiers on rheological properties of dough.

UNIT V RHEOLOGICAL TESTS**9**

Flour constituents, processing parameters and dough rheology : Influence of proteins, gluten, starch and enzymes on rheological properties of dough. Effects of mechanical work, mixing time and temperature on dough rheology. Application of dough recording mixers for assessing physical properties of the dough such as mixing behavior, water absorption, dough strength and stability. Determination of Extensograph characteristics of the dough. Application of viscoamylograph in dough testing

TOTAL:45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the use of wheat flour in bakery products
2. Perform the different tests for bakery products
3. Explain the concept of dough structure and basics of rheology
4. Assess the importance of rheological test for bakery products

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	2	1	1	-	-	-	1	2	2	2	2
2	2	2	2	1	3	2	2	-	-	-	1	3	2	1	1
3	1	2	2	2	1	1	1	-	-	-	1	3	1	1	2
4	2	3	2	1	2	2	2	-	-	-	1	2	2	2	1
Avg	1.75	2	1.75	1.5	2	1.5	1.5	0	0	0	1	2.5	1.75	1.5	1.5

REFERENCES:

1. Matz, Samuel A., —Bakery Technology and Engineering, 1992, 3rd Edition, Chapman & Hall, London.
2. Edwards W.P. — Science of bakery products, RSC, UK, 2007
3. Hui.Y.H. - Bakery products, Science and Technology, Blackwell, 2006
4. Zhou - Bakery products, Science and Technology, Second edition, 2014

UNIT I CONFECTIONERY**9**

Definition, importance of sugar confectionery. Types of confectioneries-classification-basic technical consideration of confectionery-TSS-pH-Acidity-Raw materials-types of sugar-role of sugar-alternative bulk sweeteners –syrup production-enzymes used, additives used. quality parameters, faults and corrective measures. Spoilage of confectionery products. Optimization of ingredients for different types of bread, toffees and sugar boiled confectionary.

UNIT II COMPRESSED TABLETS AND LOZENGES**9**

Introduction, formulations and ingredients – Base, binder, lubricant, disintegrant, acids, flavours, colors, actives. Processing – Lozenges / wafers, tablets. Product characteristics, Problems and trouble shooting.

UNIT III HARD CANDY**9**

Introduction , formulations and ingredients, processing – typical process steps, other hard candy technologies. Product characteristics – chemical changes, microstructure, stability / shelf life.

UNIT IV FONDANTS AND CREAMS**9**

Introduction , formulation and ingredients, manufacturing – fondant, powdered fondant, creams. Product characteristics, potential problems and trouble shooting.

UNIT V CARMEL , FUDGE AND TOFFEE**9**

Introduction , formulations and ingredients – sweeteners, dairy ingredients, fats, emulsifiers, hydrocolloids, salts, flavors, colors. Processing – Mixing & Emulsification, Cooking and browning, Cooling and forming. Product characteristics, Trouble shooting.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the basics about different confectionery products.
2. Determine the production of hard candy, fondants and creams.
3. Assess the preparation of sugar confectionary products
4. Interpret the formulations of caramel, fudge and toffee

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	-	2	2	-	-	-	1	2	2	-	2
2	3	2	1	3	-	3	2	-	-	-	1	3	3	-	2
3	2	2	2	2	-	3	1	-	-	-	2	3	2	-	3
4	2	3	2	2	-	2	2	-	-	-	1	2	2	-	1
5	2	1	2	1	-	2	2	-	-	-	1	2	1	-	1
Avg	2.2	2	1.8	2	0	2.4	1.8	0	0	0	1.2	2.4	2	0	1.8

REFERENCES:

- 1.Jackson E.B., - Sugar confectionery and chocolate manufacture, Blackie Academic & Professional, 1992.
- 2.Hartel.W ., - Confectionery science and technology, Springer, 2018

FD3053 INDUSTRIAL PRODUCTION OF COOKIES AND BISCUITS L T P C
3 0 0 3

UNIT I CLASSIFICATION AND PROCESSING TECHNOLOGY OF BISCUITS 9

Hard dough biscuits - ingredients and formulations, dough mixing, forming, baking, flavoring, cooling and packaging, Soft dough biscuits - ingredients and formulations, dough mixing, forming, baking, flavoring, cooling and packaging. Factors affecting biscuit dough spread during baking.

UNIT II BISCUIT MAKING MACHINES 9

Sheeting machines – sheeting process and some parameters, sheeters, gauge rolls, laminators. Reciprocating cutters – construction , shaping principle, crosshead drive, transmission. Rotary cutters – Construction, shaping principle, transmission.

UNIT III CLASSIFICATION AND PROCESSING TECHNOLOGY OF COOKIES 9

Characteristic features of ingredients of cookies, Quality assessment of raw ingredients used in cookies. Types of cookies, general process of cookies production - mixing, dough sheeting, baking, cooling and packaging.

UNIT IV COOKIE MAKING MACHINES 9

Rotary moulders – introduction, Construction, moulding principle, transmission system, operation. Extruder & depositor – Construction – Dough feed assembly, Die assembly, Shaping principle, Transmission system & operation.

UNIT V CRACKERS AND MISCELLANEOUS BISCUIT LIKE PRODUCTS 9

Classification of crackers - cream, soda and snack crackers. Manufacturing technology of crackers. Wafers and pretzels biscuits.

TOTAL : 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Analyze the role of ingredients in baking
2. Evaluate the processing technology of biscuits.
3. Examine the working of biscuit and cookie making machines
4. Apply the processing technology of cookies

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	2	-	2	2	-	-	-	1	2	2	1	1
2	3	2	3	3	-	3	2	-	-	-	1	3	2	1	2
3	3	2	2	2	-	3	1	-	-	-	2	3	2	2	1
4	2	3	2	3	-	2	2	-	-	-	1	2	1	2	1
Avg	2.5	2.25	2.25	2.5	0	2.5	1.75	0	0	0	1.25	2.5	1.75	1.5	2.5

REFERENCES:

1. Edwards W.P. — Science of bakery products, RSC, UK, 2007
2. Samuel A. Matz., —Equipment for Bakers, Pan Tech International Publication. 1988.
3. Matz, Samuel A., —Bakery Technology and Engineering, 1992, 3rd Edition, Chapman & Hall, London.

FD3054 INDUSTRIAL PRODUCTION OF BUN, BREAD, CAKES AND PASTRIES L T P C
3 0 0 3

UNIT I BREAD MAKING PROCESS 9

Status of bakery industry. Bread formulation, basic bread making procedure - mixing.

Fermentation, proofing and baking. Raw material receiving – quality check- batch making (addition of ingredients with respective proportion) – kneading – molding – panning - Proofing – baking – cooling – slicing – packing. Functions of mixing, types of mixer, functions of moulding and dividing, functions of proving, changes during mixing, fermentation and baking unit operations.

Straigh dough method, normal straight dough, 70% sponge and dough, 100% sponge and dough, soaker and dough method, ferment method, frozen dough process, micro-wave process. Advantages and limitations of various bread processes.

UNIT II INGREDIENTS & BREAD MAKING MACHINES 9

Role of ingredients, additives and improvers in bread making. Chemical leavening agents- baking powder, sodium bicarbonate, ammonium bicarbonate cream of tartar. Different types of bread - methods of bread preparation - quality aspects of bread and standards. Dividers – Construction, dividing principle and operation. Rounders - Construction, rounding principle and operation.

UNIT III BAKING OF CAKES 9

Role of ingredients - flours, oils and fats, eggs, sugar, dried fruits and nuts- types of cakes - methods of mixing - preparation of fancy cakes and techniques - quality - cake faults and remedies. Heat transfer in the oven, mixing and delivery of batter – batch & continuous mixers, depositing the batter, baking ovens- band, tunnel & reel ovens.

UNIT IV MIXING METHODS AND PROCESSING TECHNOLOGY OF CAKES 9

Shortening style cakes, creaming method, flour batter method, single stage , emulsion, continuous batter mixing, foam style cakes – angel food, sponge, chiffon, genoise cake. Types of cakes, formula balance in cake, production of cakes and pastry - mixing, baking, cooling and packaging. Cakes faults - shape, structure, texture, crust and colour faults. Remedies of cake faults.

UNIT V CAKE MAKING MACHINES 9

Encrusting machines – Introduction, Construction – General structure, Feed system ; Moulding – extrusion nozzle moulding, flourless encrusting moulding, encrusting disk moulding, Transmission system, Operation – Filling control, casing thickness control, product size adjustment, flour dusting regulation, stability disk adjustment.

UNIT V PASTRY 9

Basic formulation - different types - flaky, puff and danish pastry- bakery products that combines flour and fat. Pie - types and methods. Preparation methods of danish pasties and the role of ingredients used. Cold and hot pastries

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Assess the role of ingredients in cake baking process.
2. Examine the different mixing methods and machineries.
3. Evaluate the role of ingredients in pastry production.
4. Demonstrate the pastry production.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	1	-
2	3	3	2	3	-	3	2	-	-	-	1	3	2	2	-
3	3	2	2	2	-	3	1	-	-	-	1	3	1	2	-
4	3	3	2	3	-	2	2	-	-	-	1	2	2	2	-
Avg	2.75	2.25	1.75	2.5	0	2.5	1.5	0	0	0	1	2.5	1.75	1.75	0

REFERENCES:

- 1.Hui.Y.H. - Bakery products, Science and Technology, Blackwell, 2006

- 2.Zhou - Bakery products, Science and Technology, Second edition, 2014
 3.Edwards W.P. — Science of bakery products, RSC, UK, 2007

FD3055 PACKAGING OF BAKERY AND CONFECTIONERY PRODUCTS L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Introduction, History, Importance and functions of Food packaging. Properties of packaging material in relation to these functions, package design. Tests for flexible packaging materials. Materials used in packaging- rigid, semi rigid and flexible. Types of containers-primary & secondary, flexible & rigid, hermetic & non hermetic.

UNIT II BREAD PACKAGING 9

Storage of bread, packaging specifications, characteristics of packaging material, types of packaging – fundamental classification, different packaging materials.

UNIT III BISCUIT PACKAGING 9

Types of Biscuit Packaging, Packaging Functions, Packaging Materials, Modified Atmosphere Packaging, Vertical Form Fill Seal Packaging, On Edge Flowpack, Biscuits in Trays, Pile Packs, Cartons, Biscuit Tins

UNIT IV PACKAGING OF CONFECTIONERY PRODUCTS 9

The container, metal cans, paper and associated materials, types of paper, metal foil, transparent films, metallized films, shrink and stretch films, laminates, the type of wrap, wrapping materials in display and advertising, mechanical sealing methods, dessicant pouches.

UNIT V 9

Advance in packaging, different packaging materials, methods and machineries involved (primary, secondary and tertiary) in packaging. Selection of packaging materials and standards for baked products. Recent packaging techniques to extend the shelf life of the product. Technologies-MAP, hermetic packaging, convenient intelligent and smart packaging.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the basics of packaging.
2. Understand the packaging methods and materials for biscuit and bread.
3. Elaborate the packaging methods and materials for confectionery products.
4. Evaluate the different advances in packaging.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	1	2	1	-	-	-	1	2	2	1	2
2	3	1	2	2	1	2	2	-	-	-	1	3	2	1	2
3	2	2	2	2	2	2	1	-	-	-	1	3	3	1	3
4	2	2	2	3	1	2	2	-	-	-	1	2	2	1	1
Avg	2.25	1.5	1.75	2.25	1.25	2	1.5	0	0	0	1	2.5	2.25	1	2

TEXTBOOK:

1. Iain Davidson – Biscuit, cookie and cracker production – process, production and packaging equipment, Academic press, 2019.

2. Confectionery products handbook (chocolate, toffees, chewing gum & sugar free confectionery), Asia pacific business press, 2013.

REFERENCES:

1. Samuel A. Matz., —Equipment for Bakers, Pan Tech International Publication. 1988.
2. Ling-Min Cheng – Food Machinery, Ellis Horwood, 1992.
3. Matz, Samuel A., —Bakery Technology and Engineering, 1992, 3rd Edition, Chapman & Hall, London.

FD3056 LAWS AND REGULATIONS OF BAKERY AND CONFECTIONERY PRODUCTS L T P C 3 0 0 3

UNIT I SPECIFICATIONS FOR BAKERY INGREDIENTS AND PRODUCTS 9

BIS standards for whole wheat flour (atta), protein rich flour, maida, fortified maids, protein rich maids, suji (semolina), BIS standards for wheat flour used in bread/biscuit industry, limits for heavy metal contaminants in food grains, limits of pesticides/insecticides residues in food grains/milled food grains

UNIT II FOOD SAFETY REGULATIONS & CERTIFICATION 9

Need for testing of food, notified NABL labs, referral labs and reference labs in India. GMP, GHP, GLP practices, HACCP implementation program. Regulations and standards for maintaining food safety and quality –BIS, FSSAI and International standards – FSSAI packaging and labeling requirements. FSSAI registration and licensing procedure.

UNIT III BAKERY HYGIENE 9

Cleaning and Sanitation in bakery, General cleaning and sanitizing program Cleaning methods: Clean-out-of-Place Manual cleaning, Properties of food soils Cleaning agents, Sanitizers: Physical and chemical Factors affecting effectiveness of sanitizer

UNIT IV SAFETY AND SANITATION 9

Health and safety – safety rules- safe practices in the work places – sanitation – duties of the sanitation equipments – Code for hygiene condition in bakery and biscuit manufacturing unit.

UNIT V SENSORY ATTRIBUTES OF BAKERY PRODUCTS 9

Introduction to basic principles in sensory assessment – sensory attributes and senses, general requirements for sensory assessment. Sensory attributes of bakery products. Factors affecting sensory attributes of bakery products.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the different specifications for bakery products.
2. Apply the food safety regulations
3. Explain safety and sanitation followed in baking industries.
4. Appraise the different sensory attributes

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	2	2	1	2	1	-	-	-	1	2	2	-	1
2	3	3	2	3	2	3	2	-	-	-	1	3	2	-	2
3	3	2	3	2	1	3	1	-	-	-	1	3	3	-	2
4	2	3	2	3	1	2	2	-	-	-	1	2	1	-	1
Avg	2.5	2.25	2.25	2.5	1.25	2.5	1.5	0	0	0	1	2.5	2	0	1.5

REFERENCES:

- 1.Hui.Y.H. - Bakery products, Science and Technology, Blackwell, 2006

2. Zhou - Bakery products, Science and Technology, Second edition, 2014
 3. Edwards W.P. — Science of bakery products, RSC, UK, 2007

FD3057 PROCESSING, STORAGE OF SPICES AND PLANTATION CROPS L T P C
3 0 0 3

UNIT I DRYING AND STORAGE OF MAJOR SPICES 9

Different methods of drying and storage, microbial contamination of stored product, influence of temperature and time combination on active principles of spice crops, viz., Pepper, Cardamom, onion, ginger and turmeric .Extraction of oleoresin and essential oils.

UNIT II DRYING AND STORAGE OF MINOR SPICES 9

Different methods of drying and storage, microbial contamination of stored product, influence of temperature and time combination on active principles of spice crops, viz., Cumin, Coriander, Cinnamon, fenugreek, pepper, Garlic, Clove and Vanilla . Extraction of oleoresin and essential oils.

UNIT III DRYING AND STORAGE OF PLANTATION CROPS 9

Different methods of drying and storage, microbial contamination of stored product, influence of temperature and time combination on active principles of plantation crops, viz., coconut, arecanut, cashewnut, oil palm, palmyrah, cocoa, tea and coffee.

UNIT IV FORMS, FUNCTIONS, AND APPLICATION OF SPICES 9

Spice forms and composition – fresh whole spices, dried spices. Spice extractives – essential oils, oleoresins, other spice extractives. Functions of spices – primary function of spices, secondary function – preservatives, antimicrobials, antioxidants. Emerging functions of spices – spices as medicines, traditional medicine, modern medicine.

UNIT V EQUIPMENT IN SPICE PROCESSING 9

Spice cleaning - Magnets , sifters, air tables, destoners, sir separators, indent separators, spiral separators. Spice reconditioning. Spice grinding - Different mills sifting operations, ambient condition grinding, cryogenic grinding. Post processing treatments - Ethylene oxide, propylene oxide, irradiation, steam sterilization.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Learn about drying and storage of spices
2. Evaluate the extraction of flavour components from minor and major spices
3. Acquire knowledge to forms, functions and application of spices
4. Learn about equipment in spice processing.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	-	2
2	3	2	2	3	-	3	2	-	-	-	1	3	1	-	3
3	3	2	2	2	-	3	3	-	-	-	1	3	2	-	2
4	2	2	1	3	-	2	2	-	-	-	1	2	2	-	2
Avg	2.5	1.75	1.5	2.5	0	2.5	2	0	0	0	1	2.5	1.75	0	2.25

TEXTBOOKS:

1. Pandey, P. H. Post-Harvest Engineering of Horticultural Crops through objectives. Saroj Prakasam, Allahabad. 2002.
2. Shanmugavelu KG, Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018.

REFERENCES:

1. ASTA, Official analytical methods of the American Spice Trade Association, IV Edition, 1997.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1st Edition. Academic Press Inc., New York, USA. 2011.

FD3058**BLENDING AND VALUE ADDITION****L T P C**
3 0 0 3**UNIT I****9**

Value added products: Spice powders, Curry powders, Sterilized spices, Enriched Spices, Encapsulation, aqueous flavourants.

UNIT II**9**

Spice Oils & Oleoresins: Flavor extraction from spices by different methods. Estimation of principle constituents in spices & spice products, residual solvent in spice oleoresins.

UNIT III**9**

Simple seasoning blends - Soluble seasonings, celery salt, garlic salt and onion salt, chili powder, curry powder, pickling spice, poultry seasoning, pumpkin pie spice, apple pie spice, oriental five spice blend.

UNIT IV**9**

Spice applications - Marinades, rubs, glazes. Spice blends, seasonings and condiments.

UNIT V**9**

Value addition Indian spices - Whole spices, spice blends, crushed spices, curry mixes, curry pastes, pickled spices, freeze dried spices, dehydrated spices, natural food colors, spice oils and oleoresins.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Learn about different value added spices
2. Acquire knowledge to spice oil and oleoresin production
3. Learn about different spice application.
4. Explain about value additions in spices.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	2	2
2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	2
3	2	2	3	2	-	3	1	-	-	-	1	3	2	1	2
4	1	1	2	3	-	2	2	-	-	-	1	2	1	2	3
Avg	2	1.75	2	2.5	0	2.5	1.5	0	0	0	1	2.5	2	1.75	2.25

TEXTBOOK:

1. Susheela R., Handbook of Spices, Seasonings, and Flavorings, CRC Press, 2006
2. Amir Baran .S., Indian Spices – The legacy , production and processing of India’s treasured export, Springer, 2018.

FD3059**PROCESSING OF COFFEE****L T P C**
3 0 0 3**UNIT I GREEN COFFEE PROCESSING****9**

Introduction, Occurrence–chemical constituents–harvesting, dry processing method – natural and artificial drying, wet processing method – receiving, pulping, separation, fermentation, washing, draining, drying of the parchment coffee. Curing – redrying, cleaning, hulling, size grading, sorting. Storage , handling. Grading , storage, pre-treatments and blending.

UNIT II DECAFFEINATION OF COFFEE**9**

Introduction, solvent decaffeination, water decaffeination, supercritical carbon dioxide decaffeination, decaffeination of roasted coffee and extract, caffeine refining.

UNIT III ROASTING AND GRINDING**9**

Introduction , process factors in roasting – mechanisms, chemical changes, heat factors, physical changes, measurement of roast degree. Roasting equipment – horizontal drum roasters, vertical fixed drum, rotating bowl, fluidized beds and ancillaries. Grinding equipment.

UNIT IV EXTRACTION**9**

Introduction , mechanism and methods – soluble solids extraction, volatile compound extraction, compositional factors. Process equipment – percolation batteries, screw extractor.

UNIT V DRYING**9**

DRYING - Introduction , process factors in spray drying – methods, compositional changes, spray formation, spray air contact, mechanisms of water removal & volatile compound retention, agglomeration. Process factors in freeze drying – methods, mechanisms of water removal & volatile compound retention. Pre-concentration – evaporation, freeze concentration, reverse osmosis. Process equipment.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Learn about processing steps involved in green coffee processing and decaffeination.
2. Acquire knowledge to post-harvest processing of coffee
3. Assess the unit operations and processing steps involved in the manufacture of coffee
4. Learn about processing involved in instant coffee

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	2	1
2	3	2	2	1	-	3	2	-	-	-	1	3	2	1	1
3	2	2	2	2	-	3	1	-	-	-	1	2	3	2	2
4	3	2	2	1	-	2	2	-	-	-	1	2	2	1	1
Avg	2.5	1.75	1.75	1.5	0	2.5	1.5	0	0	0	1	2.25	2.25	1.5	1.25

TEXT BOOK

1. Clarke.R.J & Macrae.R – Coffee, Volume 2: Technology 1st edition.

REFERENCES

1. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1st Edition. Academic Press Inc., New York, USA. 2011.

FD3060

PROCESSING OF TEA

L T P C

3 0 0 3

9

UNIT I INTRODUCTION

Tea - Occurrence–chemistry of constituents–harvesting - tea plucking – basics of plucking, tipping, systems of plucking, standards of plucking, plucking interval, different types of plucking. Tea plucking machines –types of tea–green, oolong and ctc. Speciality teas, herbal teas, china tea, flavoured teas, teas with historical associations, packaging format, organically grown tea.

UNIT II GREEN TEA

9

Introduction to green tea production, manufacturing process – Post harvest spreading of leaves – Fixing, Rolling, Shaping and Drying. Chemical and Biochemical changes during green tea processing. Character of green tea – taste – chemical components responsible for tea taste, roast aroma.

UNIT III SEMI-FERMENTED TEA

9

Manufacturing process for semi fermented tea – Plucking, Pruning, Jat, Flush, Withering, Rolling, Shifter, Fermentation, Drying, Sorting and Grading. Character of semi fermented tea, - aroma of oolong tea, mechanism, aroma pattern under different degrees of fermentation, infusion color and taste of oolong tea.

UNIT IV BLACK TEA

9

Introduction, orthodox tea , CTC tea. principal stages of processing – withering, cutting, rolling, oxidation or fermentation – different methods, drying or firing, sorting and fibre removal. Different grades of tea. Chemistry and biochemistry of black tea production - non volatiles. Green leaf polyphenols, polyphenol oxidase, black tea polyphenols. Tea aroma - Introduction, biogenetic pathways of the aroma compounds in the tea, changes in the composition of the aroma complex, use of the aroma complex.

UNIT V INSTANT TEA

9

Introduction, production of instant tea – Extraction, Decanting, aroma stripping, De-creaming, Concentration, Blending, Drying . Grading of tea, Processing and quality control.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Learn about processing steps involved in different types of tea
2. Acquire knowledge to post-harvest processing of tea
3. Assess the unit operations and processing steps involved in the manufacture of coffee
4. Learn about processing involved in instant tea.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	-	2
2	3	2	2	1	-	3	2	-	-	-	1	3	2	-	2
3	2	2	2	2	-	3	1	-	-	-	1	2	2	-	1

4	3	2	2	1	-	2	2	-	-	-	1	2	2	-	2
Avg	2.5	1.75	1.75	1.5	0	2.5	1.5	0	0	0	1	2.25	2	0	1.75

TEXTBOOK:

1. Wilson.K.C – Tea-cultivation to consumption, Springer, 2012

REFERENCES:

1. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1st Edition. Academic Press Inc., New York, USA. 2011.

FD3061

PROCESSING OF COCOA AND CHOCOLATE

L T P C
3 0 0 3
9

UNIT I COCOA

Introduction, Flowering and pod development, Harvesting and pod opening, Bean composition and flavor precursor formation, Flavour development during post-harvest treatments of cocoa – Fermentation process and drying.

UNIT II INDUSTRIAL COCOA PROCESSING

9

Introduction, cocoa processing and technology – bean selection and quality criteria, cleaning, breaking and winnowing, sterilization, alkalization, roasting, nib grinding and liquor treatment, liquor pressing, cake grinding, cocoa powder production.

UNIT III CHOCOLATE MANUFACTURING PROCESSES

9

Mixing , refining, conching – dry conching, pastry phase, liquid conching, tempering, lipid crystallization and continuous phase character during chocolate, particle distribution in chocolate.

UNIT IV CHOCOLATE QUALITY AND DEFECTS

9

Chocolate quality – rheological measurements of chocolate quality, sensory evaluation of chocolate quality. Chocolate defects – fat bloom, sugar bloom.

UNIT V CHEMISTRY OF FLAVOR DEVELOPMENT DURING PROCESSING

9

Introduction, influence bean selection on chocolate flavour quality, effect of roasting , flavour development during chocolate manufacture, key flavour compounds in milk chocolate, key flavour compounds in dark chocolate. Sensory perception of quality in chocolates.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand the cocoa plantation
2. Acquire knowledge to cocoa processing and chocolate manufacturing technology
3. Learn about chemistry of flavour development during processing.
4. Evaluate chocolate quality and defects

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	PS O1	PS O2	PS O3
1	1	1	1	2	-	2	1	-	-	-	1	2	2	1	2
2	3	2	2	2	-	3	2	-	-	-	1	3	3	3	3
3	2	3	2	2	-	3	1	-	-	-	1	3	1	2	2
4	3	1	2	3	-	2	2	-	-	-	1	2	2	2	1
Avg	2.25	1.75	1.75	2.25	0	2.5	1.5	0	0	0	1	2.5	2	2	2

TEXTBOOK:

1. Emmanuel., - Chocolate science and technology, Wiley, 2010

REFERENCES :

1. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018

FD3062**PACKAGING OF SPICES, PLANTATION PRODUCTS****L T P C****3 0 0 3****UNIT I INTRODUCTION****9**

Introduction, History, Importance and functions of Food packaging. Properties of packaging material in relation to these functions, package design. Tests for flexible packaging materials. Materials used in packaging- rigid, semi rigid and flexible. Types of containers-primary & secondary, flexible & rigid, hermetic & non hermetic.

UNIT II PACKAGING OF SPICES**9**

Classification of spices with reference to packaging, determination of packaging requirement of spices, selection of packaging materials, objective assessment of packaging materials, Types of packaging materials – Paper and cardboard boxes, Aluminium foil, Combination of films, Co-extruded multi-layer films, tin and wooden containers.

UNIT III**9**

Nature and deteriorative characteristics of spices and spice products – Loss of aroma and flavour, Bleaching of colour, Loss of free flowing nature, microbial spoilage and insect infestation. Packaging material requirement of spices and spice products. Packaging for seeds and fruits, Packaging for leaves and stems, Packaging for flowers and buds, Packaging for roots and rhizomes, Packaging for bark, wood and resins. Storage.

UNIT IV PACKAGING METHODS AND MATERIALS FOR SPICES**9**

Packaging methods & Materials for spices and spice products: Bulk packaging – whole spice, spice powders. Unit packages – whole spices, spice powders. Packaging of dry spice mixes and pastes. Packaging of sauces/liquid salad dressings and fat spreads. Packaging of oleoresins and volatile oils. Insect infestation and microbial contamination in spices. Quality control of spices.

UNIT V PACKING OF ROAST, INSTANT COFFEE AND TEA**9**

Introduction , packing of roast whole bean coffee, packing of roast and ground coffee, packing equipment – degassing plant, roast and ground coffee, Instant coffee, methods, process and equipment involved– Chicory chemistry - Quality grading of coffee weight control. Packing of Tea.

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand the basics of food packaging
2. Acquire knowledge to spice packaging on different aspects
3. Learn about the packaging of coffee and tea.
4. Understand packaging methods and materials for spices

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	2	2
2	2	2	2	3	-	2	2	-	-	-	1	3	3	2	2
3	2	2	2	2	-	3	1	-	-	-	1	3	2	1	2

4	3	3	2	2	-	2	2	-	-	-	1	2	1	2	3
Avg	2.2 5	2	1.7 5	2.2 5	0	2.2 5	1.5	0	0	0	1	2.5	2	1.7 5	2.2 5

TEXTBOOK:

Peter K V, Handbook of herbs and spices, 2nd edition, Woodhead publishing company, 2006

REFERENCES:

1. Clarke.R.J & Macrae.R – Coffee, Volume 2: Technology 1st edition.
2. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018

FD3063	SPICE PROCESSING AND PRODUCTS LAWS, QUALITY STANDARDS AND REGULATIONS	L T P C 3 0 0 3
UNIT I	SPICE LABELING, STANDARDS, REGULATION AND QUALITY SPECIFICATIONS	9
	Spice definition and labeling, spice regulations, spice authenticity and quality concerns, spice quality specifications, maintaining spice quality.	
UNIT II	PACKAGING, GRADING AND QUALITY ANALYSIS OF SPICES	9
	Cleaning and grading of spices - packaging and storage of spices – grading specifications – AGMARK, ASTA, ESA specifications - processes involved in the manufacture of oleoresins and essential oils – quality analysis of spices and their derivatives	
UNIT III	ANALYSIS OF PLANTATION PRODUCTS	9
	Tea & Coffee- Preparation of sample, Moisture content, Total ash, Water soluble ash, Determination of Caffeine content by different methods, Microscopic examination, Determination of solubility in boiling water, Determination of Iron filings and size of the particles, Test for presence of added colouring matter	
UNIT IV	ANALYSIS OF SPICES	9
	Spices- Sample preparation, Determination of moisture, Acid insoluble ash, Determination of Cold Water Extract, Determination of Alcohol Soluble Extract , Calcium Oxide, Non Volatile Ether Extract, Volatile Oil, Crude Fibre	
UNIT V	SPICE SPECIFIC TESTS	9
	Allyl isothiocyanate in Mustard, p-hydroxybenzyl isothiocyanate in white mustard, Microscopic Examination of Spices, Black Pepper- Determination of Bulk density, Light berries, Piperine content, Turmeric- Determination of curcumin content, Starch content, Detection of chromate content, Detection of Argemone seeds in Mustard, Detection of Mineral Oil in Black Pepper, Detection of Papaya seeds in Black, Pepper, Detection of Turmeric in Chillies and Coriander, Detection of Oil Soluble Colour, Determination of Light and Heavy Filth in Spices and Condiments, Determination of capsaicin content in chilli powder.	
TOTAL: 45 PERIODS		

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the standards and specifications
2. Acquire knowledge to packaging, grading and quality analysis of spices
3. Learn about analysis of spices.
4. Assess the quality analysis of spices with respect to active constituents.

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	-	3
2	3	2	3	3	-	2	2	-	-	-	1	2	1	-	1
3	2	1	2	2	-	3	2	-	-	-	1	3	3	-	2
4	3	3	2	3	-	2	2	-	-	-	1	2	2	-	2
Avg	2.5	1.75	2	2.5	0	2.25	1.75	0	0	0	1	2.25	2	0	2

TEXTBOOK:

1. Susheela R., Handbook of Spices, Seasonings, and Flavorings, CRC Press, 2006

REFERENCES:

1. ASTA, Official analytical methods of the American Spice Trade Association, IV Edition, 1997.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1st Edition. Academic Press Inc., New York, USA. 2011.

FD3064

INTRODUCTION TO FOOD SAFETY ANALYSIS AND QUALITY RISK MANAGEMENT

**L T P C
3 0 0 3**

UNIT I

9

1 General overview of Food Safety, 2 Food Industry: A glance 3: Understanding contemporary U.S. food safety policy 4: Food laws and policies of India 5: Study on Food-borne Hazards, Illness & Epidemics, Food GMP and its regulations.

UNIT II

9

Food Safety Management System (HACCP LEVEL 4, ISO 22000/FSSC 22000), International standards and regulations for food safety, Understanding the basic concepts of microbiology in food safety, Emerging trends in food safety (like HARPC, etc), Food Quality Regulations and guidelines in India

UNIT III

9

Quality, Quality Assurance and Quality Control in pharmaceutical industry, Qualification and Validation, Quality Assurance and Quality Control- Possible Problems and Fixes, Introduction to Quality Risk Management & Total Quality Management, Computer System Validation (CSV), WHO Risk Based Approach Analysis, Case Studies

UNIT IV

9

Over view of food supply chain, Risks and Controls in Food Chain, Potential Hazards, Good Hygiene practices in food chain, Examples of Food safety Incidents, One Point Lessons in online Production, Risk and Control, Backward and forward flow of process line, Instrumental analysis of Food

UNIT V

9

Sensory Evaluation of Food, Good Laboratory Practices - Food Laws, Applied Statistical Method in Quality Assurance, Practical on Food Analysis – Hand on training on Physical Analysis, Chemical Analysis and Instrumentation Analysis of food, Laboratory demonstration, practicals and instrument

handling

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the basic Food Safety laws
2. Assess the safety with National and International standards
3. Facilitate in understanding the overall food safety and hazard controls.
4. Examine the quality with Sensory Evaluation of Food, Good Laboratory Practices

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	3	-	2
2	3	2	2	3	-	2	2	-	-	-	1	1	2	-	3
3	2	1	2	1	-	3	1	-	-	-	1	2	2	-	1
4	3	2	2	3	-	2	2	-	-	-	1	2	2	-	3
Avg	2.5	1.5	1.7 5	2.2 5	0	2.2 5	1.5	0	0	0	1	1.7 5	2.2 5	0	2.2 5

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. Food Safety Sanitation and Personal Hygiene
4. Food Safety Implementation from farm to fork – Puja Dudeja, Amarjeeth Singh, Sukhpal Khaur.

FD3065

HACCP IN FOOD PROCESSING AND PRESERVATION

L T P C
3 0 0 3

UNIT I

9

Food Safety: HACCP Principles, Haccp Plan, 2 Role of Pre requisite programmes (PRP) Operational Pre-REQUISITE Programmes (OPRP) and GMP in Food Industry, Implementation of HACCP in a food industry/retail food establishment/catering industry. Documentation required for implementation of HACCP.

UNIT II

9

HACCP levels, CP's, CCP Controls, Audit: First, second- & third-party audits, CAPA report Comprehensive global perspective of HACCP (USA, Canada, UK, EU, Africa, Japan) HACCP as a part of ISO 22000/FSSC 22000 8, HACP plan Preparation for different food products, Case Studies

UNIT III

9

Introduction to Food Processing, Food processing and its types, Microbial, Chemical, Physical Hazards, HACCP generic Model, Importance of Equipment/ Process Selection, Advantages in Implementing HACCP, Risks at different stages of Food Chain. Food Preservation and techniques, Food Good Manufacturing Practices, Good Laboratory Practices HACCP Implementation in Storage and Transport, Retail and Distribution

UNIT IV

9

Food Plant Design, layout and Food Logistics, Food Packaging Technology and Labelling Food Microbiology, food borne illness and hazards, Food Sensory Evaluation, Entrepreneurship Development in Food Processing, Case studies, Quality Risk Assessment, Quality Risk

Management: Ins and Outs, Deviation Management, CAPA, and Change control, Case Study.

UNIT V

9

HACCP based approach towards Food Safety, Principles of HACCP, Steps in HACCP, VACCP, Principles of Food Preservation, Processing and Packaging, Food Processing Operations, Principles, Good Manufacturing Practices, principles including novel and emerging methods, Hazards Associated with Sea foods, production of safe sea foods – Pre requisite programmes and HACCP, Risk assessment at different stages of sea food process, Application of HACCP, VACCP and TACCP system in Sea food Process

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the HACCP and its principles
2. Appraise the implementation of HACCP in food industries
3. Facilitate in understanding the overall protection and handling of food materials
4. Apply the Food Plant Design, layout, Food Logistics, Food Packaging Technology and Labelling

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	-	2
2	3	2	2	3	-	3	2	-	-	-	1	3	1	-	1
3	3	2	2	2	-	3	1	-	-	-	1	3	2	-	1
4	3	3	2	3	-	2	2	-	-	-	1	2	2	-	3
Avg	2.75	2	1.75	2.5	0	2.5	1.5	0	0	0	1	2.5	1.75	0	1.75

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. HACCP a Systematic Approach to Food Safety, A comprehensive Manual for Developing and Implementing a Hazard Analysis and Critical Control Points plan by Grocery manufactures Association.

FD3066 FSMS AND FOOD PRODUCT AND SUPPLY CHAIN MANAGEMENT L T P C 3 0 0 3

UNIT I

9

Introduction to GMP & PRP in the food industry, Global Food regulatory Authorities, Concept of HACCP implementation, Hazards and Risks, ISO 22000: Food Safety Management System.

UNIT II

9

Role of Management in FSMS in a Food Industry, FSMS Auditing, types of Audits and CAPA reports: Food Safety System Certification 22000 (FSSC 22000): Introduction & Audit Requirements, Pest Management, pests of Food Processing and Production, Facilities and Risks Involved, Pest Detection Strategies, Pest Control Strategies, Export and Import Clearance, Commodity Clearance at IEC and regulations, Case Studies.

UNIT III

9

Historical Background, The Need for HACCP, Principles of HACCP System, Application of HACCP, HACCP in Small-large Food Business, Assessment of HACCP, Operational Maintenance, Introductory of HACCP Concept in Product Development, HACCP team and Resource

Management, Novelties in HACCP for Food Operations , Principals Systems and schemes, Principles and associated Systems, Integrated Schemes and their limitations, CIP Background, COP Cleaning, Sanitization Chemistry, Common Cleaning Problems in Food Process environment.

UNIT IV

9

Formulation and Optimization of New Product, Sensory & Physical Estimation of Permuted Product, Analytical assessment of New Product Development Prototype, assessment with benchmark, Financial Estimation of Novel Products, Food safety Vigilance, Food Safety Problems with Acidic Foods, Contaminants, Adulterants, Legal compliance, regulatory affairs & Documentation, Hazards associated with drinking water, Risk Assessment and Risk Management, HACCP Case Studies – Industry Based Case Study

UNIT V

9

Food Industry- An Overview, Role of GMP & GAP in Food Supply Chain, Principles of Food Supply Chain Management, Principles of Management, Food Quality & Safety Aspects of Food Supply Chain (An international perspective) Food Supply Chain Risk Management and Mitigation Strategies, Industry based Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the overall food plant management
2. Understand about the regulations and their role in managing the food safety.
3. Facilitate them in understanding the overall management of food safety at all stages of food supply chain.
4. Evaluate the Formulation and Optimization of New Product

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	PS O1	PS O2	PS O3
1	2	1	1	2	1	2	1	-	-	-	1	2	2	-	2
2	3	3	3	3	1	3	2	-	-	-	1	3	3	-	2
3	2	2	2	2	2	2	1	-	-	-	1	1	2	-	2
4	3	2	2	3	1	2	2	-	-	-	1	2	2	-	3
Avg	2.5	2	2	2.5	1.2 5	2.2 5	1.5	0	0	0	1	2	2.2 5	0	2.2 5

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. Food Safety Sanitation and Personal Hygiene
4. Food Safety Implementation from farm to fork – Puja Dudeja, Amarjeeth Singh, Sukhpal Khaur.

FD3067

FOOD LAWS – INDIAN AND INTERNATIONAL

L T P C
3 0 0 3

UNIT I

9

Food Safety and Standards Act of India, 2006: Provision, definitions and different sections of the Act and implementation, FSS Rules and Regulations, Overview of other relevant national bodies (e.g. APEDA, BIS, EIC, MPEDA, Spice Board etc.), International Food Control Systems/Laws, Regulations and Standards/Guidelines with regard to Food Safety – (i) Overview of CODEX Alimentarius Commission (History, Members, Standard setting and Advisory mechanisms: JECFA, JEMRA JMPR): WTO agreements (SPS/TBT), Important national and international accreditation

bodies

UNIT II

9

Food Regulatory Affairs: Introduction to global regulatory authorities for food Industry, Food GMP and its regulations, From Farm to Fork: Understanding the Food Regulatory Cycle [International perspective of USA, Europe, UK, Canada, GCC (UAE), South Africa, Australia & New Zealand], Food safety in the process chain,

UNIT III

9

Documentation for launch of a new food product and regulatory filing in US, Europe, UK, India, Canada and Japan, Food Industry IPR, Patents, Copyrights and Trademarks, Food Product Marketing, Import and Export regulations, Compliance guidelines, Govt. Audits (FSSAI, BIS, etc), Food Regulations & Guidelines in India, Food Licensing & Registration in India, Industry based case studies

UNIT IV

9

FSSAI – Role, Functions, Initiatives (A General Understanding) Genesis and Evolution of FSSAI, Structure and Functions of Food Authority, Overview of systems and processes in Standards, Enforcement, Laboratory ecosystem, Imports, Third Party Audit etc., Promoting safe and wholesome Food (Eat Right India, Food Fortification, snf, Clean Street Food Hub, RUCO and various other social and behavioural change initiatives),

UNIT V

9

Training and capacity building, Role of State Food Authorities. Food Safety Compliance System (FoSCoS), Food Safety Training and Certification (FoSTaC), Food Licensing and Registration System' or (FLRS), food business operators, Food Import Clearance System, Indian Food Laboratory Network, (INFoLNET) RUCO, Detect Adulteration with Rapid Test (DART) FSSAI e Books on Food Safety (pink, purple, Yellow, Orange etc)

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the Food Safety
2. Understand about the regulations and training of food safety
3. Facilitate in understanding the overall view of FSSAI laws and regulations.
4. Comprehend the Training and capacity building and Role of State Food Authorities

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	1	2	1	2
2	3	2	2	1	-	3	2	-	-	-	1	3	2	1	2
3	2	2	2	2	-	3	1	-	-	-	1	2	1	1	2
4	1	2	2	2	-	2	2	-	-	-	1	2	1	1	2
Avg	2	1.7 5	1.7 5	1.7 5	0	2.5	1.5	0	0	0	1	2	1.5	1	2

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book – Ronald H. Schmidt, Gary E. Rodrick
3. Food Safety and Hygiene Regulations.
4. www.fssai.gov.in

UNIT I

9

Good Laboratory Practices GLP: FPO, Prevention of Food adulteration Act, Food Safety and Standard Act, Testing Food for its Safety, AGMARK). Hygiene and Sanitation (HACCP, Good Manufacturing Practices, Introduction, fundamentals and principles of GLP, Documentation, records and preparation of SOPs, GLP compliance & preparation for certification; ISO / IEC 17025: 2017 & Laboratory accreditation Module 4: Internal Quality Audits for various Quality Management Systems (QMS)

UNIT II

9

Use of Computers in the laboratory , General Good Testing Conduct, International GLP of the OECD, FDA etc, Management, Personnel, Buildings & Equipment , Validation and Quality Assurance , Inspection of a testing facility , Laboratory demonstration, practicals and instrument handling, Case studies

UNIT III

9

Hospitality Industry – An overview (hotels, restaurants, cafeterias, hospitals, travel & tourism, contract caterings etc) Food safety sensitization in Hospitality Industry, Food safety in preparation and service Premises, safety and personnel health & hygiene, Supply and storage of food in Hospitality Industry

UNIT IV

9

Basics of food microbiology and food borne-pathogens, Pest control management in Hospitality Industry, Food safety standards for Hospitality Industry (HACCP LEVEL 4, ISO 22000:2005, ISO 9001, ISO14000 etc), Food safety compliances in Hospitality Industry, International food safety legislations for Hospitality Industry (USA, UK, Europe, Australia, India, UAE etc perspectives) Food Quality Regulations and guidelines in India, Hospitality Industry based case studies.

UNIT V

9

Introduction to Food and Nutrition, Basics of Food Microbiology, Extrinsic and Intrinsic factors of microbial growth, Significance and principles of food preservation, Fermentation process and their products, Food Spoilage, Food safety guidelines for microbiology, Laboratory demonstration, practical and instrument handling, Industry based Case Studies

TOTAL: 45 PERIODS**COURSE OUTCOMES (COs)**

At the end of the course the students would have the knowledge to

1. Understand about the Food Safety in laboratories
2. Apply the laws of food safety in hospitality industry
3. Facilitate in understanding the overall management of food quality control.
4. Organise the basics of food microbiology and food borne-pathogens

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	2	-	2
2	3	2	2	3	-	3	2	-	-	-	1	3	3	-	2
3	3	2	2	2	-	3	1	-	-	-	1	3	2	-	2
4	3	3	2	3	-	2	2	-	-	-	1	2	1	-	3
Avg	2.7 5	2	1.7 5	2.5	0	2.5	1.5	0	0	0	1	2.5	2	0	2.2 5

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. Preventing food Poisoning in hospital and in home.

FD3069 FOOD ANALYSIS, TESTING AND MICROBIAL SAFETY ANALYSIS L T P C
3 0 0 3

UNIT I **9**

Fundamentals of field level and laboratory sampling with reference to importance of statistical tools, Overview of basic/classical methods of food analysis, Overview of modern analytical techniques including mass spectrometry and molecular techniques, Principles of Quality assurance and Quality control with reference to food analysis and testing.

UNIT II **9**

Principles and Basics of Food Chemistry and their role in Human Nutrition, Structure and functions of macro-and micro nutrients, Role of macro and micronutrients in human nutrition, Overview of food additives with respect to their technological functions, Overview of anti-nutritional factors and their removal from foods, Overview of enzymes as food processing aids, Overview of nutraceuticals and functions foods, Overview of food contaminants and adulterants and their effects on human health, Food allergens and allergen city, Importance of diet in alleviating health risks, especially non-communicable diseases.

UNIT III **9**

Food Microbiology & General principles of Food Hygiene, General principles of food microbiology and overview of food borne pathogens, Overview of sources of microorganisms in food chain (raw materials, water, air, equipment etc.) and microbiological quality of foods, Microbial food spoilage and Food borne diseases,

UNIT IV **9**

General principles and techniques in microbiological examination of foods, Overview of beneficial microorganisms and their role in food processing and human nutrition, General principles of food safety management systems including traceability and recall – sanitation, HACCP, Good production and processing practices (GMP, GAP, GHP, GLP, BAP, etc)

UNIT V **9**

General concepts of Food Analysis and Testing, Fundamentals of field level and laboratory sampling with reference to importance of statistical tools, Overview of basic/classical methods of food analysis, Overview of modern analytical techniques including mass spectrometry and molecular techniques, Principles of Quality assurance and Quality control with reference to food analysis and testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about the microbial food safety
2. Examine the hard controls at all stages of food manufacturing
3. Appraise the overall management of food laboratory
4. Elaborate the principles and Basics of Food Chemistry and their role in Human Nutrition

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	3	2	-
2	3	3	2	1	-	1	2	-	-	-	1	1	3	1	-
3	1	2	3	2	-	2	1	-	-	-	1	2	3	2	-
4	2	2	2	3	-	2	2	-	-	-	1	2	3	2	-
	2	2	2	2	0	1.7 5	1.5	0	0	0	1	1.7 5	3	1.7 5	0

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick

FD3070

FOOD QUALITY ASSURANCE AND QUALITY CONTROL

L T P C
3 0 0 3

UNIT I

9

Fundamentals of Food Quality Assurance and Quality Control, Quality Assurance in Food Industry Validation and Verification, Quality Control and testing procedures, Documentation, Good Documentation Practices, SOPs & Protocols, Establishing Quality Control Checks Inspection & Audits.

UNIT II

9

Role of Good Manufacturing Practices and their regulations in Quality Assurance and Quality Control, Total Quality Management in Food Industry, Quality Assurance- A risk-based approach (Possible problems & Fixes), Quality Certifications, Govt. Regulations, ISO, FSSAI & FDA Guidelines, Emerging trends in quality related aspects of food industry, Quality Systems in major segments of food industries, Laboratory demonstration, practicals and instrument handling

UNIT III

9

Introduction to Food GMPs, cGMPs (US FDA & WHO), HVAC Systems, Food HVAC Rules and Design, Validation of HVAC Systems, HVAC Audit and Inspection, WIP, CIP, Sanitation and Hygiene Practices and In-Process, Good Laboratory Practices (GLP), Physical & Chemical analysis of food, Molecular and Elemental Analysis of Food, Microbial Analysis of Food.

UNIT IV

9

Guidelines for Sample preparation, Instrument operation and Interpretation of results, laboratory demonstration and requirements, Lay Out and Design of Lab, ISO requirement for food testing lab (ISO 17025), Microbiological analysis of food, Swab Analysis in-Process and Off – Line Process, FSSAI Regulations for food laboratory.

UNIT V

9

Introduction of FSSAI, Recent update in FSSAI , Location, Layout & Facilities (Pre-Requisite Program), Receiving and storage, Types of cross-contamination, Pre-Production (Vegetable washing, thawing), Production (Cooking, Cooling, and Reheating), Holding, serving/catering/dining/transportation, Personal hygiene, Pest control, Cleaning and maintenance, Waste Handling, Record Keeping, Consumer Awareness.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

At the end of the course the students would have the knowledge to

1. Understand about Food Safety required for Industry
2. Comprehend the quality assurance and delivery of safe to end users.
3. Evaluate the overall food safety management
4. Explain various Food safety standards and regulations

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	PS O1	PS O2	PS O3
1	2	1	1	2	-	2	1	-	-	-	1	2	3	1	1
2	1	3	3	1	-	3	2	-	-	-	1	3	2	1	1
3	2	2	2	2	-	1	1	-	-	-	1	1	1	1	2
4	1	3	1	3	-	2	2	-	-	-	1	2	1	1	2
Avg	1.5	2.2 5	1.7 5	2	0	2	1.5	0	0	0	1	2	1.7 5	1	1.5

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick

MANDATORY COURSES I

MX3081

INTRODUCTION TO WOMEN AND GENDER STUDIES

**L T P C
3 0 0 0**

COURSE OUTLINE

UNIT I CONCEPTS

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

UNIT II FEMINIST THEORY

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

UNIT III WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL

Rise of Feminism in Europe and America.
Women's Movement in India.

UNIT IV GENDER AND LANGUAGE

Linguistic Forms and Gender.
Gender and narratives.

UNIT V GENDER AND REPRESENTATION

Advertising and popular visual media.
Gender and Representation in Alternative Media.
Gender and social media.

TOTAL : 45 PERIODS

OBJECTIVE:

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

1. COURSE CONTENTS

Introduction to Elements of Literature

1. Relevance of literature

- Enhances Reading, thinking, discussing and writing skills.
- Develops finer sensibility for better human relationship.
- Increases understanding of the problem of humanity without bias.
- Providing space to reconcile and get a cathartic effect.

2. Elements of fiction

- Fiction, fact and literary truth.
- Fictional modes and patterns.
- Plot character and perspective.

3. Elements of poetry

- Emotions and imaginations.
- Figurative language.
- (Simile, metaphor, conceit, symbol, pun and irony).
- Personification and animation.
- Rhetoric and trend.

4. Elements of drama

- Drama as representational art.
- Content mode and elements.
- Theatrical performance.
- Drama as narration, mediation and persuasion.
- Features of tragedy, comedy and satire.

3. READINGS:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Univ Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

3.1 Textbook:

3.2 *Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

4. OTHER SESSION:

4.1*Tutorials:

4.2*Laboratory:

4.3*Project: The students will write a term paper to show their understanding of a particular piece of literature

5.*ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

TOTAL : 45 PERIODS

OUTCOME OF THE COURSE:

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

PROGRESSTHROUGH KNOWLEDGE

MX3083

FILM APPRECIATION

**L T P C
3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

Theme - A: The Component of Films

A-1: The material and equipment

A-2: The story, screenplay and script

A-3: The actors, crew members, and the director

A-4: The process of film making... structure of a film

Theme - B: Evolution of Film Language

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

Theme - C: Film Theories and Criticism/Appreciation

- C-1: Realist theory; Auteurists
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

Theme – D: Development of Films

- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

Theme - E: Indian Films

- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

READING:

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

MX3084

DISASTER RISK REDUCTION AND MANAGEMENT

**L T P C
3 0 0 0**

COURSE OBJECTIVE

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

UNIT I HAZARDS, VULNERABILITY AND DISASTER RISKS

9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

UNIT II DISASTER RISK REDUCTION (DRR)

9

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT III DISASTER MANAGEMENT

9

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related

policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

UNIT V DISASTER MANAGEMENT: CASE STUDIES 9

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

TOTAL : 45 PERIODS

TEXT BOOKS:

- 1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
- 2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
- 3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
- 4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

REFERENCES

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

COURSE OUTCOME:

CO1: To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)

CO2: To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction

CO3: To develop disaster response skills by adopting relevant tools and technology

CO4: Enhance awareness of institutional processes for Disaster response in the country and

CO5: Develop rudimentary ability to respond to their surroundings with potential

Disaster response in areas where they live, with due sensitivity

CO’s – PO’s & PSO’s MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
AVG	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

MANDATORY COURSES II

MX3085

**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA
AND SIDDHA**

**L T P C
3 0 0 0**

COURSE OBJECTIVES:

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

UNIT I HEALTH AND ITS IMPORTANCE

2+4

Health: Definition - Importance of maintaining health - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

UNIT II DIET

4+6

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

Definition of BMI and maintaining it with diet

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

Common cooking mistakes

Different cooking methods, merits and demerits of each method

UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 4+4

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy.

Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - Panchekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

Prevention of illness with our traditional system of medicine

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

UNIT IV MENTAL WELLNESS 3+4

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

Stress management - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

Sleep - Sleep and its importance for mental wellness - Sleep and digestion.

Immunity - Types and importance - Ways to develop immunity

UNIT V YOGA 2+12

Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

REFERENCES:

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts
A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England

2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D,
Published by
The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200,
New York, NY 10001

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
2. **Simple lifestyle modifications to maintain health**
<https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20c,ook.>
3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>
<https://yogamedicine.com/guide-types-yoga-styles/>
Ayurveda : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
9. **Siddha** : http://www.tkdil.res.in/tkdil/langdefault/Siddha/Sid_Siddha_Concepts.asp
10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
11. **Preventive herbs** : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

COURSE OUTCOMES:

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

MX3086

HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA

L T P C
3 0 0 0

UNIT-I CONCEPTS AND PERSPECTIVES

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history

Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA

Introduction to the works of D.D. Kosambi, Dharmapal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times
Science and technology from 1st century AD to C-1200.

UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA

Legacy of technology in Medieval India, Interactions with Arabs
Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
Astronomy and Mathematics: interaction with Arabic Sciences
Science and Technology on the eve of British conquest

UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA

Science and the Empire
Indian response to Western Science
Growth of techno-scientific institutions

UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA

Science, Technology and Development discourse
Shaping of the Science and Technology Policy
Developments in the field of Science and Technology
Science and technology in globalizing India
Social implications of new technologies like the Information Technology and Biotechnology

TOTAL : 45 PERIODS

MX3087 POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY L T P C
3 0 0 0

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

OBJECTIVES:

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

COURSE TOPICS:

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

Conclusion (2 lectures)

Total lectures: 39

Preferred Textbooks: See Reference Books

Reference Books: Authors mentioned along with topics above. Detailed reading list will be provided.

GRADING:

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

TOTAL : 45 PERIODS

OUTCOME:

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

MX3088

STATE, NATION BUILDING AND POLITICS IN INDIA

**L T P C
3 0 0 0**

OBJECTIVE:

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

TOPICS:

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary, The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.
Goals, objective and philosophy.
Why a federal system?
National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)
New social movements.
The changing nature of Indian Political System, the future scenario.
What can we do?

OUTCOME OF THE COURSE:

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

SUGGESTED READING:

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
- vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

TOTAL : 45 PERIODS

MX3089

INDUSTRIAL SAFETY

L T P C
3 0 0 0

OBJECTIVES

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

UNIT I SAFETY TERMINOLOGIES

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

UNIT II STANDARDS AND REGULATIONS

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

UNIT III SAFETY ACTIVITIES

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

UNIT IV WORKPLACE HEALTH AND SAFETY

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

UNIT V HAZARD IDENTIFICATION TECHNIQUES

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

TOTAL : 45 PERIODS

OUTCOMES:

Course outcomes on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

TEXTBOOKS

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

REFERENCES

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring. (1996). Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

ONLINE RESOURCES

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>

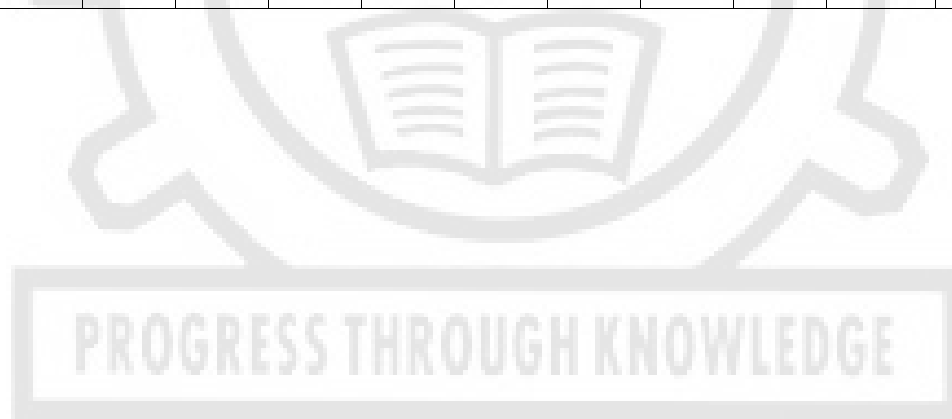
Indian Standard code of practice on occupational safety and health audit

<https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006

<https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
Industrial safety		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3



OPEN ELECTIVE I AND II

OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

L T P C
2 0 2 3

OBJECTIVES:

The main objectives of this course are to:

1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH 6

Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES 6

Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

UNIT III LEARNING 6

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

UNIT IV SUPERVISED LEARNING 6

Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree**: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines (SVM)**

UNIT V UNSUPERVISED LEARNING 6

Unsupervised Learning – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

TOTAL : 30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

Programs for Problem solving with Search

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A* algorithms.

Supervised learning

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

Unsupervised learning

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (<https://archive.ics.uci.edu/ml/datasets.html>) or constructed by the students.

OUTCOMES:

CO1: Understand the foundations of AI and the structure of Intelligent Agents

CO2: Use appropriate search algorithms for any AI problem

CO3: Study of learning methods

CO4: Solving problem using Supervised learning

CO5: Solving problem using Unsupervised learning

TOTAL PERIODS: 60

TEXT BOOK

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

REFERENCES

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligence", Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

OCS352

IOT CONCEPTS AND APPLICATIONS

L T P C
2 0 2 3

OBJECTIVES:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

UNIT I INTRODUCTION TO INTERNET OF THINGS

5

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

UNIT II COMPONENTS IN INTERNET OF THINGS

5

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT

6

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNIT IV OPEN PLATFORMS AND PROGRAMMING 7
IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

UNIT V IOT APPLICATIONS 7
Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture
30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5. Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10. Design an IOT based system

OUTCOMES:

CO 1: Explain the concept of IoT.

CO 2: Understand the communication models and various protocols for IoT.

CO 3: Design portable IoT using Arduino/Raspberry Pi /open platform

CO 4: Apply data analytics and use cloud offerings related to IoT.

CO 5: Analyze applications of IoT in real time scenario.

TOTAL PERIODS:60

TEXTBOOKS

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

REFERENCES

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. ArshdeepBahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015
6. <https://www.arduino.cc/>
https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

OCS353

DATA SCIENCE FUNDAMENTALS

**L T P C
2 0 2 3**

COURSE OBJECTIVES:

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.

- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

UNIT I INTRODUCTION 6

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

UNIT II DATA MANIPULATION 9

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

UNIT III MACHINE LEARNING 5

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

UNIT IV DATA VISUALIZATION 5

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

UNIT V HANDLING LARGE DATA 5

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS
30 PERIODS**

PRACTICAL EXERCISES:

LAB EXERCISES

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
 - a) Frequency distributions
 - b) Mean, Mode, Standard Deviation
 - c) Variability
 - d) Normal curves
 - e) Correlation and scatter plots
 - f) Correlation coefficient
 - g) Regression
6. Use the standard benchmark data set for performing the following:
 - a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
 - b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.

COURSE OUTCOMES:

At the end of this course, the students will be able to:

- CO1:** Gain knowledge on data science process.
- CO2:** Perform data manipulation functions using Numpy and Pandas.
- CO3:** Understand different types of machine learning approaches.
- CO4:** Perform data visualization using tools.
- CO5:** Handle large volumes of data in practical scenarios.

TOTAL PERIODS:60

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

REFERENCES

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

CCS333

AUGMENTED REALITY/VIRTUAL REALITY

L	T	P	C
2	0	2	3

OBJECTIVES:

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

UNIT I INTRODUCTION

7

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

UNIT II VR MODELING

6

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

UNIT III VR PROGRAMMING

6

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

UNIT IV APPLICATIONS

6

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

UNIT V AUGMENTED REALITY**5**Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-
Navigation-Wearable devices**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

TOTAL PERIODS:60**OUTCOMES:****On completion of the course, the students will be able to:****CO1:** Understand the basic concepts of AR and VR**CO2:** Understand the tools and technologies related to AR/VR**CO3:** Know the working principle of AR/VR related Sensor devices**CO4:** Design of various models using modeling techniques**CO5:** Develop AR/VR applications in different domains**TEXTBOOKS:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003

CO's – PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2	
2	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2	
3	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2	
4	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2	
5	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3	
AVg.	3.00	2.60	2.40	2.00	3.00	-	-	-	2.80	2.20	1.80	2.60	2.80	1.80	2.20	

OPEN ELCTIVE III

OHS351

ENGLISH FOR COMPETITIVE EXAMINATIONS

L T P C
3 0 0 3

Course Description:

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

Objectives:

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

UNIT I

9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

UNIT II

9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

UNIT III

9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

UNIT IV

9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

UNIT V

9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

TOTAL: 45 PERIODS

Learning Outcomes:

At the end of the course, learners will be able

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required

- identify errors with precision and write with clarity and coherence
- understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- communicate effectively in group discussions, presentations and interviews
- write topic based essays with precision and accuracy

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
AVg.	2	2.6	2.6	2	2.6	2.6	2.6	2.6	2	3	2.4	3	-	-	-

- 1-low, 2-medium, 3-high, '-'- no correlation

Note: The average value of this course to be used for program articulation matrix.

Teaching Methods:

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

Evaluative Pattern:

Internal Tests – 50%

End Semester Exam - 50%

TEXTBOOKS:

1. R.P.Bhatnagar - *General English for Competitive Examinations*. Macmillan India Limited, 2009.

REFERENCEBOOKS:

1. Educational Testing Service - *The Official Guide to the GRE Revised General Test*, Tata McGraw Hill, 2010.
2. *The Official Guide to the TOEFL Test*, Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations*, McGraw Hill Education (India) Private Limited, 2008.

Websites

<http://www.examenglish.com/>, <http://www.ets.org/>, <http://www.bankxams.com/>
<http://civilservicesmentor.com/>, <http://www.educationobserver.com>
<http://www.cambridgeenglish.org/in/>

OCE353

LEAN CONCEPTS, TOOLS AND PRACTICES

L T P C

3 0 0 3

OBJECTIVE:

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

UNIT I INTRODUCTION

9

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress

Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

UNIT II LEAN MANAGEMENT 9

Introduction to lean management - Toyota’s management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

UNIT III CORE CONCEPTS IN LEAN 9

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

UNIT IV LEAN TOOLS AND TECHNIQUES 9

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting-Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY 9

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

TOTAL : 45 PERIODS

OUTCOME:

On completion of this course, the student is expected to be able to

- CO1** Explains the contemporary management techniques and the issues in present scenario.
- CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
- CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
- CO4** Apply lean techniques to achieve sustainability in construction projects.
- CO5** Apply lean construction techniques in design and modeling.

REFERENCES:

1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

**OMG352 NGOS AND SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3**

COURSE OBJECTIVES

- to understand the importance of sustainable development
- to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management

- to comprehend the role of NGOs in attaining sustainable development

Unit I ENVIRONMENTAL CONCERNS 9

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

UNIT II ROLE OF NGOS 9

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

UNIT III SUSTAINABLE DEVELOPMENT 9

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

UNIT IV NGO'S FOR SUSTAINABILITY 9

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

UNIT V LEGAL FRAMEWORKS 9

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

TOTAL 45 : PERIODS

OUTCOMES

Upon completion of this course, the student will :

- CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development
- CO2 have a knowledge on the role of NGOs towards sustainable developemnt
- CO 3 present strategies for NGOs in attaining sustainable development
- CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO 5 understand the environmental legislations

REFERENCE BOOKS

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

OMG353	DEMOCRACY AND GOOD GOVERNANCE	L T P C
		3 0 0 3
UNIT-I		(9)
Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance		
UNIT-II		(9)
Regulatory Institutions – SEBI, TRAI, Competition Commission of India,		
UNIT-III		(9)
Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.		
UNIT- IV		(9)
Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance		
UNIT-V		(9)
Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.		

TOTAL 45 : PERIODS

REFERENCES:

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

CME365	RENEWABLE ENERGY TECHNOLOGIES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- 1 To know the Indian and global energy scenario
- 2 To learn the various solar energy technologies and its applications.
- 3 To educate the various wind energy technologies.
- 4 To explore the various bio-energy technologies.
- 5 To study the ocean and geothermal technologies.

UNIT – I ENERGY SCENARIO 9
 Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

UNIT – II SOLAR ENERGY 9
 Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT – III WIND ENERGY**9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT – IV BIO-ENERGY**9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNIT – V OCEAN AND GEOTHERMAL ENERGY**9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

TEXT BOOKS:

- Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
- Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCES:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2
Low (1) ; Medium (2) ; High (3)															

OBJECTIVES:

The course aims to

- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

UNIT I DESIGN THINKING PRINCIPLES**9**

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

UNIT II ENDUSER-CENTRIC INNOVATION**9**

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

UNIT III APPLIED DESIGN THINKING TOOLS**9**

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

UNIT IV CONCEPT GENERATION**9**

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

UNIT V SYSTEM THINKING**9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of the course, learners will be able to:

- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

TEXT BOOKS

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadacos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

REFERENCES

1. <https://www.ideo.com/pages/design-thinking#process>
2. https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86_24
3. <https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356>
4. <https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e>
5. <https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd>
6. <https://blog.forgeforward.in/star-tup-failure-is-like-true-lie-7812cdf9b85>

MF3003

REVERSE ENGINEERING

LT P C
3 0 0 3

COURSE OBJECTIVES:

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

UNIT I INTRODUCTION & GEOMETRIC FORM

9 Hours

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION

9 Hours

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT III DATA PROCESSING

9 Hours

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV 3D SCANNING AND MODELLING

9 Hours

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

UNIT V INDUSTRIAL APPLICATIONS

9 Hours

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Apply the fundamental concepts and principles of reverse engineering in product design

and development.

- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

TEXT BOOKS:

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

REFERENCES:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluwer Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer-Verlag London Limited 2008.

OPR351

SUSTAINABLE MANUFACTURING

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT – I ECONOMIC SUSTAINABILITY

9

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY

9

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT – III SUSTAINABILITY PRACTICES

9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements

–Cost and time model.

UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT – V TRENDS IN SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- CO1: Discuss the importance of economic sustainability.
- CO2: Describe the importance of sustainable practices.
- CO3: Identify drivers and barriers for the given conditions.
- CO4: Formulate strategy in sustainable manufacturing.
- CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

Mapping of COs with POs and PSOs															
COs/Pos & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.

REFERENCES:

1. Jovane F, Eµper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

COURSE OBJECTIVES:

- The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT II ENERGY SOURCES 9

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III MOTORS AND DRIVES 9

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV POWER CONVERTERS AND CONTROLLERS 9

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

UNIT V HYBRID AND ELECTRIC VEHICLES 9

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the student will be able to

- Understand the operation and architecture of electric and hybrid vehicles
- Identify various energy source options like battery and fuel cell
- Select suitable electric motor for applications in hybrid and electric vehicles.
- Explain the role of power electronics in hybrid and electric vehicles
- Analyze the energy and design requirement for hybrid and electric vehicles.

TEXT BOOKS:

- Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
- Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005.

REFERENCES:

- James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
- Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
- Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1		3	2					2		1	3
2	1	1	2	1		3	2					2		1	3
3	1	1	2	1		3	2					2		1	3
4	1	1	2	1		3	2					2		1	3
5	1	1	2	1		3	2					2		1	3
Avg.	1	1	2	1		3	2					2		1	3

OAS352

SPACE ENGINEERING

L T P C
3 0 0 3

OBJECTIVES:

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

UNIT I STANDARD ATMOSPHERE

6

History of aviation – standard atmosphere - pressure, temperature and density altitude.

UNIT II AERODYNAMICS

10

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

UNIT III PERFORMANCE AND PROPULSION

9

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY

10

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

UNIT V SPACE APPLICATIONS

10

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

TOTAL: 45 PERIODS

OUTCOMES:

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS:

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.

REFERENCE:

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

COURSE OBJECTIVES:

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management

UNIT I INTRODUCTION**9**

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

UNIT II FUNCTIONS OF MANAGEMENT**9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

UNIT III ORGANIZATIONAL BEHAVIOUR**9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

UNIT IV GROUPDYNAMICS**9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

UNIT V MODERN CONCEPTS**9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

- CO1: Understand the basic concepts of industrial management
 CO2: Identify the group conflicts and its causes.
 CO3: Perform swot analysis
 CO4 : Analyze the learning curves
 CO5 : Understand the placement and performance appraisal

REFERENCES:

Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
AVg.	2	2.2	2.3	3									1.8	2	2.6

OIE354

QUALITY ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

UNIT I INTRODUCTION

9

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

UNIT II CONTROL CHARTS

9

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X, R and S charts, attribute control charts - p, np, c and u- Construction and application.

UNIT III SPECIAL CONTROL PROCEDURES

9

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

UNIT IV STATISTICAL PROCESS CONTROL

9

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

UNIT V ACCEPTANCE SAMPLING

9

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

- CO1:** Control the quality of processes using control charts for variables in manufacturing industries.
- CO2:** Control the occurrence of defective product and the defects in manufacturing companies.
- CO3:** Control the occurrence of defects in services.
- CO4:** Analyzing and understanding the process capability study.
- CO5:** Developing the acceptance sampling procedures for incoming raw material.

CO's – PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
AVg.	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1

OSF351

FIRE SAFETY ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES

- To enable the students to acquire knowledge of Fire and Safety Studies
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- To learn about fire area, fire stopped areas and different types of fire-resistant doors
- To learn about the method of fire protection of structural members and their repair due to fire damage.
- To develop safety professionals for both technical and management through systematic and quality-based study programmes

UNIT I INHERENT SAFETY CONCEPTS

9

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

UNIT II PLANT LOCATIONS

9

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.

UNIT III WORKING CONDITIONS

9

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES

9

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

UNIT V WORKING AT HEIGHTS

9

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

TOTAL PERIODS: 45

COURSE OUTCOMES

On completion of the course the student will be able to

CO1: Understand the effect of fire on materials used for construction

CO2: Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

CO3: To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

CO4: To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

TEXT BOOKS

- Roytman, M. Y, "Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975
- John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK, 2009.

REFERENCES:

- Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A, 1979.
- Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.
- Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010.
- Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition, 1999
- Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-	-
AVg.	1.3	-	1.75	-	-	1	1.3	1	-	1	-	1	-	-	-	-

OML351

INTRODUCTION TO NON-DESTRUCTIVE TESTING

L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

- UNIT I INTRODUCTION TO NDT & VISUAL TESTING 9**
 Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibrosopes – light sources and special lighting.
- UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING 9**
 Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.
 Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.
- UNIT III EDDY CURRENT TESTING & THERMOGRAPHY 9**
 Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.
 Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.
- UNIT IV ULTRASONIC TESTING & AET 9**
 Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.
 Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.
- UNIT V RADIOGRAPHY TESTING 9**
 Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Realize the importance of NDT in various engineering fields.
2. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
3. Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.
4. Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.
5. Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

TEXT BOOKS:

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.

REFERENCES:

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3			2	2				2	1	2	
C02	3	1	2	2			2	2				2	2	2	1
C03	3	2	1	2			2	2				2	2	2	
CO4	3	1	2	2			2	2				2	2	2	2
CO5	3	2	2	2			2	2				2	2	2	1
Avg	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

OMR351

MECHATRONICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

UNIT – I INTRODUCTION AND SENSORS

9

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors.

UNIT – II 8085 MICROPROCESSOR

9

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE

9

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER

9

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN

9

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Select sensors to develop mechatronics systems.

CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

CO 4: Apply PLC as a controller in mechatronics system.

CO 5: Design and develop the apt mechatronics system for an application.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

ORA351

FOUNDATION OF ROBOTICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To study the kinematics, drive systems and programming of robots.
2. To study the basics of robot laws and transmission systems.
3. To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4. To familiarize students with the various Programming and Machine Vision application in robots.
5. To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

UNIT – I FUNDAMENTALS OF ROBOT

9

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

UNIT – II ROBOT KINEMATICS**9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS**9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

UNIT – IV SENSORS IN ROBOTICS**9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

UNIT – V PROGRAMMING AND APPLICATIONS OF ROBOT**9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

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

CO1: Interpret the features of robots and technology involved in the control.

CO2: Apply the basic engineering knowledge and laws for the design of robotics.

CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

Mapping of COs with POs and PSOs															
COs/POs& PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.

2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.

REFERENCES:

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

OAE352**FUNDAMENTALS OF AERONAUTICAL ENGINEERING****L T P C
3 0 0 3****OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

UNIT I HISTORY OF FLIGHT**8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS**10**

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

UNIT III BASICS OF AERODYNAMICS**9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

UNIT IV BASICS OF AIRCRAFT STRUCTURES**9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.

UNIT V BASICS OF PROPULSION**9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

TOTAL : 45 PERIODS**OUTCOMES:**

- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. . E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

REFERENCE

1. SADHU SINGH, "INTERNAL COMBUSTION ENGINES AND GAS TURBINE"-, SS Katarai & sons, 2015
2. KERMODE , "FLIGHT WITHOUT FORMULAE" , -, Pitman; 4th Revised edition 1989

OGI351

REMOTE SENSING CONCEPTS

L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

UNIT III ORBITS AND PLATFORMS 9

Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

UNIT IV SENSING TECHNIQUES 9

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

UNIT V DATA PRODUCTS AND INTERPRETATION 9

Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO 1 Understand the concepts and laws related to remote sensing

CO 2 Understand the interaction of electromagnetic radiation with atmosphere and earth material

CO 3 Acquire knowledge about satellite orbits and different types of satellites

CO 4 Understand the different types of remote sensors

CO 5 Gain knowledge about the concepts of interpretation of satellite imagery

TEXTBOOKS:

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

REFERENCES:

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

CO-PO MAPPING

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

OAI351

URBAN AGRICULTURE

L T P C
3 0 0 3

OBJECTIVES:

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

UNIT I INTRODUCTION**9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

UNIT II VERTICAL FARMING**9**

Vertical farming- types, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

UNIT III SOIL LESS CULTIVATION**9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

UNIT IV MODERN CONCEPTS**9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

UNIT V WASTE MANAGEMENT**9**

Concept, scope and maintenance of waste management- **recycle of organic waste, garden wastes- solid waste management-scope**, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops
5. Explain the concept of waste management on roof tops

TEXT BOOKS:

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

REFERENCES:

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. <https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24>.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

CO-PO MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2

PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2
PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

OEN351

DRINKING WATER SUPPLY AND TREATMENT

**L T P C
3 0 0 3**

OBJECTIVE:

- To equip the students with the principles and design of water treatment units and distribution system.

UNIT I SOURCES OF WATER

9

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

UNIT II CONVEYANCE FROM THE SOURCE

9

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

UNIT III WATER TREATMENT

9

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – sand filters - Disinfection - –Construction, Operation and Maintenance aspects.

UNIT IV ADVANCED WATER TREATMENT

9

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

UNIT V WATER DISTRIBUTION AND SUPPLY**9**

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

TOTAL: 45 PERIODS**OUTCOMES**

CO1: an understanding of water quality criteria and standards, and their relation to public health

CO2: the ability to design the water conveyance system

CO3: the knowledge in various unit operations and processes in water treatment

CO4: an ability to understand the various systems for advanced water treatment

CO5: an insight into the structure of drinking water distribution system

TEXTBOOKS :

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

REFERENCES :

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3						3		3			3		
2		3		2		2				3			3		
3				2		2				3			3		
4			3	2				3	2	3			3		
5			3	2			1		2	3		1			
Avg.		3	3	2		2	1	3	2	3		1	3		

1.low, 2-medium, 3-high, '-'- no correlation

Note: The average value of this course to be used for program articulation matrix.

OEE352**ELECTRIC VEHICLE TECHNOLOGY****L T P C
3 0 0 3****COURSE OBJECTIVES**

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

UNIT I ROTATING POWER CONVERTERS 9
 Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

UNIT II STATIC POWER CONVERTERS 9
 Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9
 Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9
 History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES 9
 Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: Able to understand the principles of conventional and special electrical machines.
- CO2: Acquired the concepts of power devices and power converters
- CO3: Able to understand the control for DC and AC drive systems.
- CO4: Learned the electric vehicle architecture and power train components.
- CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2			3								3	3	3
CO2	3	2	2			3			3				3	3	3
CO3	3			3		2	2						3	3	3
CO4	3	2	2		3								3	3	3
CO5	3		2								2		3	3	3
Avg	3	2	2	3	3	1	2		3		2		3	3	3

REFERENCES:

- 1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.
- 2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
- 3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
- 4 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition,

10th Impression 2021.

- 5 Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021.
- 6 Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017
- 7 James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition, Wiley, 2012

OEI353

INTRODUCTION TO PLC PROGRAMMING

L T P C
3 0 0 3

COURSE OBJECTIVES:

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.
5. Exposures about communication architecture of PLC/SCADA.

UNIT I INTRODUCTION TO PLC 9

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

UNIT II PLC INSTRUCTIONS 9

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

UNIT III PLC PROGRAMMING 9

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

UNIT IV COMMUNICATION OF PLC AND SCADA 9

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

UNIT V CASE STUDIES 9

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

TOTAL:45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

COURSE OUTCOMES:

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)
CO2 Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)

- CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
- CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)
- CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

TEXT BOOKS:

1. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

REFERENCES:

1. MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles and Applications, Pearson publication

List of Open Source Software/ Learning website:

1. <https://nptel.ac.in/courses/108105063>
2. <https://www.electrical4u.com/industrial-automation/>
3. <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
4. <https://www.electrical4u.com/industrial-automation/>

MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

PO,PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1					1	1						
CO2	3	3	2					1	1	2					2
CO3	3	3	3	3	1			1	1						
CO4	3	3		3	3			1	1				3	3	
CO5	3	3	3	2	1			1	1				3	3	3
Avg	3	2.9	2.25	2.6	1.6			1	1				3	3	2.9

OCH351

NANO TECHNOLOGY

L T P C
3 0 0 3

UNIT I

INTRODUCTION

8

General definition and size effects–important nano structured materials and nano particles-importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

UNIT II

SYNTHESIS OF NANOMATERIALS

8

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

UNIT III

NANO COMPOSITES

10

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based-influence of size, shape and role of interface in composites applications.

UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 10

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

UNIT V APPLICATIONS OF NANO MATERIALS 9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots-Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

TOTAL : 45 PERIODS

OUTCOMES:

- CO1 - understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.
- CO2 – able to acquire knowledge about the different types of nano material synthesis
- CO3 – describes about the shape, size,structure of composite nano materials and their interference
- CO4 – understand the different characterization techniques for nanomaterials
- CO5 - develop a deeper knowledge in the application of nanomaterials in different fields.

TEXT BOOKS

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, “ Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press
2. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties &Applications” Imperial College Press, 2004
3. William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 3rd Edition, CRC Taylor and Francis group 2012.

REFERENCES

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gbtl & Co
3. Ivor Brodie and Julius J.Murray, 'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

Course articulation matrix

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 1	PO 2	PSO 3
CO1	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	describes about the shape, size,structure of composite nano materials and their	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3

	interference															
CO4	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
	Overall CO	2	2	1	3	3	1	1	1	1	1	1	3	2	1	3

OCH352

FUNCTIONAL MATERIALS

L T P C
3 0 0 3

OBJECTIVE:

- The course emphasis on the molecular self assembly and materials for polymer electronics

UNIT I INTRODUCTION

9

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

UNIT II MOLECULAR SELF ASSEMBLY

9

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

UNIT III BIO-INSPIRED MATERIALS

9

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization-En route to Nanotechnology.

UNIT IV SMART OR INTELLIGENT MATERIALS

9

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

UNIT V MATERIALS FOR POLYMER ELECTRONICS

9

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

TOTAL: 45 PERIODS

OUTCOME:

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

TEXT BOOK:

- Vijayamohan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

REFERENCE:

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

OPY352**IPR FOR PHARMA INDUSTRY****L T P C
3 0 0 3****COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

UNIT II PATENTS 9

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

TOTAL:45 PERIODS**TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

REFERENCES:

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open

access, Croatia, 2017.

COURSE OUTCOME

The student will be able to

- C1** Understand and differentiate the categories of intellectual property rights.
- C2** Describe about patents and procedure for obtaining patents.
- C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
- C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
- C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
- C6** Understand the interrelationships between different Intellectual Property Rights on International Society

CO – PO MAPPING												
IPR FOR PHARMA INDUSTRY												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C1	3	3		2					2	2		
C2		3	3				2	2				
C3	3	3					2	2				1
C4					2		3	3		2	2	
C5		3					3			2		1
C6	3	2				2	2					2

OTT351

BASICS OF TEXTILE FINISHING

LT PC
3 0 0 3

OBJECTIVE:

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

UNIT I RESIN FINISHING

9

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

UNIT II FLAME PROOF & WATERPROOF

9

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

UNIT III SOIL RELEASE AND ANTISTATIC FINISHES

9

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

UNIT IV MECHANICAL FINISHES

9

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

UNIT V STIFFENING AND SOFTENING

9

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET

.Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to Understand the

CO: 1 Basics of Resin Finishing Process.

CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

TEXT BOOKS:

1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

REFERENCES:

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY

**L T P C
3 0 0 3**

OBJECTIVES:

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

UNIT I INTRODUCTION

9

Scope of industrial engineering in apparel Industry, role of industrial engineers.

Productivity: Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

UNIT II WORK STUDY

9

Definition, Purpose, Basic procedure and techniques of work-study.

Work environment – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

Material Handling – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

UNIT III METHOD STUDY

9

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

MOTION STUDY: Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

UNIT IV WORK MEASUREMENT**9**

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

UNIT V WORK STUDY APPLICATION**9**

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

TOTAL: 45 PERIODS**OUTCOMES:**

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity

CO2: Method study

CO3: Motion analysis

CO4: Work measurement and SAM

CO5: Ergonomics and its application to garment industry

TEXTBOOKS:

1. George Kanwaty, "Introduction to Work Study ", ILO, Geneva, 1996, ISBN: 9221071081 | ISBN-13: 9789221071082
2. Enrick N. L., "Time study manual for Textile industry", Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., "Industrial Engineering and Management", Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

REFERENCES

1. Norberd Lloyd Enrick., "Industrial Engineering Manual for Textile Industry", Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., "Introduction to Clothing Production Management", Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-

CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
Overall CO		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OTT353

BASICS OF TEXTILE MANUFACTURE

L T P C

3 0 0 3

OBJECTIVES:

To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

UNIT I NATURAL FIBRES

9

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

UNIT II REGENERATED AND SYNTHETIC FIBRES

9

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

UNIT III BASICS OF SPINNING

9

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

UNIT IV BASICS OF WEAVING

9

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

UNIT V BASICS OF KNITTING AND NONWOVEN

9

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres

CO2: Regenerated and synthetic fibres

CO3: Yarn spinning

CO4: Weaving

CO5: Knitting and nonwoven

TEXTBOOKS

1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

REFERENCES:

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., "Clothing Technology: From Fibre to Fabric", Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., "Motivate Series-Textiles", Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., "The Technology of Clothing Manufacture" Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483. Klein W., "The Rieter Manual of Spinning, Vol.1", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., "The Rieter Manual of Spinning, Vol.2", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., "The Rieter Manual of Spinning, Vol.1-3", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., "Weaving: Machines, Mechanisms, Management", Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., "Textile Science", CBS Publishers and distributors, 1987, ISBN 0582685958

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
Overall CO		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OPE351

**INTRODUCTION TO PETROLEUM REFINING AND
PETROCHEMICALS**

**L T P C
3 0 0 3**

OBJECTIVE:

The course is aimed to

Gain knowledge about petroleum refining process and production of petrochemical products.

UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

UNIT II CRACKING 9

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

UNIT III REFORMING AND HYDROTREATING 9

Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

UNIT IV INTRODUCTION TO PETROCHEMICALS 9

Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

UNIT V PRODUCTION OF PETROCHEMICALS 9

Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

CO2: Understand the insights of primary treatment processes to produce the precursors.

CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes.

CO6: Learn the importance of optimization of process parameters for the high yield of petroleum products.

TEXT BOOKS

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition., McGraw Hill, New York, 1985.

2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons, 1986.

REFERENCES

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.

2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

OBJECTIVES:

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

UNIT I INTRODUCTION**9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II ELECTRICAL SYSTEMS**9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III THERMAL SYSTEMS**9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES**9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT V ECONOMICS**9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL: 45 PERIODS**OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

TEXT BOOKS:

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

REFERENCES:

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.

2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

OPT351

BASICS OF PLASTICS PROCESSING

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

UNIT I INTRODUCTION TO PLASTICS PROCESSING 9

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

UNIT II EXTRUSION 9

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

UNIT III INJECTION MOLDING 9

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

UNIT IV COMPRESSION AND TRANSFER MOLDING 9

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-

positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

UNIT V BLOW MOLDING, THERMOFORMING AND CASTING 9

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

TOTAL HOURS: 45

COURSE OUTCOMES

- Ability to find out the correlation between various processing techniques with product properties.
- Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- Acquire knowledge on additives for plastic compounding and methods employed for the same
- Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- Select an appropriate processing technique for the production of a plastic product

REFERENCES

1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).



OEC351

SIGNALS AND SYSTEMS

**L T P C
3 0 0 3**

COURSE OBJECTIVES :

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals -Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

UNIT II	ANALYSIS OF CONTINUOUS TIME SIGNALS	9
Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties		
UNIT III	LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS	9
Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.		
UNIT IV	ANALYSIS OF DISCRETE TIME SIGNALS	9
Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties		
UNIT V	LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS	9
Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.		

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

- CO1:determine if a given system is linear/causal/stable
- CO2: determine the frequency components present in a deterministic signal
- CO3:characterize continuous LTI systems in the time domain and frequency domain
- CO4:characterize discrete LTI systems in the time domain and frequency domain
- CO5:compute the output of an LTI system in the time and frequency domains

TEXT BOOKS:

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002

REFERENCES :

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.
2. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	-	3	-	3	2	-	-	-	-	-	3	-	-	1
2	3	-	3	-	-	2	-	-	-	-	-	3	-	3	-
3	3	3	-	-	3	2	-	-	-	-	-	3	2	-	-
4	3	3	-	-	3	2	-	-	-	-	-	3	-	3	1
5	3	3	-	3	3	2	-	-	-	-	-	3	-	3	1
C	3	3	3	3	3	2	-	-	-	-	-	3	2	3	1

COURSE OBJECTIVES :

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

UNIT I SEMICONDUCTOR DEVICES 9

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

UNIT II AMPLIFIERS 9

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

TOTAL: 45 PERIODS**COURSE OUTCOMES :**

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

CO1: Explain the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Analyze frequency response of BJT and MOSFET amplifiers

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Design and analyze power amplifiers and supply circuits

TEXT BOOKS :

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

REFERENCES :

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

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

CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I BASICS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping -

Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia – The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXT BOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1						1		1			
2	3	2	3	1						1		1			
3	3	2	3	1	1			1	1	1		1			
4	3	2	3	1	1			1	1	1		1			
5	3	2	3	1	1			1	1	1		1			
AVg.															

OBJECTIVES:

The student should be made to:

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

UNIT I CARDIAC ASSIST DEVICES**9**

Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

UNIT II HEMODIALYSERS**9**

Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT III HEARING AIDS**9**

Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

UNIT IV PROSTHETIC AND ORTHODIC DEVICES**9**

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

UNIT V RECENT TRENDS**9**

Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

TOTAL :45 PERIODS**OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.

CO2: Describe the underlying principles of hemodialyzer machine.

CO3: Indicate the methodologies to assess the hearing loss.

CO4: Evaluate the types of assistive devices for mobilization.

CO5: Explain about TENS and biofeedback system.

TEXT BOOKS

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

REFERENCES

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1	3	1	1	1	1											
2	3	1	1	1	1											
3	3	1	1	1	1											
4	3	1	1	1	1											
5	3	1	1	1	1											
AVg.																

OMA352

OPERATIONS RESEARCH

L T P C
3 0 0 3

OBJECTIVES:

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

UNIT I LINEAR PROGRAMMING

9

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

UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS

9

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

UNIT III INTEGER PROGRAMMING

9

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

UNIT IV DYNAMIC PROGRAMMING PROBLEMS

9

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

UNIT V NON - LINEAR PROGRAMMING PROBLEMS

9

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

TOTAL:45 PERIODS

OUTCOMES :

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

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.

- analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- solve the integer programming problems using various methods.
- conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- determine the optimum solution for non linear programming problems.

TEXT BOOKS:

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

REFERENCES :

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " (Schaum’s Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-



OMA353

ALGEBRA AND NUMBER THEORY

**L T P C
3 0 0 3**

OBJECTIVES :

To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.

- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

UNIT I GROUPS AND RINGS

9

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

UNIT II FINITE FIELDS AND POLYNOMIALS 9

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS 9

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES 9

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS 9

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

TOTAL: 45 PERIODS**OUTCOMES :**

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

TEXT BOOKS :

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.

REFERENCES:

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition , 2006.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
CO2	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
CO3	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
CO4	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
CO5	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
Avg	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

COURSE OBJECTIVES:

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS 9

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

UNIT II VECTOR SPACES 9

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

UNIT III LINEAR TRANSFORMATION 9

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

UNIT IV INNER PRODUCT SPACES 9

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION 9

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

After the completion of the course the student will be able to

1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

TEXT BOOKS

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5th Edition, 2019.

REFERENCES

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8th Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7th Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4th

Edition, 2005.

6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

OBT352

BASICS OF MICROBIAL TECHNOLOGY

L T P C

3 0 0 3

COURSE OBJECTIVE:

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

UNIT I BASICS OF MICROBES AND ITS TYPES

9

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

UNIT II MICROBIAL TECHNIQUES

9

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

UNIT III PATHOGENIC MICROBES

9

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

UNIT IV BENEFICIAL MICROBES

9

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

UNIT V PRODUCTS FROM MICROBES

9

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

1. Microbes and their types
2. Cultivation of microbes
3. Pathogens and control measures for safety
4. Microbes in different industry for economy.

TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.

2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

OBT353

BASICS OF BIOMOLECULES

L T P C

3 0 0 3

OBJECTIVES:

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

UNIT I CARBOHYDRATES

9

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

UNIT II LIPID AND FATTY ACIDS

9

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

UNIT III AMINO ACIDS AND PROTEIN.

9

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

UNIT IV NUCLEIC ACIDS

9

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature. DNA double helix (Watson and crick) model, types of DNA, RNA.

UNIT V VITAMINS AND HORMONES

9

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

OUTCOMES:

- Students will learn about various kinds of biomolecules and their physiological role.
- Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017
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. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

REFERENCES

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

OBT354 FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY

L T P C
3 0 0 3

OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

UNIT-I INTRODUCTION TO CELL 9

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria, mycoplasma and prions.

UNIT II CELL ORGANELLES 9

Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

UNIT III BIO-MEMBRANE TRANSPORT 9

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transport mechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

UNIT IV CELL CYCLE 9

Cell cycle- Cell division by mitosis and meiosis, Comparison of meiosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

UNIT V CENTRAL DOGMA 9

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

TOTAL: 45 PERIODS

OUTCOMES:

- Understanding of cell at structural and functional level.
- Understand the central dogma of life and its significance.
- Comprehend the basic mechanisms of cell division.

TEXTBOOKS:

1. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition, Oxford University Press, 2018

2. Friefelder, David. "Molecular Biology." Narosa Publications, 1999
3. Weaver, Robert F. "Molecular Biology" IInd Edition, Tata McGraw-Hill, 2003.

REFERENCES:

1. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J.
2. Molecular Cell Biology, 6th Edition, 2007.
3. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003.
4. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.
5. Alberts, Bruce et al., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.

OPEN ELECTIVE IV

OHS352

PROJECT REPORT WRITING

L T P C

3 0 0 3

COURSE OBJECTIVE

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

UNIT I

9

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

UNIT II

9

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

UNIT III

9

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

UNIT IV

9

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

UNIT V

9

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

TOTAL:45 PERIODS

OUTCOMES

By the end of the course, learners will be able to

- Write effective project reports.
- Use statistical tools with confidence.

- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

- 1-low, 2-medium, 3-high, ‘-’- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

REFERENCES

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT

L T P C
3 0 0 3

OBJECTIVES

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

UNIT I OVERVIEW OF IWRM

9

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION

9

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

UNIT III WATER ECONOMICS

9

Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

UNIT IV RECENT TREANDS IN WATER MANAGEMENT

9

River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

UNIT V IMPLEMENTATION OF IWRM

9

Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.
- CO1** Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
- CO2** Discuss on the different water uses; how it is impacted and ways to tackle these impacts.
- CO3** Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
- CO4** Illustrate the recent trends in water management.
- CO5** Understand the implementation hitches and the institutional frameworks.

TEXT BOOKS

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

REFERENCES

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET.
http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial_text.pdf
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

OMA355

ADVANCED NUMERICAL METHODS

L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research

UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM

9

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

UNIT II INTERPOLATION

9

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

**UNIT III NUMERICAL METHODS FOR
ORDINARY DIFFERENTIAL EQUATIONS**

9

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor -Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS

9

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL
DIFFERENTIAL EQUATIONS**

9

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;

CO2: understand the interpolation theory;

CO3: understand the concepts of numerical methods for ordinary differential equations;

CO4: demonstrate the understandings of common numerical methods for elliptic equations;

CO5: understand the concepts of numerical methods for time dependent partial differential equations

TEXT BOOKS :

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

REFERENCES:

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers",4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

OBJECTIVES:

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

UNIT I RANDOM VARIABLES**9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

UNIT II RANDOM PROCESSES**9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

UNIT III SPECIAL RANDOM PROCESSES**9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

UNIT IV CORRELATION AND SPECTRAL DENSITIES**9**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS**9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

TOTAL: 45 PERIODS**OUTCOMES**

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

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

TEXT BOOKS

1. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.

REFERENCES

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.

3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO5	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
Avg	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

OMA357

QUEUEING AND RELIABILITY MODELLING

**L T P C
3 0 0 3**

OBJECTIVES:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

UNIT I RANDOM PROCESSES

9

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

UNIT II MARKOVIAN QUEUEING MODELS

9

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little’s formula - Queues with finite waiting rooms.

UNIT III ADVANCED QUEUEING MODELS

9

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E_k/1 as special cases – Series queues – Open Jackson networks.

UNIT IV SYSTEM RELIABILITY

9

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

UNIT V MAINTAINABILITY AND AVAILABILITY

9

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

TOTAL: 45 PERIODS

OUTCOMES

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

- Enable the students to apply the concept of random processes in engineering disciplines.
- Students acquire skills in analyzing various queueing models.
- Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- Students can analyze reliability of the systems for various probability distributions.
- Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

TEXT BOOKS

1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018.
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

REFERENCES

1. Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
4. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

L T P C
3 0 0 3

OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

UNIT II PRODUCTION & OPERATION SYSTEMS 9
 Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

UNIT III PRODUCTION & OPERATIONS PLANNING 9
 Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9
 Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters — Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9
 Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course the learners will be able :

- CO 1 To understand the basics and functions of Production and Operation Management for business owners.
- CO 2 To learn about the Production & Operation Systems.
- CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
- CO 4 To known about the Production & Operations Management Processes in organisations.
- CO 5 To comprehend the techniques of controlling , Production and Operations in industries.

REFERENCES

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

OMG355 MULTIVARIATE DATA ANALYSIS L T P C
3 0 0 3

OBJECTIVE:

- To know various multivariate data analysis techniques for business research.

UNIT I	INTRODUCTION	9
Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.		
UNIT II	PREPARING FOR MULTIVARIATE ANALYSIS	9
Conceptualization of research model with variables, collection of data –Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.		
UNIT III	MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS	9
Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.		
UNIT IV	LATENT VARIABLE TECHNIQUES	9
Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.		
UNIT V	ADVANCED MULTIVARIATE TECHNIQUES	9
Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.		

TOTAL: 45 PERIODS

OUTCOMES :

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

REFERENCES :

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

OME352	ADDITIVE MANUFACTURING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.

- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

UNIT I INTRODUCTION

9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION

9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.
Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

UNIT III POWDER BED FUSION AND BINDER JETTING

9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.
Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION

9

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.
Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.

UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY

9

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.
Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course students shall be able to:

CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

CO3: Elaborate the process and applications of powder bed fusion and binder jetting.

CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

CO5: Acquire knowledge on sheet lamination and direct write technology.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCES:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.

CME343

NEW PRODUCT DEVELOPMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- 1 To introduce the fundamental concepts of the new product development
- 2 To develop material specifications, analysis and process.
- 3 To Learn the Feasibility Studies & reporting of new product development.
- 4 To study the New product qualification and Market Survey on similar products of new product development
To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

UNIT – I

FUNDAMENTALS OF NPD

9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

UNIT – II

MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS

9

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT – III

ESSENTIALS OF NPD

9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programming. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT – IV

CRITERIONS OF NPD

9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

UNIT – V REPORTING & FORWARD-THINKING OF NPD

9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	2
2	1	1	3	1				1	1			1	1	3	2
3	1	1	3	1				1	1			1	1	3	2
4	1	1	3	1				1	1			1	1	3	2
5	1	1	3	1				1	1			1	1	3	2
Low (1) ; Medium (2) ; High (3)															

OME355 INDUSTRIAL DESIGN AND RAPID PROTOTYPING TECHNIQUES

**L T P C
3 0 0 3**

OBJECTIVES:

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

UNIT I	UI/UX	9
Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives		
UNIT II	APP DEVELOPMENT	9
SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.		
UNIT III	INDUSTRIAL DESIGN	9
Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing		
UNIT IV	MECHANICAL RAPID PROTOTYPING	9
Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing		
UNIT V	ELECTRONIC RAPID PROTOTYPING	9
Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA		

TOTAL: 45 PERIODS

Course Outcomes

At the end of the course, learners will be able to:

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

Text Books

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

References

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. https://help.prusa3d.com/en/category/prusaslicer_204

COURSE OBJECTIVES:

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

UNIT I INTRODUCTION TO MICROSYSTEMS**9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS:**9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

UNIT III INTRODUCTION TO PRECISION ENGINEERING**9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

UNIT IV PRECISION MACHINING PROCESSES**9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

UNIT V METROLOGY FOR MICRO SYSTEMS**9**

Metrology for micro systems - Surface integrity and its characterization.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to

- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system

TEXT BOOKS:

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

REFERENCES:

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in ManufacturingII, New Age International, New Delhi, 2005

OMF354	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT – I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

UNIT – II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT – III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT – IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT – V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the costing concepts and their role in decision making.

CO2: Understand the project management concepts and their various aspects in selection.

CO3: Interpret costing concepts with project execution.

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

CO5: Become familiar with quantitative techniques in cost management.

TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

AU3002

BATTERIES AND MANAGEMENT SYSTEM

L T P C

3 0 0 3

COURSE OBJECTIVES:

- The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

UNIT I ADVANCED BATTERIES

9

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

UNIT II BATTERY PACK

9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

UNIT III BATTERY MODELLING

9

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks

UNIT IV BATTERY STATE ESTIMATION

9

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS

9

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

TOTAL =45 PERIODS

COURSE OUTCOMES:

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

1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a BatteryModel or Simulation.
4. Estimate State-of-Charges in a Battery Pack.
5. Approach different BMS architectures during real world usage.

TEXT BOOKS

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

REFERENCE BOOKS

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

AU3008

SENSORS AND ACTUATORS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS

9

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

UNIT II VARIABLE RESISTANCE AND INDUCTANCE SENSORS

9

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

UNIT III VARIABLE AND OTHER SPECIAL SENSORS

9

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV AUTOMOTIVE ACTUATORS

9

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS

9

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TOTAL =45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment's for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application

4. Understand the operation of the sensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

TEXT BOOKS:

1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin Dhanesh N. Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001
3. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

REFERENCES:

1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

OAS353

SPACE VEHICLES

L T P C
3 0 0 3

OBJECTIVES:

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

UNIT I FUNDAMENTAL ASPECTS

9

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS

9

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION

9

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

UNIT IV THRUST VECTOR CONTROL

9

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

UNIT V NOSE CONE CONFIGURATION**9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

TOTAL: 45 PERIODS**OUTCOMES:**

On successful completion of this course, the student will be able to

- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- Interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design

OIM352**MANAGEMENT SCIENCE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Of this course are

1. To introduce fundamental concepts of management and organization to students.
2. To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION**9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y- Herzberg Two Factor Theory of Motivation- Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

UNIT II OPERATIONS AND MARKETING MANAGEMENT**9**

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering(BPR)-Statistical Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on Product Life Cycle.

UNIT III HUMAN RESOURCES MANAGEMENT**9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating - Capability Maturity Model (CMM) Levels.

UNIT IV PROJECT MANAGEMENT**9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cards Contemporary Business Strategies.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

CO1: Plan an organizational structure for a given context in the organisation to carry out production operation through Work-study.

CO2: Survey the markets, customers and competition better and price the given products appropriately

CO3: Ensure quality for a given product or service.

CO4: Plan, schedule and control projects through PERT and CPM.

CO5: Evaluate strategy for a business or service organisation.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
AVg.	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

TEXTBOOKS:

1. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2007.
2. Stoner, Freeman, Gilbert, Management, 6th Ed, Pearson Education, New Delhi, 2004.
3. Thomas N. Duening & John M. Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India, 2012.

REFERECES:

1. Kotler Philip and Keller Kevin Lane: Marketing Management, Pearson, 2012.
2. Koontz and Weihrich: Essentials of Management, McGraw Hill, 2012.
3. Lawrence R Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGraw Hill, 2012.
4. Samuel C. Certo: Modern Management, 2012.

COURSE OBJECTIVES:

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION**9**

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT II WORK STUDY**9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING**9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning-Steps in process planning-Quantity determination in batch production-Machine capacity, balancing-Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING**9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC**9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems-elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course,

- CO1:The students can able to prepare production planning and control act work study,
- CO2:The students can able to prepare product planning,
- CO3:The students can able to prepare production scheduling,
- CO4:The students can able to prepare Inventory Control.
- CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

TEXT BOOKS:

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing

and services” Mcgraw Hill International edition 1992.

2. Martand Telsang, “Industrial Engineering and Production Management”, First edition, S. Chand and Company, 2000.

REFERENCES

1. Chary. S.N., “Theory and Problems in Production & Operations Management”, Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., “Production Planning Control and Industrial Management”, Khanna Publishers, 1990.
4. Kanishka Bedi, “Production and Operations management”, 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, “ Operations management – A value driven approach” Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, “Operations Management” 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corpn.1984
8. Upendra Kachru, “ Production and Operations Management – Text and cases” 1st Edition, Excel books 2007

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			3		1				1		3		
2	3	2			3									2	
3		2			3									2	
4		2	2												
5	3	3	2											1	
AVg.	3	2.6	2		3		1				1		3	1.8	

OIE353

OPERATIONS MANAGEMENT

L T P C

3 0 0 3

COURSE OBJECTIVE:

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm’s competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT

9

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN

9

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

UNIT IV MATERIALS MANAGEMENT 9

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

UNIT V SCHEDULING AND PROJECT MANAGEMENT 9

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.
- CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
- CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
- CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
- CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

CO’s- PO’s & PSO’s MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
AVg.	3	2.6	3	2.6								2	2	3	3

TEXT BOOKS

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12th Edition, 2010.

- Norman Gaither and Gregory Frazier, Operations Management, South Western CengageLearning, 2002.

REFERENCES

- William J Stevenson, Operations Management, Tata McGraw Hill, 9th Edition, 2009.
- Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
- Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
- Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
- Aswathappa K and Shridhara Bhat K, Production and Operations Management, HimalayaPublishing House, Revised Second Edition, 2008.
- Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
- Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

OSF352

INDUSTRIAL HYGIENE

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

UNIT I INTRODUCTION AND SCOPE 9

Occupational Health and Environmental Safety Management - Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT 9

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

UNIT-V INDUSTRIAL HAZARDS**9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

TEXT BOOKS:

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

REFERENCES:

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2		2	-	-	-	-	-	2	-	-	-	-
2	-		2		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2		-	-	-

OSF353**CHEMICAL PROCESS SAFETY****L T P C
3 0 0 3****COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.

- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

UNIT II CHEMICAL REACTION HAZARDS 9

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

UNIT V SAFETY AND ANALYSIS 9

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students able to

- CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
- CO2** Develop thorough knowledge about safety in the operation of chemical plants.
- CO3** Apply the principles of safety in the storage and handling of gases.
- CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.
- CO5** Develop thorough knowledge about

TEXT BOOK

- 1 David A Crowl & Joseph F Louvar, "Chemical Process safety", Pearson publication, 3rd Edition, 2014
- 2 Maurice Jones .A, "Fire Protection Systems, 2nd edition, Jones & Bartlett Publishers, 2015

REFERENCES:

1. Ralph King and Ron Hirst, "King's safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council, "Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety", 3rd Edition, Gulf professional publishing, 2006

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-	-	-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-	-	-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
AVg.	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Understanding the importance of various materials used in electrical, electronics and magnetic applications
2. Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
3. Gaining knowledge on the selection of suitable materials for the given application
4. Knowing the fundamental concepts in Semiconducting materials
5. Getting equipped with the materials used in optical and optoelectronic applications.

UNIT- I DIELECTRIC MATERIALS

9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

UNIT – II MAGNETIC MATERIALS

9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose

materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

UNIT – III SEMICONDUCTOR MATERIALS 9

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

UNIT – IV MATERIALS FOR ELECTRICAL APPLICATIONS 9

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

UNIT – V OPTICAL AND OPTOELECTRONIC MATERIALS 9

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand various types of dielectric materials, their properties in various conditions.
2. Evaluate magnetic materials and their behavior.
3. Evaluate semiconductor materials and technologies.
4. Select suitable materials for electrical engineering applications.
5. Identify right material for optical and optoelectronic applications

TEXT BOOKS:

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

REFERENCE BOOKS:

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	3	2	2	3								2	2	2	1
C02	3	1	2	2								2	2	2	1

C03	3	2	1	2								2	2	2	1
CO4	3	2	1	2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	3	1.8	1.6	2.2								2	2	2	1.2

OML353

NANOMATERIALS AND APPLICATIONS

L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

UNIT I NANOMATERIALS

9

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS

9

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

UNIT III PROCESSING

9

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

UNIT IV STRUCTURAL CHARACTERISTICS

9

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

UNIT V APPLICATIONS

9

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties

3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

TEXT BOOKS:

1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

REFERENCES:

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid’ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
CO4	3	1		2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

OMR352

HYDRAULICS AND PNEUMATICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To knowledge on fluid power principles and working of hydraulic pumps
2. To obtain the knowledge in hydraulic actuators and control components
3. To understand the basics in hydraulic circuits and systems
4. To obtain the knowledge in pneumatic and electro pneumatic systems
5. To apply the concepts to solve the trouble shooting

UNIT – I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS

9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal’s Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS

9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning –

Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps
- CO 2: Recognize the concepts in hydraulic actuators and control components
- CO 3: Obtain the knowledge in basics of hydraulic circuits and systems
- CO 4: Know about the basics concept in pneumatic and electro pneumatic systems
- CO 5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1		2	2						1	2	2	1
CO2	3	2	1		2	2						1	2	2	1
CO3	3	2	1		2	2						1	2	2	1
CO4	3	2	1		2	2						1	2	2	1
CO5	3	2	1		2	2						1	2	2	1
CO/PO & PSO Average	3	2	1		2	2						1	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997.

REFERENCES

1. Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, Tata McG Raw Hill, 2001.
3. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987

5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, "Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

OMR353

SENSORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

UNIT – I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

UNIT – II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

UNIT – III FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

UNIT – IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS 9

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

UNIT – V SIGNAL CONDITIONING 9

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.
 CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
 CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.
 CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

Mapping of COs with POs and PSOs																
COs/POs & PSOs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	3	3	2									1	2	3	2	1
CO2	3	3	2	1	1	1						1	2	3	2	1
CO3	3	3	2	1	1	1						1	2	3	2	1
CO4	3	3	2	1	1	1						1	2	3	2	1
CO5	3	3	2	1	1	1						1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8						0.8	2	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.

REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

ORA352	CONCEPTS IN MOBILE ROBOTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9
 Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots –

Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

UNIT – II KINEMATICS 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

UNIT – III PERCEPTION 9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

UNIT – IV LOCALIZATION 9

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Evaluate the appropriate mobile robots for the desired application.

CO2: Create the kinematics for given wheeled and legged robot.

CO3: Analyse the sensors for the intelligence of mobile robotics.

CO4: Create the localization strategies and mapping technique for mobile robot.

CO5: Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

TEXTBOOK

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

REFERENCES:

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsuchita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

COURSE OBJECTIVES:

1. To impart knowledge on basics of propulsion system and ship dynamic movements
2. To educate them on basic layout and propulsion equipment's
3. To impart basic knowledge on performance of the ship
4. To impart basic knowledge on Ship propeller and its types
5. To impart knowledge on ship rudder and its types

UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS 9

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

UNIT III SHIPS SPEED AND ITS PERFORMANCE 9

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

UNIT IV BASICS OF PROPELLER 9

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

UNIT V BASICS OF RUDDER 9

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

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

- CO1: Explain the basics of propulsion system and ship dynamic movements
 CO2: Familiarize with various components assisting ship stabilization.
 CO3: Demonstrate the performance of the ship.
 CO4: Classify the Propeller and its types, Materials etc.
 CO5: Categories the Rudder and its types, design criteria of rudder.

TEXT BOOKS:

1. GP. Ghose, "Basic Ship propulsion",2015
2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5,2010
3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers",4th Edition,2009

REFERENCES BOOKS:

1. DJ Eyers and GJ Bruse, "Ship Construction", 7th Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1, 5th Edition, 2001.

MAPPING OF COS AND POS:

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

OMV351

MARINE MERCHANT VESSELS

**L T P C
3 0 0 3**

OBJECTIVES:

At the end of the course, students are expected to acquire

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

UNIT I INTRODUCTION TO HYDROSTATICS

9

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

UNIT II TYPES OF SHIP

10

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

UNIT III SHIPBUILDING MATERIALS

9

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

UNIT IV MARINE PROPELLER AND RUDDER

8

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY

9

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships) , **MLC**

(Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students would

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

TEXT BOOKS:

1. D.J.Eyres, "Ship Constructions", Seventh Edition, Butter Worth Heinemann Publishing, USA, 2015
2. Dr.DA Taylor, "Merchant Ship Naval Architecture" I. Mar EST publications, 2006
3. EA Stokoe, E.A, "Naval Architecture for Marine Engineers", Vol.4, Reeds Publications,2000

REFERENCES:

1. Kemp & Young "Ship Construction Sketches & Notes", Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

OMV352

ELEMENTS OF MARINE ENGINEERING

**L T P C
3 0 0 3**

OBJECTIVES:

At the end of the course, students are expected to

1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. Be aware of ship propellers and steering system

UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS

9

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

UNIT II MARINE PROPULSION MACHINERY SYSTEM

9

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

UNIT III MARINE AUXILIARY MACHINERY SYSTEM

9

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

UNIT IV MARINE BOILER SYSTEM**9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

UNIT V SHIP PROPELLERS AND STEERING MECHANISM**9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

TOTAL: 45 PERIODS**OUTCOMES:**

At the end of the course, students should able to,

1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system
4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellers and steering system

TEXT BOOKS:

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

REFERENCES:

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

CRA332**DRONE TECHNOLOGIES**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY**9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING**9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of

autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

- Upon successful completion of the course, students should be able to:
 CO1: Know about a various type of drone technology, drone fabrication and programming.
 CO2: Execute the suitable operating procedures for functioning a drone
 CO3: Select appropriate sensors and actuators for Drones
 CO4: Develop a drone mechanism for specific applications
 CO5: Createthe programs for various drones

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/Pos&PS Os	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrnsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

OBJECTIVES:

To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

UNIT I FUNDAMENTALS OF GIS**9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

UNIT II SPATIAL DATA MODELS**9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

UNIT III DATA INPUT AND TOPOLOGY**9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

UNIT IV DATA QUALITY AND STANDARDS**9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

UNIT V DATA MANAGEMENT AND OUTPUT**9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

TOTAL:45 PERIODS**COURSE OUTCOMES:**

•On completion of the course, the student is expected to

CO1 Have basic idea about the fundamentals of GIS.

CO2 Understand the types of data models.

CO3 Get knowledge about data input and topology

CO4 Gain knowledge on data quality and standards

CO5 Understand data management functions and data output

TEXTBOOKS:

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

REFERENCES:

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

OAI352

AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT

**L T P C
3 0 0 3**

OBJECTIVES

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT

9

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmes (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE

9

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE

9

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing- Directing-Motivation-ordering-leading-supervision- communication and control-Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios,

coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE

9

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

UNIT V ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT

9

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

TOTAL: 45 PERIODS

COURSE OUTCOMES

1. Judge about agricultural finance, banking and cooperation
2. Evaluate basic concepts, principles and functions of financial management
3. Improve the skills on basic banking and insurance schemes available to customers
4. Analyze various financial data for efficient farm management
5. Identify the financial institutions

TEXT BOOKS

1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

REFERENCES

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

CO-PO MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1
PO10	Communication	1	1	1	1	2	1
PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1

OEN352**BIODIVERSITY CONSERVATION****L T P C
3 0 0 3****OBJECTIVE:**

The identification of different aspects of biological diversity and conservation techniques.

UNIT I INTRODUCTION**9**

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY**9**

Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

UNIT III MICROBIAL DIVERSITY**9**

Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

UNIT IV MEGA DIVERSITY**9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

UNIT V CONSERVATIONS OF BIODIVERSITY**9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 13th Edition 2019

REFERENCES:

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.

OUTCOMES

Upon successful completion of this course, students will:

CO1: An insight into the structure and function of diversity for ecosystem stability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: An understanding of biodiversity in community resource management.

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1-low, 2-medium, 3-high, '-'- no correlation

Note: The average value of this course to be used for program articulation matrix.

OBJECTIVES

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS 9

Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

UNIT II TIME RESPONSE ANALYSIS & ROOT LOCUS TECHNIQUE 9

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

UNIT III FREQUENCY RESPONSE ANALYSIS 9

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

UNIT IV STABILITY CONCEPTS & ANALYSIS 9

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response.

UNIT V STATE VARIABLE ANALYSIS 9

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

TOTAL : 45 PERIODS**OUTCOMES:**

Ability to

CO1: Design the basic mathematical model of physical System.

CO2: Analyze the time response analysis and techniques.

CO3: Analyze the transfer function from different plots.

CO4: Apply the stability concept in various criterion.

CO5: Assess the state models for linear and continuous Systems.

TEXTBOOKS

1. Farid Golnarghi, Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition 2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

REFERENCES

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5th Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.

5. Yaduvir Singh and S.Janardhanan, Modern Control, Cengage Learning, First Impression2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2							2	3	3	3
CO2	3	3	2	3	1								3	3	3
CO3	3	3	3	2	2								3	3	3
CO4	3	3	3	2	2							2	3	3	3
CO5	3	3	3	1	1							1	3	3	3
													3	3	3

OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

UNIT I INTRODUCTION

9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

UNIT II AUTOMATION COMPONENTS

9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS

9

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS

9

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT V DISTRIBUTED CONTROL SYSTEM

9

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

TOTAL:45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content

Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

5

1. Market survey of the recent PLCs and comparison of their features.

2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

COURSE OUTCOMES:

Students able to

- CO1** Design a signal conditioning circuits for various application (L3).
CO2 Acquire a detail knowledge on data acquisition system interface and DCS system (L2).
CO3 Understand the basics and Importance of communication buses in applied automation Engineering (L2).
CO4 Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
CO5 Able to develop a PLC logic for a specific application on real world problem. (L5)

TEXT BOOKS:

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

REFERENCES:

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3 rd Edition,2005.

List of Open Source Software/ Learning website:

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
CO2	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
CO3	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
CO4	3	3	3	3	1			1		1			1		1
CO5	3	3	3	3	1	1		1		1			1		1
AVg.	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

UNIT I INTRODUCTION

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

UNIT II CONVENTIONAL ENERGY

8

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III NON-CONVENTIONAL ENERGY

10

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV BIOMASS ENERGY

10

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

UNIT V ENERGY CONSERVATION

9

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

TOTAL : 45 PERIODS**OUTCOMES:**

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

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

TEXT BOOKS

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

REFERENCES

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

Course articulation matrix

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
OVERALL CO		2	2	1	3	3	2	2	1	1	1	1	3	2	1	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OCH354

SURFACE SCIENCE

L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES

9

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

UNIT III LIQUID INTERFACES 9

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

UNIT IV HETEROGENEOUS CATALYSIS 9

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

TEXT BOOK:

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

REFERENCE:

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

OPY353

NUTRACEUTICALS

**L T P C
3 0 0 3**

OBJECTIVES:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

UNIT I INTRODUCTION AND SIGNIFICANCE 6

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS 11

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene,

chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 11

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

UNIT IV ROLE IN HEALTH AND DISEASE 11

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

UNIT V SAFETY ISSUES 6

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.

REFERENCES:

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

COURSE OUTCOME - NUTRACEUTICALS

CO 1	acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
CO 2	acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
CO 3	attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
CO 4	distinguish the various <i>In vitro</i> and <i>In vivo</i> assessment of Antioxidant activity of compounds from plant sources.

CO 5	gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
CO 6	Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

CO – PO MAPPING												
NUTRACEUTICALS												
Course outcome	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO8	PO 9	PO10	PO11	PO12
CO 1	3											1
CO 2	3											1
CO 3	3					2						
CO 4	3											
CO 5	3					2						1
CO 6	3							2				1

OTT354

BASICS OF DYEING AND PRINTING

**L T P C
3 0 0 3**

OBJECTIVE:

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

UNIT I INTRODUCTION

9

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

UNIT II PRE TREATMENT

9

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring- Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

UNIT III DYEING

9

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

UNIT IV PRINTING

9

Definition of printing – Difference between printing and dyeing- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

UNIT V MACHINERIES

9

Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to Understand the

CO1: Basics of grey fabric

CO2: Basics of pre treatment

CO3: Concept of Dyeing

CO4: Concept of Printing
 CO5: Machinery in processing industry

TEXT BOOKS:

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

REFERENCES:

1. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018
3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
Overall CO		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

COURSE OBJECTIVES

- To enable the students to learn about the types of fibre and its properties

UNIT I INTRODUCTION TO TEXTILE FIBRES 9

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

UNIT II REGENERATED FIBRES 9

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

UNIT III SYNTHETIC FIBRES 9

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

UNIT IV SPECIALITY FIBRES 9

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

UNIT V FUNCTIONAL SPECIALITY FIBRES 9

Properties and end uses : Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

TOTAL : 45 PERIODS**COURSE OUTCOMES**

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

TEXT BOOKS:

- Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
- Meredith R., and Hearle J. W. S., "Physical Methods of Investigation of Textiles", Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
- Mukhopadhyay S. K., "Advances in Fibre Science", The Textile Institute,1992, ISBN: 1870812379

REFERENCES:

- Meredith R., "Mechanical Properties of Textile Fibres", North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
- Hearle J. W. S., Lomas B., and Cooke W. D., "Atlas of Fibre Fracture and Damage to Textiles", The Textile Institute, 2nd Edition, 1998, ISBN: 1855733196.
- Raheel M. (ed.), "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737
- Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
- Hearle J.W.S., "Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1", Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
Avg	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

OPE353

INDUSTRIAL SAFETY

L T P C
3 0 0 3

OBJECTIVES:

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

UNIT I INTRODUCTION

9

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

UNIT II OCCUPATIONAL HEALTH AND HYGIENE

9

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS

9

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

UNIT IV HAZARDS AND RISK MANAGEMENT

9

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

TOTAL: 45 PERIODS

OUTCOMES:

After completion of this course, the student is expected to be able to:

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354 UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES L T P C
3 0 0 3**

OBJECTIVES:

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

UNIT I FLUID MECHANICS CONCEPTS 9

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS 9

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER 9

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

UNIT IV BASICS OF MASS TRANSFER 9

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

UNIT V MASS TRANSFER OPERATIONS**9**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Drying- drying operations, batch and continuous drying. Conceptual numerical.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

TEXTBOOK(S)

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchero, J.T., Tata McGraw Hill New York 1997

REFERENCE BOOKS

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I & II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

OPT352**PLASTIC MATERIALS FOR ENGINEERS****L T P C
3 0 0 3****COURSE OBJECTIVES**

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

UNIT I INTRODUCTION TO PLASTIC MATERIALS**9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS**9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

UNIT III THERMOSETTING PLASTICS 9

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanooates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

TOTAL : 45 PERIODS

COURSE OUTCOMES

- To study the importance, advantages and classification of plastic materials
- Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
- To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
- Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
- To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

REFERENCES

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8th Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7th Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4th Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3rd Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2nd Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

OPT353

PROPERTIES AND TESTING OF PLASTICS

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

UNIT II MECHANICAL PROPERTIES 9

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

UNIT III THERMAL RHEOLOGICAL PROPERTIES 9

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.
- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

REFERENCES

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2nd Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3rd Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

OBJECTIVES:

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

UNIT I MOS TRANSISTOR PRINCIPLES**9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

UNIT II COMBINATIONAL LOGIC CIRCUITS**9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES**9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

UNIT IV INTERCONNECT, MEMORY ARCHITECTURE**9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS**9**

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

TOTAL: 45 PERIODS**OUTCOMES:**

Upon successful completion of the course the student will be able to

CO1: Understand the working principle and characteristics of MOSFET

CO2: Design Combinational Logic Circuits

CO3: Design Sequential Logic Circuits and Clocking systems

CO4: Understand Memory architecture and interconnects

CO5: Design of arithmetic building blocks.

TEXTBOOKS

1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.(Units - I).

REFERENCES

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000

4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
C	3	3	2	2	1	2	-	-	-	-	2	2	3	3	3

CBM370

WEARABLE DEVICES

L T P C
3 0 0 3

OBJECTIVES:

The student should be made to:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

UNIT IV SMART TEXTILE 9

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe the concepts of wearable system.

CO2: Explain the energy harvestings in wearable device.

CO3: Use the concepts of BAN in health care.

CO4: Illustrate the concept of smart textile
 CO5: Compare the various wearable devices in healthcare system

TOTAL PERIODS:45

TEXT BOOKS

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and Jamil Y. Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

REFERENCES

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1		1
2	3	2	1	1	2			1					1		1
3	3	2	1	1	2			1					1		1
4	3	2	1	1	2			1					1		1
5	3	2	1	1	2			1					1		1
AVg.	3	2	1	1	2			1					1		1

CBM356

MEDICAL INFORMATICS

L T P C
3 0 0 3

Preamble:

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

UNIT I INTRODUCTION TO MEDICAL INFORMATICS

9

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING

9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

UNIT III COMPUTERISED PATIENT RECORD

9

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer-assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

TOTAL : 45 PERIODS

Course Outcomes:

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

1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

TEXT BOOKS:

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata Mcgraw Hill, 2005

REFERENCES:

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3rd Edition, Springer, 2006.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1	1	1
2	3	2	1	1	2			1					1	1	1
3	3	2	1	1	2			1					1	1	1
4	3	2	1	1	2			1					1	1	1
5	3	2	1	1	2			1					1	1	1
AVg.	3	2	1	1	2			1					1	1	1

**OBT355 BIOTECHNOLOGY FOR WASTE MANAGEMENT L T P C
3 0 0 3**

UNIT I BIOLOGICAL TREATMENT PROCESS 9

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continuous fermentation

UNIT II WASTE BIOMASS AND ITS VALUE ADDITION 9

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

UNIT III BIOCONVERSION OF WASTES TO ENERGY 9

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES 9

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

UNIT V BIOCUMPOSTING OF ORGANIC WASTES 9

Overview of composting process - Benefits of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students should be able

1. To learn the various methods biological treatment
2. To know the details of waste biomass and its value addition
3. To develop the bioconversion processes to convert wastes to energy
4. To synthesize the chemicals and enzyme from wastes
5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

TEXT BOOKS

1. Antoine P. T., (2017) “Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation”, CRC press
2. Joseph C A., (2019)“Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook”, CRC Press,

REFERENCE BOOKS

1. Palmiro P. and Oscar F.D’Urso, (2016) ‘Biotransformation of Agricultural Waste and By-Products’, The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)‘Biotransformation of Waste Biomass into High Value Biochemicals’, Springer.
3. Keikhosro K, Editor, (2015) ‘Lignocellulose-Based Bioproducts’, Springer.
4. John P, (2014) ‘Waste Management Practices-Municipal, Hazardous, and Industrial’, Second Edition, CRC Press, 2014

OBT356

LIFESTYLE DISEASES

**L T P C
3 0 0 3**

UNIT I INTRODUCTION

9

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

UNIT II CANCER 9
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

UNIT III CARDIOVASCULAR DISEASES 9
Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -- Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

UNIT IV DIABETES AND OBESITY 9
Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

UNIT V RESPIRATORY DISEASES 9
Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.Kumar&Meenal Kumar, “Guide to Prevention of Lifestyle Diseases”, Deep & Deep Publications, 2003
2. Gary Eggar et al, “Lifestyle Medicine”, 3rd Edition, Academic Press, 2017

REFERENCES:

1. James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008

**OBT357 BIOTECHNOLOGY IN HEALTH CARE L T P C
3 0 0 3**

COURSE OBJECTIVES

The aim of this course is to

1. Create higher standard of knowledge on healthcare system and services
2. Prioritize advanced technologies for the diagnosis and treatment of various diseases

UNIT I PUBLIC HEALTH 9
Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

UNIT II CLINICAL DISEASES 9
Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

UNIT III VACCINOLOGY 9
History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

UNIT IV OUTPATIENT & IN PATIENT SERVICES**9**

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

UNIT V BASICS OF IMAGING MODALITIES**9**

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

REFERENCE BOOKS

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

VERTICAL 1: FINTECH AND BLOCK CHAIN**CMG331****FINANCIAL MANAGEMENT****LT P C
3 0 0 3****LEARNING OBJECTIVES**

- 1.To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

UNIT I INTRODUCTION TO FINANCIAL MANGEMENT**9**

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

UNIT II . SOURCES OF FINANCE**9**

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

UNIT III INVESTMENT DECISIONS**9**

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting -- Payback -ARR – NPV – IRR –Profitability Index.
Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

UNIT IV FINANCING AND DIVIDEND DECISION**9**

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .
Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

UNIT V WORKING CAPITAL DECISION 9

Working Capital Management: Working Capital Management - concepts - importance -Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

TOTAL : 45 PERIODS

TEXT BOOKS

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

REFERENCES .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

CMG332

FUNDAMENTALS OF INVESTMENT

**L T P C
3 0 0 3**

OBJECTIVES:

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

UNIT I THE INVESTMENT ENVIRONMENT 9

The investment decision process, Types of Investments – Commodities, Real Estate and FinancialAssets, the Indian securities market, the market participants and trading of securities, securitymarket indices, sources of financial information, Concept of return and risk, Impact of Taxes andInflationonreturn.

UNIT II FIXED INCOME SECURITIES 9

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, defaultrisk andcreditrating.

UNIT III APPROACHES TOEQUITYANALYSIS 9

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

UNIT V INVESTOR PROTECTION 9

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness andactivism

TOTAL : 45 PERIODS

REFERENCES

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14TH Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5th, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. ZviBodie, Alex Kane, Alan J Marcus, PitabusMohanty, Investments, McGraw Hill Education (India), 11 Edition(SIE), 2019

CMG333

BANKING, FINANCIAL SERVICES AND INSURANCE

**LT P C
3 0 0 3**

OBJECTIVES

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM

9

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

UNIT II MANAGING BANK FUNDS/ PRODUCTS

9

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

UNIT III DEVELOPMENT IN BANKING TECHNOLOGY

9

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money – forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

UNIT IV FINANCIAL SERVICES

9

Introduction – Need for Financial Services – Financial Services Market in India – NBFC — Leasing and Hire Purchase — mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

UNIT V INSURANCE

9

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

TOTAL : 45 PERIODS

REFERENCES :

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.

2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

CMG334	INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS	LT P C 3 0 0 3
UNIT I	INTRODUCTION TO BLOCKCHAIN	9
Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.		
UNIT II	INTRODUCTION TO CRYPTOCURRENCY	9
Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain		
UNIT III	ETHEREUM	9
Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network		
UNIT IV	WEB3 AND HYPERLEDGE	9
Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.		
UNIT V	EMERGING TRENDS	9
Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.		
		TOTAL : 45 PERIODS

REFERENCE

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, "Blockchain Applications: A Hands On Approach", VPT, 2017.

CMG335	FINTECH PERSONAL FINANCE AND PAYMENTS	LT P C 3 0 0 3
UNIT I	CURRENCY EXCHANGE AND PAYMENT	9
Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory		

Implications of Crypto currencies, Payment systems and their regulations. Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

UNIT III INSURETECH 9

InsurTech Introduction , Business model disruption AI/ML in InsurTech • IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

UNIT IV PEER TO PEER LENDING 9

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

UNIT V REGULATORY ISSUES 9

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

TOTAL : 45 PERIODS

REFERENCE

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

CMG336

INTRODUCTION TO FINTECH

LT P C

3 0 0 3

OBJECTIVES:

1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

UNIT I INTRODUCTION 9

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry,

Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

UNIT II PAYMENT INDUSTRY 9

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

UNIT III INSURANCE INDUSTRY 9

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

UNIT IV FINTECH AROUND THE GLOBE 9

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

UNIT V FUTURE OF FINTECH 9

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

TOTAL : 45 PERIODS

REFERENCES

1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

VERTICAL 2: ENTREPRENEURSHIP

**CMG337 FOUNDATIONS OF ENTREPRENEURSHIP L T P C
3 0 0 3**

COURSE OBJECTIVES

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

UNIT II BUSINESS OWNERSHIP & ENVIRONMENT 9

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -- Success Stories of Technopreneurs - Case Studies

UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP 9

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.

TOTAL45 : PERIODS

OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship

CO 4 Learn about applications of technopreneurship and successful technopreneurs

CO 5 Acquaint with the recent and emerging trends in entrepreneurship

Text Books:

- 1) S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
- 2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

References :

- 1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
- 2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Ed: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5) HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>
- 6) JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009

- 7) Basics of Technopreneuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8) Journal articles pertaining to Entrepreneurship

CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS L T P C
3 0 0 3

COURSE OBJECTIVES

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businessess.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

UNIT I INTRODUCTION TO MANAGING TEAMS 9

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Devlopment - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9

Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

UNIT III INTRODUCTION TO LEADERSHIP 9

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

UNIT IV LEADERSHIP IN ORGANISATIONS 9

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

UNIT V LEADERSHIP EFFECTIVENESS 9

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course, the student should be able to:

- CO 1 Learn the basics of managing teams for business.
- CO 2 Understand developing effective teams for business management.
- CO 3 Understand the fundamentals of leadership for running a business.
- CO 4 Learn about the importance of leadership for business development.
- CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurus.”

REFERENCES :

- 1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).

2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP

L T P C
3 0 0 3

COURSE OBJECTIVES

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

UNIT I CREATIVITY 9

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- - Creative Personality and Motivation.

UNIT II CREATIVE INTELLIGENCE 9

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training-- Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

UNIT III INNOVATION 9

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

UNIT IV INNOVATION AND ENTREPRENEURSHIP 9

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

UNIT V INNOVATIVE BUSINESS MODELS 9

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

TOTAL 45 : PERIODS

OUTCOMES:

- Upon completion of this course, the student should be able to:
- CO 1 Learn the basics of creativity for developing Entrepreneurship
- CO 2 Understand the importance of creative intelligence for business growth

CO 3 Understand the advances through Innovation in Industries
 CO 4 Learn about applications of innovation in building successful ventures
 CO 5 Acquaint with developing innovative business models to run the business effecientlty and effectively

Suggested Readings:

Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand
 Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
 Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
 Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.
 Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
 A. Dale Timpe, Creativity, Jaico Publishing House, 2003.
 Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
 Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9
 Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

UNIT II MARKETING ENVIRONMENT 9
 Introduction - Environmental Scanning - Analysing the Organisation’s Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

UNIT III PRODUCT AND PRICING MANAGEMENT 9
 Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

UNIT IV PROMOTION AND DISTRIBTUION MANAGEMENT 9
 Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT**9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

TOTAL 45 : PERIODS**COURSE OUTCOMES:**

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

CO1 Have the awareness of marketing management process

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

REFERENCES:

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	3

OBJECTIVES:

1. To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
2. To create an awareness of the roles, functions and functioning of human resource department.
- 3.To understand the methods and techniques followed by Human Resource Management practitioners.

UNIT I INTRODUCTION TO HRM**9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

UNIT II HUMAN RESOURCE PLANNING**9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

UNIT III RECRUITMENT AND SELECTION**9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

UNIT V CONTROLLING HUMAN RESOURCES 9

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To know about the methods of Training and Employee Development.

CO 5 To comprehend the techniques of controlling human resources in organisations.

REFERENCES

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

CMG342 FINANCING NEW BUSINESS VENTURES

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.

UNIT I ESSENTIALS OF NEW BUSINESS VENTURE 9

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

UNIT II INTRODUCTION TO VENTURE FINANCING 9

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.

UNIT III SOURCES OF DEBT FINANCING 9
Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

UNIT IV SOURCES OF EQUITY FINANCING 9
Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9
Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

TOTAL 45 : PERIODS

OUTCOMES:

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

- CO 1 Learn the basics of starting a new business venture.
- CO 2 Understand the basics of venture financing.
- CO 3 Understand the sources of debt financing.
- CO 4 Understand the sources of equity financing.
- CO 5 Acquaint with the methods of fund raising for new business ventures.

REFERENCES :

- 1) Principles of Corporate Finance by Brealey and Myers et al.,12TH ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight,Butterworth-Heinemann, 2006.
- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

VERTICAL 3: PUBLIC ADMINISTRATION

CMG343 PRINCIPLES OF PUBLIC ADMINISTRATION

**L T P C
3 0 0 3
(9)**

UNIT-I

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration

3. Evolution of Public Administration

- UNIT-II** (9)
1. New Public Administration
2. New Public Management
3. Public and Private Administration

- UNIT-III** (9)
1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

- UNIT-IV** (9)
1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

- UNIT-V** (9)
1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

TOTAL: 45 PERIODS

REFERENCES:

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

CMG344

CONSTITUTION OF INDIA

L T P C
3 0 0 3
(9)

- UNIT-I**
1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

- UNIT-II** (9)
1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

- UNIT-III** (9)
1. President
2. Parliament
3. Supreme Court

- UNIT-IV** (9)
1. Governor
2. State Legislature
3. High Court

UNIT-V**(9)**

1. Secularism
2. Social Justice
3. Minority Safeguards

TOTAL: 45 PERIODS**REFERENCES:**

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

CMG345**PUBLIC PERSONNEL ADMINISTRATION****L T P C****3 0 0 3****UNIT-I****(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

UNIT-II**(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

UNIT-III**(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

UNIT-IV**(9)**

1. All India Services
2. Service Conditions
3. State Public Service Commission

UNIT-V**(9)**

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

TOTAL: 45 PERIODS**REFERENCES:**

1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations

CMG346	ADMINISTRATIVE THEORIES	L T P C 3 0 0 3
UNIT I		(9)
Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration		
UNIT II		(9)
Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory		
UNIT III		(9)
Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.		
UNIT IV		(9)
Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making		
UNIT V		(9)
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker		
		TOTAL: 45 PERIODS

REFERENCES:

1. Crozier M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

CMG347	INDIAN ADMINISTRATIVE SYSTEM	L T P C 3 0 0 3
UNIT I		(9)
Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India		
UNIT II		(9)
Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government		
UNIT III		(9)
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992		
UNIT IV		(9)
Coalition politics in India, Integrity and Vigilance in Indian Administration		
UNIT V		(9)
Corruption – Ombudsman, Lok Pal & Lok Ayuktha		
		TOTAL: 45 PERIODS

REFERENCES:

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

CMG348**PUBLIC POLICY ADMINISTRATION****L T P C**
3 0 0 3**UNIT-I****(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

UNIT-II**(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

UNIT-III**(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

UNIT-IV**(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

UNIT-V**(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

TOTAL: 45 PERIODS**REFERENCES:**

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

VERTICAL 4: BUSINESS DATA ANALYTICS**CMG349****STATISTICS FOR MANAGEMENT****L T P C**
3 0 0 3**OBJECTIVE:**

- To learn the applications of statistics in business decision making.

UNIT I INTRODUCTION**9**

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION**9**

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS 9
Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

UNIT IV NON-PARAMETRIC TESTS 9
Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

UNIT V CORRELATION AND REGRESSION 9
Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

TOTAL:45 PERIODS

OUTCOMES:

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

REFERENCES:

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

CMG350 DATAMINING FOR BUSINESS INTELLIGENCE L T P C
3 0 0 3

OBJECTIVES :

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

UNIT I INTRODUCTION 9
Data mining, Text mining, Web mining, Data ware house.

UNIT II DATA MINING PROCESS 9
Datamining process – KDD, CRISP-DM, SEMMA
Prediction performance measures

UNIT III PREDICTION TECHNIQUES 9
Data visualization, Time series – ARIMA, Winter Holts,

UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES 9
Classification, Association, Clustering.

UNIT V MACHINE LEARNING AND AI**9**

Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

TOTAL: 45 PERIODS**OUTCOMES:**

1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

REFERENCES :

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition, 2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriack C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. Galit Shmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

CMG351**HUMAN RESOURCE ANALYTICS****L T P C
3 0 0 3****OBJECTIVE:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

UNIT I - INTRODUCTION TO HR ANALYTICS**9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

UNIT II - HR ANALYTICS I: RECRUITMENT**9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

UNIT III - HR ANALYTICS - TRAINING AND DEVELOPMENT 9
Training & Development Metrics : Percentage of employees trained- Internally and externally trained - Training hours and cost per employee - ROI.

UNIT IV - HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9
Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9
Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

TOTAL: 45 PERIODS

OUTCOME:

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

REFERENCES:

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrics, HBR, 2001.

CMG352

MARKETING AND SOCIAL MEDIA WEB ANALYTICS

**L T P C
3 0 0 3**

OBJECTIVE:

- To showcase the opportunities that exist today to leverage the power of the web and social media

UNIT I - MARKETING ANALYTICS 9
Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

UNIT II - COMMUNITY BUILDING AND MANAGEMENT 9
History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.

UNIT III - SOCIAL MEDIA POLICIES AND MEASUREMENTS **9**
Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

UNIT IV - WEB ANALYTICS **9**
Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

UNIT V - SEARCH ANALYTICS **9**
Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

TOTAL: 45 PERIODS

OUTCOME:

➤ The Learners will understand social media, web and social media analytics and their potential impact.

REFERENCES:

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

CMG353 **OPERATION AND SUPPLY CHAIN ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVE:

➤ To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

UNIT I - INTRODUCTION **9**
Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

UNIT II - WAREHOUSING DECISIONS **9**
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.

UNIT III - INVENTORY MANAGEMENT **9**
Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

UNIT IV - TRANSPORTATION NETWORK MODELS **9**
Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

UNIT V - MCDM MODELS

9

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic and Techniques, the analytical network process (ANP), TOPSIS.

TOTAL: 45 PERIODS

OUTCOME:

➤ To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

REFERENCES:

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

CMG354

FINANCIAL ANALYTICS

L T P C
3 0 0 3

OBJECTIVE:

➤ This course introduces a core set of modern analytical tools that specifically target finance applications.

UNIT I - CORPORATE FINANCE ANALYSIS

9

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

UNIT II - FINANCIAL MARKET ANALYSIS

9

Estimation and prediction of risk and return (bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

UNIT III - PORTFOLIO ANALYSIS

9

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

UNIT IV - TECHNICAL ANALYSIS

9

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

UNIT V - CREDIT RISK ANALYSIS

9

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

TOTAL: 45 PERIODS

OUTCOME

➤ The learners should be able to perform financial analysis for decision making using excel, Python and R.

REFERENCES:

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT

**L T P C
3 0 0 3**

OBJECTIVE:

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

UNIT I SUSTAINABLE DEVELOPMENT GOALS

9

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING

9

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement & Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES

9

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS

9

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-

design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS

9

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to

CO1 Understand the environment sustainability goals at global and Indian scenario.

CO2 Understand risks in development of projects and suggest mitigation measures.

CO3 Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

CO4 Explain Life Cycle Analysis and life cycle cost of construction materials.

CO5 Explain the new technologies for maintenance of infrastructure projects.

REFERENCES:

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		1	1		2	3	1	1		2	1	1	2	1
2	3	1	3	2	1	2	2		1	1	1	2	2	2	2
3	2	2	3	1	1	1	1				1	1	1	3	1
4	3	1	3	2	2	1	3	1	1	1	1	2	2	2	2
5	3	1	2	2	2	2	3	1		1	1	2	2	3	2
Avg.	3	1	3	2	2	2	3	1	1	1	1	2	2	3	2

CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9

Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

UNIT III WATER MANAGEMENT 9

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

UNIT IV ENERGY AND WASTE MANAGEMENT 9

Types and sources of agricultural wastes - Composition of agricultural wastes – Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

TOTAL: 45 PERIODS

OUTCOME

On completion of the course, the student is expected to be able to

CO1 Have an in-depth knowledge about the concepts, principles and advantages of sustainable

agriculture

- CO2** Discuss the sustainable ways in managing soil health, nutrients, pests and diseases
- CO3** Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources
- CO4** Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas
- CO5** Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

REFERENCES:

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1 – Low; 2 – Medium; 3 – High; ‘-’ – No correlation

CES333

SUSTAINABLE BIOMATERIALS

**L T P C
3 0 0 3**

OBJECTIVES

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

UNIT I INTRODUCTION TO BIOMATERIALS

9

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility- Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

UNIT II BIO POLYMERS**9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials -Polyethylene -Polymethylmethacrylate (PMMA)-Poly(lactic acid (PLA) and polyglycolic acid (PGA) -Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

UNIT III BIO CERAMICS AND BIOCOMPOSITES**9**

General properties- Bio ceramics -Silicate glass - Alumina (Al_2O_3) -Zirconia (ZrO_2)-Carbon- Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites- Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

UNIT IV METALS AS BIOMATERIALS**9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

UNIT V NANOBIMATERIALS**9**

Meatlllicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor- Bioimaging/Molecular Imaging- challenges and future perspective.

TOTAL : 45 PERIODS**OUTCOMES**

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

REFERENCES

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani "Introduction to Biomaterials Basic Theory with Engineering Applications" Cambridge University Press, 2014.
2. Donglu shi "Introduction to Biomaterials" Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes "Biomaterials An Introduction" third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh "Characterization of Biomaterials" Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science "An Introduction to Material in Medicine" Third Edition, 2013.
6. VasifHasirci, NesrinHasirci "Fundamentals of Biomaterials" Springer, 2018
7. Leopoldo Javier Rios Gonzalez. "Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process" Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad "Functional Bionanomaterials" springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

OBJECTIVES

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

UNIT I SUSTAINABLE ENERGY SOURCE 9

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

UNIT II ELECTROCHEMICAL DEVICES 9

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O₂ battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO₂, LiFePO₄, LiMn₂O₄) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

UNIT III FUEL CELLS 9

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane (proton conducting and anion conducting) – Catalysts (Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

UNIT IV PHOTOVOLTAICS 9

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – Cu(InGa)Se₂ solar cells – Cadmium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells (metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylic bis - benzene – fullerenes - boron subphthalocyanine- tin (II) phthalocyanine)

UNIT V SUPERCAPACITORS 9

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite- conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon-carbon

composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

TOTAL : 45 PERIODS

OUTCOMES

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

CES335

GREEN TECHNOLOGY

**L T P C
3 0 0 3**

COURSE OBJECTIVE:

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

UNIT I PRINCIPLES OF GREEN CHEMISTRY

9

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

UNIT II POLLUTION TYPES

9

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

UNIT III GREEN REAGENTS AND GREEN SYNTHESIS

9

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

UNIT IV DESIGNING GREEN PROCESSES 9
 Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

UNIT V GREEN NANOTECHNOLOGY 9
 Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1: To understand the principles of green engineering and technology
- CO2: To learn about pollution using hazardous chemicals and solvents
- CO3: To modify processes and products to make them green and safe.
- CO4: To design processes and products using green technology
- CO5 – To understand advanced technology in green synthesis

TEXT BOOKS

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications,2008

REFERENCE BOOKS

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS L T P C
3 0 0 3

OBJECTIVES:

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

UNIT I ENVIRONMENTAL MONITORING AND STANDARDS 9
 Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS 9
 Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING 9
 Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical

oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT 9

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING 9

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability of the environment.
CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

TEXTBOOKS

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soil wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

REFERENCES

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

Course Articulation Matrix

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

COURSE OBJECTIVES:

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

UNIT I ENERGY SCENARIO 9

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

UNIT II ENERGY AND ENVIRONMENT 9

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

UNIT III SUSTAINABLE DEVELOPMENT 9

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

UNIT IV RENEWABLE ENERGY TECHNOLOGY 9

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristiri and Jack P. Kraushaar, “Energy and the environment”, Willey, 2005.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3**

COURSE OBJECTIVES:

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

UNIT I ENERGY AND ENVIRONMENT 9
Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

UNIT II ENERGY AUDITING 9
Need and types of energy audit. Energy management (audit) approach - understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9
Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

UNIT IV ENERGY CONSERVATION IN ELECTRICAL UTILITIES 9
Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

UNIT V SUSTAINABLE DEVELOPMENT 9
Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

REFERENCES:

1. Energy Manager Training Manual (4 Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India. 2004
2. Eastop.T.D& Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
4. Pratap Bhattacharyya, "Climate Change and Greenhouse Gas Emission", New India Publishing Agency- Nipa, 2020
5. Matthew John Franchetti , Defne Apul "Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies" CRC Press, 2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, "Energy and the Environment", 4th Edition, Wiley, 2022
7. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.

