



**ANNA UNIVERSITY, CHENNAI**  
**NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES**  
**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**

**B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING**

**1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)**

- a) To produce employable graduates with the knowledge and competency in Chemical and Electrochemical Engineering
- b) To impart problem solving, analytical skills in the contemporary processes.
- c) To design and develop eco-friendly sustainable technologies with the aid of computational skills
- d) To facilitate the ability to learn, innovate and communicate technical developments for the benefit of humanity
- e) To enable the students to work as teams on multidisciplinary projects with effective communication skills, individual, supportive and leadership qualities
- f) To disseminate the knowledge related to intellectual property ownership rights, ethics, professionalism, entrepreneurship, and their societal impact.

**2. PROGRAMME OUTCOMES (POS)**

On successful completion of B. Tech. Chemical and Electrochemical Engineering programme, the graduates of this programme would have following skills

	Graduate Attribute	Programme Outcome
PO1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design / development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The Engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
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.
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### 3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of chemical and electrochemical Engineering Programme the student will have following Program-specific outcomes.

1. Graduates will have a strong foundation in engineering, science and current Chemical Engineering practices and will have experience in solving structured and unstructured problems using conventional and innovative solutions.
2. Graduates will be able to effectively describe the Chemical Engineering problem, analyze the data, develop potential solutions, evaluate these solutions, and present the results using their oral, written and electronic media skills.
3. Graduates will have an understanding of ethical and professional responsibilities of an engineer and the impact of engineering solutions on society and the global environment.

#### 4. PEOs / POs Mapping

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	1	2	3	4	5	6	7	8	9	10	11	12
a	3	3	1	3	1	1	1	-	-	-	-	3
b	2	3	3	1	2	-	2	-	-	-	-	3
c	2	2	3	-	3	3	3	2	-	-	-	3
d	2	2	3	1	-	3	3	2	-	2	2	3
e	2	1	2	3	2	-	-	1	3	1	1	3
f	-	-	-	-	-	3	3	3	-	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

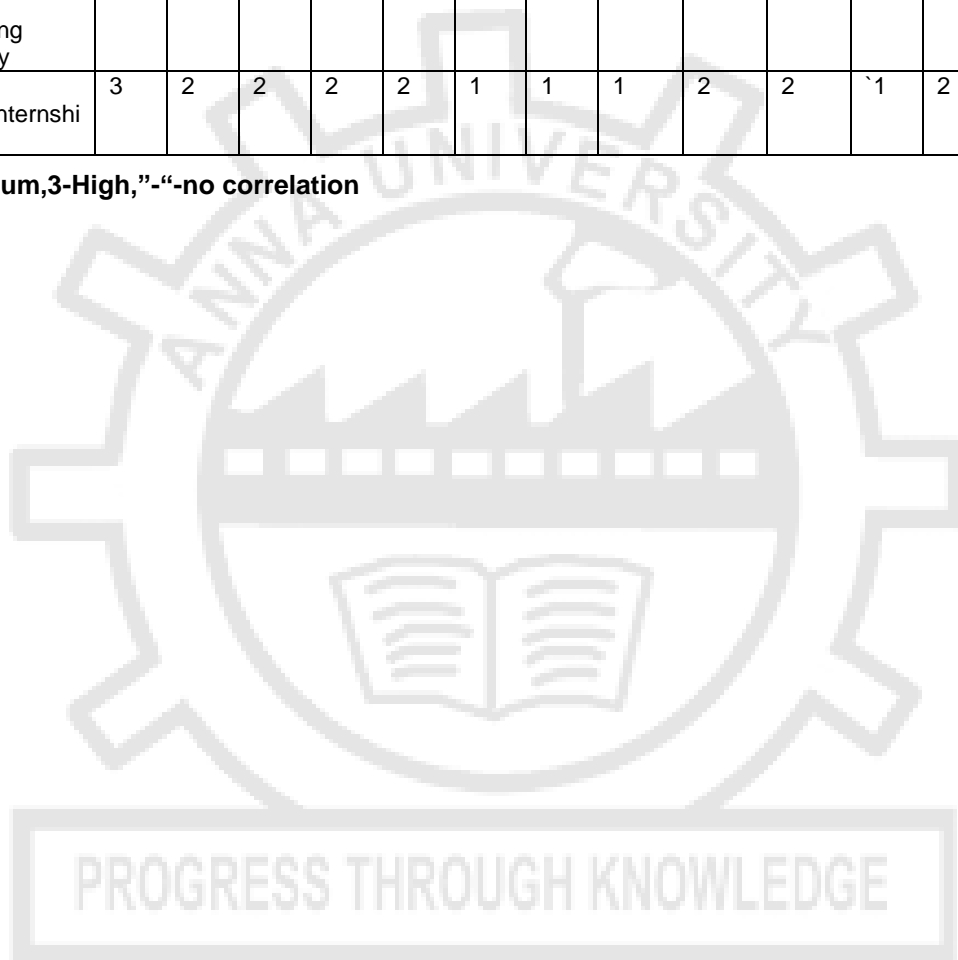
#### 4. PEOs / POs & PSO Mapping

	COURSE NAME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO 11	PO 12	PS O1	PSO 2	PS O3
		YEAR 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	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	3.2.6		2.4.1.3	2.6.1.6	1.1	1.1	1.4	1.8	-	-	-	-	1.3	-	-	-
English Laboratory	3		3	3	3	1	3	3	3	3	3	3	3	-	-	-
SEMESTER 2	Professional English - II		3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-
	Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
	Physics of Materials	3	2.2.5	2	1.6.6	2	1.6	1.7.5	1				1			
	Basic Electrical and Electronics Engineering	2	1	1					1					-	-	-
	Engineering Graphics	3	1	2		2					3		2	2	2	
	Introduction to Chemical Engineering	3	2	3	1	1	1	1	1	-	-	1	1	2	2	-
	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology															

		Engineering Practices Laboratory	3	2			1	1	1					2	2	1	1	
		Basic Electrical and Electronics 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	Differential Equations	3	3	3	3	2	1	1	2	3	2	2	3	2	2	2	
		Chemical Process Calculations	2	3	2	3	3	2	1	1	1	1	1	1	1	2	3	1
		Heat Transfer and its Applications	3	2	3	3	2	2	1	1	1	1	1	1	1	2	2	2
		Fluid and Solid Operations	3	3	3	3	1	1	3	1	1	1	1	1	2	3	3	2
		Principles of Electrochemistry	3	2	2	2	1	1	1	1	1	1	1	1	1	2	1	1
		Instrumental Methods of Analysis	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
		Computer Aided Drafting and Modeling Laboratory	1	1	3	-	2	-	-	-	-	1	1	1	2	3	3	2
		Fluid and Solid Operations Laboratory	3	3	3	3	1	1	3	1	1	1	1	1	2	3	3	2
		Professional Development <sup>s</sup>	2	2	3	2	3	1	2	1	3	3	1	2	3	3	3	2
	SEMESTER 4	Transform Techniques	3	3	3	3	2	1	1	2	1	2	2	3	2	2	2	
		Mass Transfer	3	3	3	-	-	1	1	1	-	1	-	3	3	2	2	
		Chemical Reaction Engineering		3	3	3	2	1	1	1	-	-	1	1	3	3	2	
		Chemical Engineering Thermodynamics	3	3	3	3	1	-	-	1	1	-	1	2	3	3	1	
		Electronics and Electrocatalysis	3	3	2	3	1	-	-	1	1	-	1	2	3	3	1	
		Environmental Sciences and Sustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-	
		Heat and Mass Transfer Laboratory	3	3	3	3	3	-	-	-	1	-	1	1	3	3	2	
		Electrochemistry Laboratory	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
		Industrial Training/Internship I*	3	2	2	2	2	1	1	1	2	2	1	2	2	1	1	
	YEAR 3	SEMESTER 5	Electrochemical Reaction Engineering	3	3	3	3	2	1	1	1	-	-	1	1	3	3	2
CRE & ECRE Laboratory			3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
Industrial Training/Internship I**			3	2	2	2	2	1	1	1	2	2	1	2	2	1	1	
S		Process Dynamics and	3	3	3	2	2	1	2	-	-	2	2	2	2	3	1	

	Control																
	Process Dynamics and Control Laboratory	3	3	3	2	2	1	2	-	-	2	2	2	2	3	1	
	Electrochemical Processes Laboratory	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
	Industrial Training/Internship II##	3	2	2	2	2	1	1	1	2	2	1	2	2	1	1	
YEAR 4	SEMESTER 7	Science and Technology of Lead Acid Battery	3	3	3	3	2	1	1	1	-	-	1	1	3	3	2
		Computer Applications in Chemical Engineering Laboratory	3	3	3	3	3	3	-	-	-	3	3	1	3	3	3
		Industrial Training/Internship II##	3	2	2	2	2	1	1	1	2	2	1	2	2	1	1

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



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**B.TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING**  
**CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS**  
**SEMESTER I**

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
<b>THEORY</b>								
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
<b>PRACTICALS</b>								
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 <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>16</b>	<b>1</b>	<b>10</b>	<b>27</b>	<b>22</b>

§ Skill Based Course

**SEMESTER II**

S. No.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
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.	CH3251	Introduction to Chemical Engineering	PCC	3	0	0	3	3
7.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
8.		NCC Credit Course Level 1 <sup>#</sup>	-	2	0	0	2	2
<b>PRACTICALS</b>								
9.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	2	2
10.	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	2	2
11.	GE3272	Communication Laboratory / Foreign Language <sup>§</sup>	EEC	0	0	4	4	2
<b>TOTAL</b>				<b>17</b>	<b>1</b>	<b>16</b>	<b>30</b>	<b>26</b>

#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	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3356	Differential Equations	BSC	3	1	0	4	4
2.	CH3351	Chemical Process Calculations	PCC	3	0	0	3	3
3.	EL3301	Heat Transfer and its Applications	PCC	3	0	0	3	3
4.	EL3302	Fluid and Solid Operations	PCC	3	0	0	3	3
5.	EL3303	Principles of Electrochemistry	PCC	3	0	0	3	3
6.	EL3304	Instrumental Methods of Analysis	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	EL3311	Computer Aided Drafting and Modeling Laboratory	ESC	0	0	4	4	2
8.	EL3312	Fluid and Solid Operations Laboratory	PCC	0	0	4	4	2
9.	GE3361	Professional Development <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>18</b>	<b>1</b>	<b>10</b>	<b>29</b>	<b>24</b>

§ Skill Based Course

**SEMESTER IV**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3451	Transform Techniques	BSC	3	1	0	4	4
2.	EL3491	Mass Transfer	PCC	3	0	0	3	3
3.	EL3401	Chemical Reaction Engineering	PCC	3	0	0	3	3
4.	PE3451	Chemical Engineering Thermodynamics	PCC	3	0	0	3	3
5.	EL3402	Electrodics and Electrocatalysis	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 #
<b>PRACTICALS</b>								
8.	EL3411	Heat and Mass Transfer Laboratory	PCC	0	0	4	4	2
9.	EL3412	Electrochemistry Laboratory	PCC	0	0	4	4	2
10.	EL3512	Industrial Training/Internship I*	EEC	-	-	-	-	-
<b>TOTAL</b>				<b>17</b>	<b>1</b>	<b>8</b>	<b>26</b>	<b>22</b>

# 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.

\*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

### SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EL3501	Electrochemical Reaction Engineering	PCC	3	0	0	3	3
2.		Professional Elective I	PEC	3	0	0	3	3
3.		Professional Elective II	PEC	3	0	0	3	3
4.		Professional Elective III	PEC	3	0	0	3	3
5.		Professional Elective IV	PEC	3	0	0	3	3
6.		Mandatory Course- I <sup>&amp;</sup>	MC	3	0	0	3	Non-Credit Course
<b>PRACTICALS</b>								
7.	EL3511	Chemical and Electrochemical Reaction Engineering Laboratory	PCC	0	0	4	4	2
8.	EL3512	Industrial Training/Internship I <sup>*</sup>	EEC	-	-	-	-	2
<b>TOTAL</b>				<b>18</b>	<b>0</b>	<b>4</b>	<b>22</b>	<b>19</b>

<sup>&</sup> Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

<sup>\*</sup> Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

### SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	CH3651	Process Dynamics and Control	PCC	3	0	0	3	3
2.		Open Elective – I <sup>*</sup>	OEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
4.		Professional Elective VI	PEC	3	0	0	3	3
5.		Professional Elective VII	PEC	3	0	0	3	3
6.		Professional Elective VIII	PEC	3	0	0	3	3
7.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
8.		Mandatory Course- II <sup>&amp;</sup>	MC	3	0	0	3	Non-Credit Course
<b>PRACTICALS</b>								
9.	EL3611	Process Dynamics and Control Laboratory	PCC	0	0	4	2	2
10.	EL3612	Electrochemical Processes Laboratory	PCC	0	0	4	2	2
11.	EL3712	Industrial Training/Internship II <sup>##</sup>	EEC	-	-	-	-	-
<b>TOTAL</b>				<b>21</b>	<b>0</b>	<b>8</b>	<b>25</b>	<b>22</b>

<sup>\*</sup> Open Elective – I shall be chosen from the emerging technologies.

<sup>##</sup> Four weeks industrial training/internship carries two credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

<sup>&</sup> Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

<sup>#</sup> 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		
<b>THEORY</b>								
1.	EL3701	Science and Technology of Lead Acid Batteries	PCC	3	0	0	3	3
2.	GE3791	Human values and Ethics	HSMC	2	0	0	2	2
3.		Elective - Management #	HSMC	3	0	0	3	3
4.		Open Elective – II**	PCC	3	0	0	3	3
5.		Open Elective – III***	PCC	3	0	0	3	3
6.		Open Elective – IV***	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	EL3711	Computer Applications in Chemical Engineering Laboratory	PCC	0	0	4	4	2
8.	EL3712	Industrial Training/Internship II##	EEC	-	-	-	-	2
<b>TOTAL</b>				<b>17</b>	<b>0</b>	<b>4</b>	<b>21</b>	<b>21</b>

\*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		
<b>PRACTICALS</b>								
1.	EL3811	Project Work / Internship#	EEC	0	0	20	20	10
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>	<b>10</b>

\*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: 166**

**ELECTIVE – MANAGEMENT COURSES**

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

### MANDATORY COURSES I\*

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

\* Mandatory Courses are offered as Non –Credit Courses

### MANDATORY COURSES II\*

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

\* Mandatory Courses are offered as Non –Credit Courses

### PROFESSIONAL ELECTIVE COURSES VERTICALS

Vertical I Advanced Electrochemical Processes	Vertical II Diversified Courses
Electrochemical Process Technology	Air Pollution and Control Engineering
Corrosion Science and Engineering	Energy Conservation and Management
Electrochemical Energy Conversion and Storage	Design of Experiments
Advanced Electrochemical Energy Storage Systems	Selection of Materials
Industrial Metal Finishing	Testing of Materials
Cathodic Protection and Electrophoretic Coatings	Industrial Safety in chemical industries
Electrometallurgy and Thermics	Renewable Energy Sources
Electrochemical Materials Science	Control Systems Engineering

#### Registration of Professional Elective Courses from Verticals:

Refer to the regulations 2021, Clause 6.3. (Amended on 27.07.2023)

**VERTICAL I - ADVANCED ELECTROCHEMICAL PROCESSES**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL3001	Electrochemical Process Technology	PEC	3	0	0	3	3
2.	EL3002	Corrosion Science and Engineering	PEC	3	0	0	3	3
3.	EL3003	Electrochemical Energy Conversion and Storage	PEC	3	0	0	3	3
4.	EL3004	Advanced Electrochemical Energy Storage Systems	PEC	3	0	0	3	3
5.	EL3005	Industrial Metal Finishing	PEC	3	0	0	3	3
6.	EL3006	Cathodic Protection and Electrophoretic Coatings	PEC	3	0	0	3	3
7.	EL3007	Electrometallurgy and Thermics	PEC	3	0	0	3	3
8.	EL3008	Electrochemical Materials Science	PEC	3	0	0	3	3

**VERTICAL II - DIVERSIFIED COURSES**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL3009	Air Pollution and Control Engineering	PEC	3	0	0	3	3
2.	CPE334	Energy Conservation and Management	PEC	3	0	0	3	3
3.	EL3010	Design of Experiments	PEC	3	0	0	3	3
4.	EL3011	Industrial Safety in chemical industries	PEC	3	0	0	3	3
5.	EL3012	Selection of Materials	PEC	3	0	0	3	3
6.	EL3013	Testing of Materials	PEC	3	0	0	3	3
7.	EL3014	Renewable Energy Sources	PEC	3	0	0	3	3
8.	EL3015	Control Systems Engineering	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	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
9.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
10.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
11.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
12.	CCS333	Augmented Reality / Virtual Reality	OEC	2	0	2	4	3

### OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OCE353	Lean Concepts, Tools And Practices	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 Vehicles	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.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3

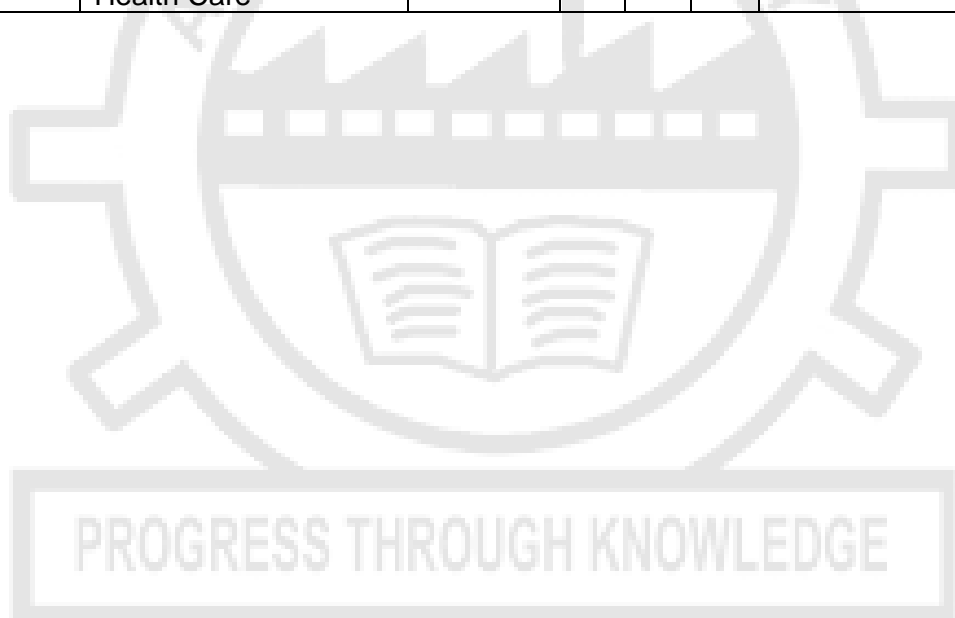
16.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
20.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
21.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
22.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
23.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
24.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
25.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
26.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
27.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
28.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
29.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
30.	OEC351	Signals and Systems	OEC	3	0	0	3	3
31.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
32.	CBM348	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
33.	CBM333	Assistive Technology	OEC	3	0	0	3	3
34.	OMA352	Operations Research	OEC	3	0	0	3	3
35.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
36.	OMA354	Linear Algebra	OEC	3	0	0	3	3
37.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
38.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
39.	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	OEC	3	0	0	3	3

		Water Resources Management						
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	3	0	0	3	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.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
17.	OIE353	Operations Management	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
20.	OMR353	Sensors	OEC	3	0	0	3	3
21.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
22.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
23.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
24.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
25.	CRA332	Drone Technologies	OEC	3	0	0	3	3
26.	OGI352	Geographical Information System	OEC	3	0	0	3	3
27.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
28.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
29.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
30.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3

31.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
32.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
33.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
34.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
35.	FT3201	Fibre Science	OEC	3	0	0	3	3
36.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
37.	OPE353	Industrial safety	OEC	3	0	0	3	3
38.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
39.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
40.	OEC353	VLSI Design	OEC	3	0	0	3	3
41.	CBM370	Wearable devices	OEC	3	0	0	3	3
42.	CBM356	Medical Informatics	OEC	3	0	0	3	3
43.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
44.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
45.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3



**SUMMARY**

<b>B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING</b>										
<b>S.No</b>	<b>Subject Area</b>	<b>Credits per Semester</b>								<b>Total Credits</b>
		<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>	<b>VI</b>	<b>VII/VIII</b>	<b>VIII/VII</b>	
<b>1</b>	<b>HSMC</b>	<b>4</b>	<b>3</b>					<b>5</b>		<b>12</b>
<b>2</b>	<b>BSC</b>	<b>12</b>	<b>7</b>	<b>4</b>	<b>6</b>					<b>29</b>
<b>3</b>	<b>ESC</b>	<b>5</b>	<b>11</b>	<b>2</b>						<b>18</b>
<b>4</b>	<b>PCC</b>		<b>3</b>	<b>17</b>	<b>16</b>	<b>5</b>	<b>7</b>	<b>14</b>		<b>62</b>
<b>5</b>	<b>PEC</b>					<b>12</b>	<b>12</b>			<b>24</b>
<b>6</b>	<b>OEC</b>						<b>3</b>			<b>3</b>
<b>7</b>	<b>EEC</b>	<b>1</b>	<b>2</b>	<b>1</b>		<b>2</b>		<b>2</b>	<b>10</b>	<b>18</b>
<b>8</b>	<b>Non-Credit (Mandatory)</b>					√	√			
<b>Total</b>		<b>22</b>	<b>26</b>	<b>24</b>	<b>22</b>	<b>19</b>	<b>22</b>	<b>21</b>	<b>10</b>	<b>166</b>





### **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)**

<b>Vertical I Fintech and Block Chain</b>	<b>Vertical II Entrepreneurship</b>	<b>Vertical III Public Administration</b>	<b>Vertical IV Business Data Analytics</b>	<b>Vertical V Environment and Sustainability</b>
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	CATEGORY	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	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	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

## **IP3151**

## **INDUCTION PROGRAMME**

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 II 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	-	-	-
<b>AVg.</b>	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

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

## TEXT BOOKS :

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10<sup>th</sup> Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44<sup>th</sup> Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8<sup>th</sup> 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, 10<sup>th</sup> Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., " Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7<sup>th</sup> Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi, 5<sup>th</sup> 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 ", 14<sup>th</sup> Edition, Pearson India, 2018.

## CO-PO & PSO MAPPING

	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	-	-	-

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

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. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> 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

- Understand the importance of mechanics.
- Express their knowledge in electromagnetic waves.
- Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- Understand the importance of quantum physics.
- 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.
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.
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, 2012.

**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	-	-	-	-	-	-	-	-	-	-
<b>AVG</b>	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. CO<sub>2</sub> 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: H<sub>2</sub>-O<sub>2</sub> 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:

- To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To apply the knowledge of phase rule and composites for material selection requirements.
- To recommend suitable fuels for engineering processes and applications.
- 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", 17<sup>th</sup> 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, 12<sup>th</sup> 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, 2<sup>nd</sup> 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	-	-	-
<b>Avg.</b>	<b>2.8</b>	<b>1.3</b>	<b>1.6</b>	<b>1</b>	<b>-</b>	<b>1.5</b>	<b>1.8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.5</b>	<b>-</b>	<b>-</b>	<b>-</b>

- 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

GE3152

தமிழர் மரபு

LTPC

1 0 0 1

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, கையெழுத்துப்படிக்கள் - 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) (Publishedby: 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**

**L T P C  
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, Oyillattam, Leatherpuppetry, 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)
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.

**GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C  
0 0 4 2**

**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
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	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	-	-
<b>AVg.</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	-

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**

#### OUTCOMES:

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

- Understand the functioning of various physics laboratory equipment.
- Use graphical models to analyze laboratory data.
- Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- Access, process and analyze scientific information.
- 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  $\text{Na}_2\text{CO}_3$  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 ( $\text{TiO}_2/\text{ZnO}/\text{CuO}$ ) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL: 30 PERIODS**

##### OUT COMES :

- 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

##### TEXTBOOK:

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	-	-	-
<b>Avg.</b>	<b>2.6</b>	<b>1.3</b>	<b>1.6</b>	<b>1</b>	<b>1</b>	<b>1.4</b>	<b>1.8</b>	-	-	-	-	<b>1.3</b>	-	-	-

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.

**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 -  $2^2$  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, 10<sup>th</sup> 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, 8<sup>th</sup> Edition, 2015.

**REFERENCES:**

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

**CO-PO & PSO MAPPING**

	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
<b>CO1</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO2</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO3</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO4</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>CO5</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
<b>Avg</b>	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

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

**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<sub>c</sub> 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

- acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques
- familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.
- gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.
- realize with theories and applications of dielectric and ferromagnetic materials
- 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	-	-	-
<b>AVG</b>	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 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**

**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', 10<sup>th</sup> Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7<sup>th</sup> edition, 2017
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4<sup>th</sup> 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					-	-	-

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

PROGRESS THROUGH KNOWLEDGE

**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 BOOKS:**

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53<sup>rd</sup> 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, 2<sup>nd</sup> Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27<sup>th</sup> 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, 2<sup>nd</sup> 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 MAPPING**

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	
<b>Avg</b>	<b>3</b>	<b>1</b>	<b>2</b>		<b>2</b>					<b>3</b>		<b>2</b>	<b>2</b>	<b>2</b>	
Low (1) ; Medium (2) ; High (3)															

**CH3251**

**INTRODUCTION TO CHEMICAL ENGINEERING**

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

**COURSE OBJECTIVES:**

- To acquaint the students with the fundamentals of Chemical Engineering and to build their perspective in a wholesome manner

**UNIT I INTRODUCTION**

**9**

Chemical Engineering in day to life with examples, Origin and growth of chemical Engineers in chemical process industries, unit operations and unit processes concepts, scaling up or down, units and dimensions, application of mathematics in chemical Engg, recent developments in chemical process industries

**UNIT II INTRODUCTION TO MATERIAL AND ENERGY BALANCES**

**9**

Basic concepts of material and energy balances, energy and mass transport, and kinetics of chemical reactions. Introduction to heat and mass transfer. Process flow sheeting and symbols.

**UNIT III FLUID FLOW**

**9**

Nature of fluid, Viscosity, Flow field, Conservation of mass and energy. Frictional losses, pumping of fluids. Dimensional Analysis and Correlations.

**UNIT IV CHEMICAL ENGINEERING COMPUTER SOFTWARE TOOLS AND APPLICATIONS**

**9**

Introduction to Process Engineering Design Software (HYSYS and PRO II) , Computations Using Microsoft Excel, Computer-Aided Design & Drafting, Piping and Equipment Design Software

## **UNIT V CAREER DIVERSITIES IN CHEMICAL ENGINEERING**

**9**

Career Development Leading to Specialization, Chemical Engineering Job Titles/Options, Chemical and Process Engineers, Commissioning Engineer, Process Control/Automation Engineer, Process Safety Engineer, Research & Development Engineer Pharmaceutical Engineer/Pharmaceutical Process Engineer, Pipeline Engineer Chemical Manufacturing Engineer, Environment Engineer

**TOTAL : 45 PERIODS**

### **COURSE OUTCOMES:**

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

CO1. Correlate day to day like with the principles of chemical Engineering.

CO2. Assess the mass and energy involved in any chemical plant.

CO3. Have an insight into areas where Chemical Engineering plays major role.

CO4. Carry out modelling and simulation using software tools.

CO5. Identify their right future.

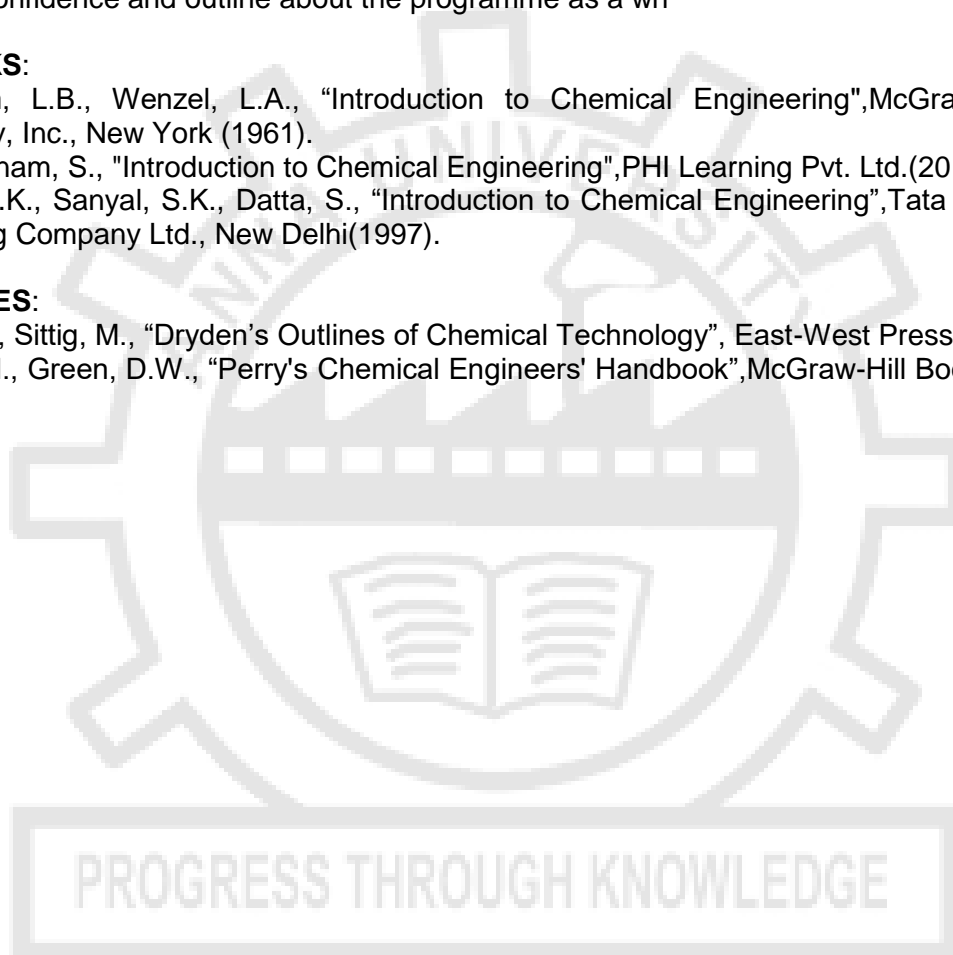
CO6: Gain confidence and outline about the programme as a wh

### **TEXT BOOKS:**

1. Anderson, L.B., Wenzel, L.A., "Introduction to Chemical Engineering", McGraw-Hill Book Company, Inc., New York (1961).
2. Pushpavanam, S., "Introduction to Chemical Engineering", PHI Learning Pvt. Ltd. (2012).
3. Ghosal, S.K., Sanyal, S.K., Datta, S., "Introduction to Chemical Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi (1997).

### **REFERENCES:**

1. Rao, M.G., Sittig, M., "Dryden's Outlines of Chemical Technology", East-West Press (1997).
2. Perry, R.H., Green, D.W., "Perry's Chemical Engineers' Handbook", McGraw-Hill Book Company (2008).



**Course Articulation Matrix:**

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Correlate day to day like with the principles of chemical	3	2	3	1	-	-	-	-	-	-	-	1	2	-	-
CO2	Assess the mass and energy involved in any chemical plant.	3	2	3	1	-	-	-	-	-	-	-	1	2	2	-
CO3	Have an insight into areas where Chemical Engineering plays major role.	3	2	3	1	-	-	-	-	-	-	1	-	2	2	-
CO4	Carry out modelling and simulation using software tools	3	2	3	1	1	1	1	1	-	-	1	1	2	2	-
CO5	Identify their right future															
CO6	Gain confidence and outline about the programme as a whole	3	2	3	-	-	-	-	-	-	-	-	1	2	2	-
<b>Overall CO</b>		3	2	3	1	1	1	1	1	-	-	1	1	2	2	-

1,2and3arecorrelationlevelswith weightingsasSlight (Low), Moderate(Medium)andSubstantial (High)respectively

PROGRESS THROUGH KNOWLEDGE

**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.

**GE3252**

**TAMILS AND TECHNOLOGY**

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

**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 beads - 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. பொருறை – 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\***

<b>NX3251 (ARMY WING) NCC Credit Course Level - I</b>		<b>L T P C</b>
		<b>2 0 0 2</b>
<b>NCC GENERAL</b>		<b>6</b>
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
<b>NATIONAL INTEGRATION AND AWARENESS</b>		<b>4</b>
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
<b>PERSONALITY DEVELOPMENT</b>		<b>7</b>
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
<b>LEADERSHIP</b>		<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>		<b>8</b>
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
<b>TOTAL : 30 PERIODS</b>		

**NCC Credit Course Level 1\***

<b>NX3252</b>	<b>(NAVAL WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**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				

**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\***

<b>NX3253</b>	<b>(AIR FORCE WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**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
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PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
<b>LEADERSHIP</b>		<b>5</b>
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
<b>SOCIAL SERVICE AND COMMUNITY DEVELOPMENT</b>		<b>8</b>
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**

**GE3271                      ENGINEERING PRACTICES LABORATORY                      L T P C**  
**0 0 4 2**

**OBJECTIVES:**

**The main learning objective of this course is to provide hands on training to the students in:**

1. 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 commonhousehold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. 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.
4. 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:**

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

**WOOD WORK:**

- a) Sawing,
- b) Planing and
- c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

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

**PART II                      ELECTRICAL ENGINEERING PRACTICES                      15**

- a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket

- b) Staircase wiring
- c) Fluorescent Lamp wiring with introduction to CFL and LED types.
- d) Energy meter wiring and related calculations/ calibration
- e) Study of Iron Box wiring and assembly
- f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- g) Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)**

**PART III**

**MECHANICAL ENGINEERING PRACTICES**

**15**

**WELDING WORK:**

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

**BASIC MACHINING WORK:**

- a) (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**

**OUTCOMES:**

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

- 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.
- Wire various electrical joints in common household electrical wire work.
- 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.
- 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
<b>Avg</b>	<b>3</b>	<b>2</b>			<b>1</b>	<b>1</b>	<b>1</b>					<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>
Low (1) ; Medium (2) ; High (3)															

**BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY L T P C 0 0 4 2**

**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**

**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
<b>1</b>	2	3	1	2				1.5	2				-	-	-
<b>2</b>	2	3	1	2				1.5	2				-	-	-
<b>3</b>	2	3	1	2				1.5	2				-	-	-
<b>4</b>	2	3	1	2				1.5	2				-	-	-
<b>Avg.</b>	1.6	1.4	0.8	1.6				1.2	1.6						

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

**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	-	-	-

<b>4</b>	3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
<b>5</b>	3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
<b>AVg.</b>	2.4	2.8	3	3	1.8	3	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.

**MA3356**

**DIFFERENTIAL EQUATIONS**

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

**OBJECTIVES**

- To acquaint the students with Differential Equations which are significantly used in engineering problems
- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.
- To understand the finite methods for time dependent partial differential equations.

**UNIT I ORDINARY DIFFERENTIAL EQUATIONS**

**9+3**

Higher order linear differential equations with constant coefficients – Particular integrals: Operator methods, Method of variation of parameters, Methods of undetermined coefficients– Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

**UNIT II PARTIAL DIFFERENTIAL EQUATIONS**

**9+3**

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

**UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS**

**9+3**

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+3**

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes.

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION**

**9+3**

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – First order hyperbolic equations – method of characteristics, different explicit and implicit methods; Wave equation: Explicit scheme- Stability of above schemes.

**TOTAL: 60 PERIODS**

**OUTCOMES**

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

- Apply various methods of solving differential equation which arise in many application problems.

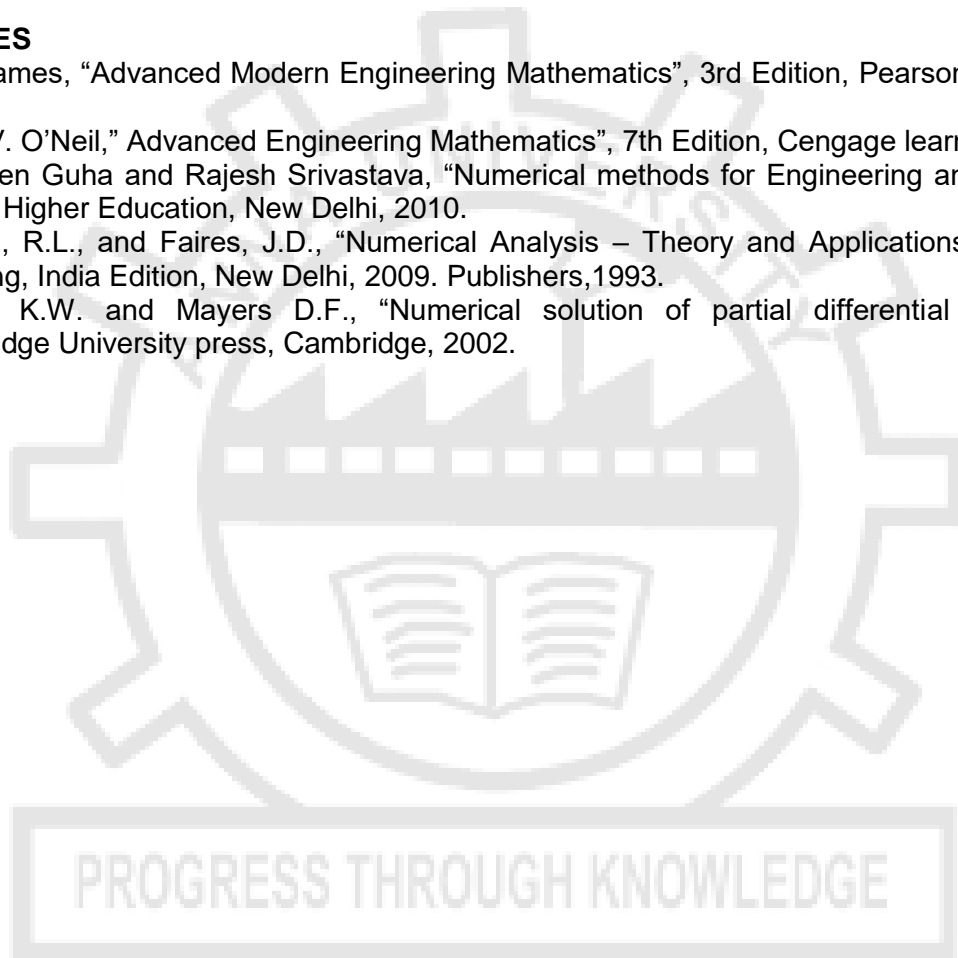
- Understand how to solve the given standard partial differential equations.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
- Familiar with various methods to solve time dependent partial differential equations.

#### **TEXT BOOKS**

1. Grewal. B.S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, New Delhi, 2018.
2. Gupta S.K., "Numerical Methods for Engineers" (Third Edition), New Age Publishers, New Delhi , 2015.
3. M K Jain , S R K Iyengar , R K Jain, "Computational Methods for Partial Differential Equations", New Age Publishers, New Delhi , 1994.

#### **REFERENCES**

1. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
2. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
3. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
4. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009. Publishers,1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.





	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	0	0	0	0	1	2	2	1	2
CO2	3	3	2	2	1	1	2	0	2	1	2	0	3	1	1
CO3	3	3	3	2	2	1	0	0	0	0	0	2	1	2	1
CO4	3	3	2	1	2	1	0	0	0	0	0	2	2	1	0
CO5	3	3	2	1	1	1	0	0	0	0	0	2	2	1	1
Avg.	3	3	2.4	1.8	1.6	1	0.4	0	0.4	0.2	0.6	1.6	2	1.2	1



**OBJECTIVE:**

- To impart knowledge on laws of chemistry and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

**UNIT I****9**

Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

**UNIT II****9**

Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

**UNIT III****9**

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

**UNIT IV****9**

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. 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 with and without chemical reaction - Unsteady state energy balances

**UNIT V****9**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

**TOTAL: 45 PERIODS****OUTCOMES:****Upon completion of the course, the students would**

- Understand the concepts of dimensional consistency and effective application of units and dimensions.
- Analyze a problem statement and balance the material flowing through single and various operations
- Understand the gas behavior and its properties.
- Understand general energy balance, simplify and apply to open and closed systems
- Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes

**TEXT BOOKS:**

- Bhatt, B.L., Vora, S.M., "Stoichiometry", 4<sup>th</sup> Edition, Tata McGraw-Hill (2004)
- Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Eighth Edition, Prentice Hall Inc., 2012
- Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 5<sup>th</sup> Edn., John Wiley & Sons, New York, 2005.

**REFERENCE:**

- Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers, Second edition, 2004.

Course articulation matrix:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the concepts of dimensional consistency and effective application of units and dimensions.	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO2	Analyze a problem statement and balance the material flowing through single and various operations	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO3	Understand the gas behavior and its properties	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO4	Understand general energy balance, simplify and apply to open and closed systems	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
<b>OVERALL CO</b>		<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

- To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

**UNIT I CONDUCTION****9**

Heat transfer by conduction in solids. Fourier's law. Steady state heat conduction through plane and composite wall. Radial heat conduction through hollow cylinder and hollow sphere. Concepts of thermal conductivity and thermal diffusivity. Unsteady state heat conduction. Heisler charts.

**UNIT II CONVECTION****9**

Heat flow in fluids. Boundary layers. Parallel, counter current and cross flow heat exchangers. Log mean temperature difference. Overall and individual heat transfer coefficients. Application of dimensional analysis to convection. Natural and forced convection. Convective heat transfer in ducts, flat plates, falling film etc for laminar and turbulent regions. Heat transfer correlations and analogies.

**UNIT III CONDENSATION & BOILING****9**

Heat transfer from condensing vapors. Drop wise and film type condensation, Nusselt equation for vertical and horizontal plates / tubes. Heat transfer to boiling liquids and molten metals. Mechanisms of boiling. Pool boiling. Convective boiling. Correlations. Design of condensers and vaporizers.

**UNIT IV HEAT EXCHANGE EQUIPMENTS****9**

Shell and tube heat exchangers. Single pass and multi pass shell and tube heat exchangers. LMTD correction for multipass exchangers. Heat exchanger effectiveness. Fouling factors. Heat transfer units. Plate heat exchangers. Extended surface equipments. Heat transfer in packed and fluidized beds.

**UNIT V RADIATION & EVAPORATION****9**

Concept of thermal radiation. Black body and gray body concepts. Laws of radiation. Radiation between surfaces. View factors. Radiation shield. Evaporation. Single effect and multiple effect evaporators. Mass and enthalpy balance. Calculation of heat transfer area. Factors affecting the performance of evaporators.

**TOTAL: 45 PERIODS****OUTCOME:**

- Understand heat transfer by conduction in solids for steady state
- Understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows
- Understand heat transfer from condensing vapors and mechanisms of boiling
- Understand the design of heat exchange equipments
- Understand evaporation radiative heat transfer including blackbody radiation

**TEXT BOOKS:**

- Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", Fifth Edition, Wiley – India, New Delhi, 2009.
- J.P. Holman, "Heat transfer", Ninth Edition, Tata - McGraw Hill, New Delhi, 2009.

**REFERENCES:**

- D.Q. Kern, "Process Heat Transfer", Eighteenth Reprint, McGraw Hill, New York, 2008.
- J.M.Coulson and J.F. Richardson with J.R.Backhurst and J.H.Harker, "Coulson and Richardson's chemical Engineering", Vol.1, "Fluid Flow, Heat Transfer and Mass Transfer", Butterworth Heinmann, 6<sup>th</sup> Edition, 2000.

Course articulation matrix:

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand heat transfer by conduction in solids for steady state	3	3	3	2	1	1	-	-	-	-	-	1	2	2	2
CO2	Understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows	2	2	3	3	2	1	-	1	1	1	1	-	2	2	2
CO3	Understand heat transfer from condensing vapors and mechanisms of boiling	3	2	2	2	2	1	1	1	1	1	-	1	2	2	2
CO4	Understand the design of heat exchange equipments	2	2	3	2	2	1	1	-	-	-	-	1	2	2	2
CO5	Understand evaporation radiative heat transfer including blackbody radiation	2	3	3	2	3	1	1	-	1	-	1	1	2	2	2
<b>OVERALL CO</b>		3	2	3	3	2	2	1	1	1	1	1	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

- To impart the students, the knowledge on fluid properties, fluid static and dynamic characteristics flow metering and transport, particle mechanics, techniques of solid – fluid separation

**UNIT I PROPERTIES OF FLUID****9**

Newtonian fluids Classification of fluid motion Fluid statics – equilibrium of fluid element – pressure variation in a static fluid – Differential analysis of fluid motion – continuity, Euler's and Bernoulli equation, Navier-Stokes Equation, Hagen-Poiseuille flow.

**UNIT II FLOW THROUGH PIPES & BOUNDARY LAYER CONCEPTS****9**

Reynolds number regimes, Flow through pipes – pressure drop under laminar and turbulent flow conditions; boundary layer concepts; Friction factor, Moody Chart, Flow meters ; different types of flowmeters; Valves, pumps, compressors – characteristics and sizing; Agitation and Mixing;

**UNIT III SIZE ANALYSIS****9**

General characteristics of solids, techniques of size analysis; Laws of size reduction, equipments for size reduction

**UNIT IV FLOW THROUGH FLUIDIZED BEDS****9**

Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds. Filtration – batch and continuous, filtration equipments - selection, operation

**UNIT V CLASSIFIERS****9**

Screening, gravity separation - sedimentation, thickening, elutriation, classifiers - Centrifugal separation - continuous centrifuges, cyclones and hydro cyclones, electrostatic and magnetic separators

**TOTAL: 45 PERIODS****OUTCOMES:**

- Understand the fundamental properties of fluids and its characteristics , Bernoulli principle, Navier - Stokes equation
- Understand flow through pipes & boundary layer concepts
- Understand characteristics of solids and size analysis
- Understand flow through fluidized beds and filtration equipments
- Understand various separation and purification techniques employed in solid particles

**TEXT BOOKS:**

- Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Second Edition, McGraw-Hill, (1991).
- Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.

**REFERENCES:**

- Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5<sup>th</sup> Edition, John Wiley, 2006
- McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, V Edition, 2001
- Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4<sup>th</sup> Edn., Asian Books Pvt. Ltd., India, 1998.

## COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
<b>CO1</b>	Understand the fundamental properties of fluids and its characteristics , Bernoulli principle, Navier - Stokes equation	3	3	3	2	1	1	-	-	-	-	1	1	2	2	2
<b>CO2</b>	Understand flow through pipes & boundary layer concepts	3	3	3	2	1	1	-	1	1	1	1	-	2	2	2
<b>CO3</b>	Understand characteristics of solids and size analysis	3	3	3	2	1	1	1	1	1	1	-	1	2	2	2
<b>CO4</b>	Understand flow through fluidized beds and filtration equipments	3	3	3	2	1	1	1	-	-	-	-	1	2	2	2
<b>CO5</b>	Understand various separation and purification techniques employed in solid particles	3	3	3	2	1	1	1	-	1	-	1	1	2	2	2
<b>OVERALL CO</b>		3	3	3	2	1	2	1	1	1	1	1	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVES:**

- To impart knowledge on basic principles of electrochemistry and its applications.

**UNIT I ION-SOLVENT & ION-ION INTERACTIONS****9**

ion-solvent interaction, Experimental  $\Delta H$  and  $\Delta$  ion-solvent interaction – Expression for verification of Born Model, Ion-dipole model of ion-solvent interaction and expression for heat of solvation, Ion-Ion Interaction – True and Potential electrolytes, Debye-Huckel (ion-cloud) theory of ion-ion interactions, Activity coefficients and ion-ion interaction

**UNIT II ION TRANSPORT IN SOLUTION****9**

Diffusion & Diffusion coefficient, Einstein-Smoluchowski equation, Conduction, Molar & Equivalent conductivity, Kohlrausch's Law, Ionic mobility, Stokes-Einstein relation, Nernst-Einstein equation, Transport numbers – determination by Hittorf's & Moving Boundary methods – Walden's rule - Debye Huckel-Onsager equation, Non-aqueous solutions

**UNIT III POLARISATION AND OVER POTENTIAL****9**

Electrolytic polarization, Dissolution and Decomposition potential, Overvoltage – hydrogen and oxygen overvoltage, applications, Polarography – principles, diffusion layer, limiting current density, polarographic circuit, dropping mercury electrode, merits & demerits, supporting electrolyte, current maxima, polarograms, half wave potential, diffusion current, applications

**UNIT IV COLLOIDAL ELECTROCHEMISTRY****9**

Electrochemical properties of colloids – Charge on colloidal particles, Electrical Double Layer, Cogulation of colloidal sols, Electrokinetic phenomena - Electro-Osmosis – Determination of zeta potential, Electrophoresis – sedimentation potential (Dorn effect), Determination of colloidal particle size, Surfactant, Emulsion, Emulsifiers, gels - Applications

**UNIT V ELECTROACTIVE LAYERS AND MODIFIED ELECTRODES****9**

Chemically modified electrodes, Types and methods of modification – chemisorption, covalent bond formation, polymer film coatings, inorganic materials, Langmuir-Blodgett (LB) methods, properties of the modified electrodes, electrochemistry at monolayer and multilayer modified electrodes, characterisation of modified electrodes

**TOTAL: 45 PERIODS****OUTCOMES:**

- Understand ion-solvent interaction
- Understand ion transport in solution
- Understand the concept of polarisation and over potential
- Understand colloidal electrochemistry
- Understand electrochemistry at monolayer and multilayer modified electrodes and characterisation of modified electrodes

**TEXT BOOKS:**

- J.O.M.Bockris & A.K.N.Reddy, "Modern Electrochemistry –Vol. I & II", Plenum Press, New York, 2000.
- Peter Atkins and Julio de Paula, "Physical Chemistry", VII Edition, Oxford University Press, New York, 2002.

**REFERENCES:**

- A.J. Bard and L.R. Faulkner, "Electrochemical Methods – Fundamentals and applications" 3rd edition John Wiley & Sons Inc, 2001.
- Pallab Ghosh, "Colloid and Interface Science", PHI Ltd, 2009.



## COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	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	PSO 3
CO1	Understand ion-solvent interaction,	3	2	2	2	1	1	-	-	-	-	-	1	2	1	-
CO2	Understand ion transport in solution	3	2	2	2	1	1	-	1	1	1	1	-	2	1	-
CO3	Understand the concept of polarisation and over potential	3	2	2	2	1	1	1	1	1	1	-	1	2	1	1
CO4	Understand colloidal electrochemistry	3	2	2	2	1	1	1	-	-	-	-	1	2	1	1
CO5	Understand electrochemistry at monolayer and multilayer modified electrodes and characterisation of modified electrodes	3	2	2	2	1	1	1	1	1	-	1	1	2	1	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVES:**

- To impart knowledge on the principle and importance of various analytical instruments used for the characterization of various materials

**UNIT I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS 9**

Electromagnetic radiation: various ranges, dual properties, various energy levels, interaction of photons with matter, absorbance & transmittance and their relationship, permitted energy levels for the electrons of an atom and simple molecules, various electronic transitions in organic and inorganic compounds effected by UV, and visible radiations, various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and visible radiations, choice of solvents, cut off wavelengths for solvents

**UNIT II QUALITATIVE ANALYSIS BY UV AND VISIBLE SPECTROSCOPY 9**

Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks(Bathochromic, hypsochromic, hypochromic), Instrumentation for UV and Visible spectrophotometers (source, optical parts and detectors), Applications of UV and Visible spectroscopy.

**UNIT III QUANTITATIVE ANALYSIS BY UV AND VISIBLE SPECTROSCOPY 9**

Beer-Lambert's law, limitations, deviations (real, chemical, instrumental), estimation of inorganic ions such as Fe, Ni and estimation of nitrite using Beer -Lambert's law, multicomponent analysis (no overlap, single way overlap and two way overlap), photometric titration(experimental set -up and various types of titrations and their corresponding curves).

**UNIT IV IR SPECTROSCOPY 9**

Theory of IR spectroscopy, various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (near, mid, finger print and far) and their usefulness, Instrumentation (only the sources and detectors used in different regions), sample preparation techniques, qualitative analysis of alkanes, alkenes and carbonyl compounds.

**UNIT V CHROMATOGRAPHIC METHODS 9**

Classification of chromatographic methods, column, thin layer, paper, gas, High Performance Liquid Chromatographical methods (principle, mode of separation and technique).

**TOTAL: 45 PERIODS****OUTCOMES:**

At the end of this course, the students would

- Understand the fundamentals, concepts and mechanisms involved in spectral analysis.
- Understand the purpose and theories in qualitative analysis
- Understand the purpose and theories in quantitative analysis
- Understand the purpose and theories in IR spectral analysis
- Understand the purpose and theories of chromatographic methods

**TEXT BOOKS :**

- Sivasankar B., "Instrumental Methods of Analysis", Oxford University Press, 2012.
- William Kemp, Organic Spectroscopy, 3<sup>rd</sup> Edition, Palgrave publishers, 2007.

**REFERENCES:**

- Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis, CENGAGE Learning, India, 7<sup>th</sup> Edition, 2007.
- Willard H.H, Merritt L.L, Dean J.A and Settle F.A, Instrumental method of analysis, 7<sup>th</sup> edition, Wadsworth Publishing Company, 1988.
- Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of Chemical Analysis, Himalaya Publishers, New Delhi, 2014
- John R Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prentice-hall of India Pvt. Ltd., 2012
- Robert M. Silverstein, Francis X. Webster, David Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8<sup>th</sup> Edition, 2010.

## COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	Understand the fundamentals, concepts and mechanisms involved in spectral analysis.	3	2	2	2	1	1	-	-	-	-	-	1	1	1	-
<b>CO2</b>	Understand the purpose and theories in qualitative analysis	3	2	2	2	1	1	-	1	1	1	1	-	1	1	-
<b>CO3</b>	Understand the purpose and theories in quantitative analysis	3	2	2	2	1	1	1	1	1	1	-	1	1	1	1
<b>CO4</b>	Understand the purpose and theories in IR spectral analysis	3	2	2	2	1	1	1	-	-	-	-	1	1	1	1
<b>CO5</b>	Understand the purpose and theories of chromatographic methods	3	2	2	2	1	1	1	1	1	-	1	1	1	1	1
<b>OVERALL CO</b>		3	2	2	2	1	1	1	1	1	1	1	1	1	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVES:**

- To develop skill to use software to create 2D and 3D models.

**List of Exercises using software capable of Drafting and Modeling**

- Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
- Drawing of a Title Block with necessary text and projection symbol.
- Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
- Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
- Drawing front view, top view and side view of objects from the given pictorial views (eg.V-block, Base of a mixie, Simple stool, Objects with hole and curves).
- Drawing of a plan of residential building ( Two bed rooms, kitchen, hall, etc.)
- Drawing of a simple steel truss.
- Drawing sectional views of prism, pyramid, cylinder, cone, etc,
- Drawing isometric projection of simple objects.
- Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

**OUTCOMES:**

Upon completion of the laboratory course, the students would have the

- Understand capabilities of software for drafting and modeling
- Able to use the softwares for drafting and modeling
- Able to create 2D and 3D models of Engineering Components
- Able to draw of a plan of residential building and isometric projection of simple objects
- Able to create 3D models of simple objects and obtaining 2D multi-view drawings from 3-D model

**TOTAL: 60 PERIODS****CO-PO & PSO MAPPING**

Course Outcomes	Statements	Program Outcomes															
		P O 1	P O 2	P O 3	PO 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	P O 13	P O 14	P O 15	P O 16
CO1	Understand capabilities of software for drafting and modeling	1	1	3	-	2	-	-	-	1	1	1	2	3	3	2	
CO2	Able to use the softwares for drafting and modeling	1	1	3	-	2	-	-	-	1	1	1	2	3	3	2	
CO3	Able to create 2D and 3D models of Engineering Components	1	1	2	-	3	-	-	-	1	1	1	2	3	3	2	
CO4	Able to draw of a plan of residential building and isometric projection of simple objects	1	1	3	-	1	-	-	-	1	-	1	2	3	3	-	
CO5	Able to create 3D models of simple objects and obtaining 2D multi-view drawings from 3-D model	1	1	3	-	2	-	-	-	1	-	1	2	3	3	2	
OVERALL CO		1	1	3	-	2	-	-	-	1	1	1	2	3	3	2	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVE:**

To enable the students to

- Develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.
- learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

**LIST OF EXPERIMENTS**

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Characteristics of batch Sedimentation
4. Reduction ratio in Jaw Crusher / Pulverizer/ Hammer Mill
5. Reduction ratio in Ball mill
6. Reduction ratio of Roll Crusher
7. Size separation using Sub-Sieving
8. Viscosity measurement of non Newtonian fluids
9. Flow through annular pipe
10. Flow through helical coil and spiral coil
11. Pressure drop studies in packed column
12. Hydrodynamics of fluidized bed

**TOTAL: 60 PERIODS**

**Minimum 10 experiments shall be offered**

**OUTCOME:**

Upon completion of the course, the students would have the

- Determine the size analysis in solid- solid separation systems
- Capability to select different solid - fluid separation equipments
- Evaluate the size reduction and various crushing parameters
- Ability to use variable area flow meters and variable head flow meters
- Understand hydrodynamics of packed column fluidized bed columns and its application

**Course articulation matrix**

Course Outcomes	Program Outcomes															
	Statements	P O 1	P O 2	P O 3	PO 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	P S O 1	P S O 2	P S O 3
CO1	Determine the size analysis in solid- solid separation systems	3	3	3	3	1	1	3	1	1	1	1	2	3	3	2
CO2	Capability to select different solid - fluid separation equipments	3	3	3	3	1	1	3	1	1	1	1	2	3	3	2
CO3	Evaluate the size reduction and various crushing parameters	3	3	2	3	1	1	3	1	1	1	1	2	3	3	2
CO4	Ability to use variable area flow meters and variable head flow meters	-	3	3	3	-	-	-	-	-	-	-	2	3	3	-
CO5	Understand hydrodynamics of packed column fluidized bed columns and its application	-	3	3	3	-	-	-	-	-	-	-	2	3	3	2
OVERALL CO		3	3	3	3	1	1	3	1	1	1	1	2	3	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**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:****10 Hours**

Create and format a document

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.

**MA3451**

**TRANSFORM TECHNIQUES**

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

**OBJECTIVES:**

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- 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 transform techniques used in wide variety of situations.
- To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.
- 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 VECTOR CALCULUS**

**9+3**

Gradient and directional derivative – Divergence and curl - Irrotational and solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and applications in evaluating line, surface and volume integrals.

**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 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 IV LAPLACE TRANSFORMS**

**9+3**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

**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**

**COURSE OUTCOMES**

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

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- 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.
- Understand the mathematical principles on Laplace transforms and 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", 44<sup>th</sup> Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10<sup>th</sup> Edition, John Wiley, New Delhi, India, 2016.

## REFERENCES

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

## CO-PO & PSO MAPPING

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	0	0	0	0	2	1	2	2	1
CO2	3	3	2	2	1	2	1	0	1	0	2	0	3	2	1
CO3	3	2	1	2	1	0	1	1	0	0	3	0	2	2	2
CO4	3	3	3	1	0	0	0	0	0	0	1	0	1	2	1
CO5	3	3	2	2	1	0	1	0	2	1	2	0	3	1	2
Overall CO	3	2.8	2.2	1.6	0.8	0.6	0.8	0.2	0.6	0.2	2	0.2	2.2	1.8	1.4

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

PROGRESS THROUGH KNOWLEDGE



**UNIT I MOLECULAR DIFFUSION 9**

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

**UNIT II CONVECTIVE TRANSFER AND INTERPHASE MASS TRANSFER 9**

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients.

**UNIT III ABSORPTION 9**

Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; determination of height of packing using HTU and NTU calculations.

**UNIT IV DISTILLATION 9**

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 reflux, minimum reflux ratio, optimum reflux ratio.

**UNIT V LEACHING & EXTRACTION 9**

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for single stage extraction, multi-stage cross current extraction, multi-stage counter current operation. Solid-liquid equilibria- equilibrium diagram for leaching, single stage leaching, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

On completion of the course students are expected to

CO1: Understand the fundamentals, types and mechanism of mass transfer operations

CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer

CO3: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process

CO4: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower

CO5: Apply the ternary equilibrium diagram concepts for separation of liquid-liquid extraction process, Describe core principles of leaching, estimate the number of ideal stages in leaching operation

**TEXT BOOKS:**

1. Robert E. Treybal, "Mass Transfer Operations" McGraw Hill Education India
2. Christie John Geankoplis Transport Processes and Separation Process Principles 4<sup>th</sup> Edition PHI
3. K Asokan, Mass Transfer concepts, University Press

**REFERENCES:**

1. Warren Mc Cabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering 7th Edition, Mc Graw Hil.
2. J.M.Coulson and J.F. Richardson with J.R.Backhurst and J.H.Harker, "Coulson and Richardson's chemical Engineering", Vol.1, "Fluid Flow, Heat Transfer and Mass Transfer", Butterworth Heinmann, 6th Edition, 2000.

Course articulation matrix

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand the fundamentals, types and mechanism of mass transfer operations	3	3	3	-	-	-	-	-	-	-	-	3	3	-	-
CO2	Understand the theories of mass transfer and the concept of inter-phase mass transfer	3	3	3	-	-	-	-	-	-	-	-	3	3	-	-
CO3	Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process	3	3	3	-	-	1	1	1	-	1	-	3	3	2	2
CO4	Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower	3	3	3	-	-	1	1	1	-	1	-	3	3	2	2
CO5	Apply the ternary equilibrium diagram concepts for separation of liquid-liquid extraction process , Describe core principles of leaching, estimate the number of ideal stages in leaching operation	3	3	3	-	-	1	1	1	-	1	-	3	3	2	2
OVERALL CO		3	3	3	-	-	1	1	1	-	1	-	3	3	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To enable the students to gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

**UNIT I****9**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

**UNIT II****9**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel, size comparison of reactors.

**UNIT III****9**

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

**UNIT IV****9**

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

**UNIT V****9**

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

- Understand the kinetics of homogenous reaction
- Understand the reactor arrangement in series and parallel configuration
- Develop performance equation and determine the conversion for different reactors
- Understand the non-isotherm operation of the reactor
- Understand the residence time distribution function and analyze the non-ideality in the reactor.

**TEXT BOOKS:**

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition, 2000.
2. Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition, 1981.
3. Fogler.H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd., 3<sup>rd</sup> Edition, 2000.

**REFERENCE:**

1. Froment. G.F. &K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons, 1979.

**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 13	PS O2	PS O3
<b>CO1</b>	Understand the kinetics of homogenous reaction	3	3	3	2	2	1	1	-	-	-	1	1	3	3	2
<b>CO2</b>	Understand the reactor arrangement in series and parallel configuration	3	3	3	2	2	1	1	-	-	-	1	1	3	3	2
<b>CO3</b>	Develop performance equation and determine the conversion for different reactors	3	3	3	2	-	1	1	-	-	-	1	1	3	3	2
<b>CO4</b>	Understand the non-isotherm operation of the reactor	3	3	3	2	2	1	1	-	-	-	1	1	3	3	2
<b>CO5</b>	Understand the residence time distribution function and analyze the non-ideality in the reactor.	3	3	3	2	2	1	1	-	-	-	1	1	3	3	2
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>

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 PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

**UNIT I PVT RELATIONS AND FIRST LAW OF THERMODYNAMICS 9**

Scope of thermodynamics, basic concepts and definitions, Equilibrium state and phase rule, Energy, Work, Temperature and Zeroth Law of Thermodynamics, reversible and irreversible process, Ideal gas- Equation of State involving ideal and real gas, Law of corresponding states, Compressibility chart, First Law of Thermodynamics and its consequences.

**UNIT II SECOND LAW AND THERMODYNAMIC CORRELATIONS 9**

Application of first Law of Thermodynamics for Flow and non-flow processes. Limitations of the first Law, statements of second Law of Thermodynamics, Thermodynamic Temperature scale, Entropy, Third law of thermodynamics. Thermodynamic Potentials, thermodynamic correlation, Maxwell relations. Clapeyron equation.

**UNIT III SOLUTION THERMODYNAMICS 9**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, activity and property change of mixing, excess properties of mixtures. Activity coefficient-composition models.

**UNIT IV PHASE EQUILIBRIA 9**

Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry's law, fugacity, Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium.

**UNIT V REACTION EQUILIBRIA 9**

Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon successful completion of the course, the students would be able to

- Understand PVT relations and first law of thermodynamics
- Apply second law and analyse the feasibility of system/devices
- Understand the systematic development of new class of properties to describe real mixtures
- Develop the idea of chemical potential to derive the idea of phase equilibria
- Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.

**TEXT BOOKS:**

- Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7<sup>th</sup> Edition, Wiley India, New Delhi, 2009.
- Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004
- Smith, van Ness and Abbott, "Chemical Engineering Thermodynamics", 7<sup>th</sup> Edition, McGraw Hill, New York, 2005

**REFERENCES:**

- S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley New York, 2006

2. Y V C Rao, "Chemical Engineering Thermodynamics", Universities Press, Hyderabad 2005.
3. Pradeep Ahuja, "Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
4. Gopinath Halder, "Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).



## COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	P O7	PO 8	P O 9	P O1 0	PO 11	P O1 2	PS O1	P S O 2	P S O 3
<b>CO1</b>	Understand PVT relations and first law of thermodynamics	3	3	3	-	1	-	-	1	-	2	1	2	3	-	1
<b>CO2</b>	Apply second law and analyse the feasibility of system/devices	3	3	3	3	1	-	-	1	1	2	1	2	3	3	1
<b>CO3</b>	Understand the systematic development of new class of properties to describe real mixtures	3	3	3	3	1	-	-	1	-	-	-	2	3	3	1
<b>CO4</b>	Develop the idea of chemical potential to derive the idea of phase equilibria	3	3	3	3	1	-	-	-	-	-	-	2	3	3	1
<b>CO5</b>	Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.	3	3	3	3	1	-	-	-	1	-	-	2	3	3	1
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES:**

- To impart necessary basic knowledge in order to understand, analyze and solve problems related to electrochemical processes.

**UNIT I ELECTRICAL DOUBLE LAYER 9**

Thermodynamics of ideally polarizable and non-polarizable interfaces- Lipman equation-determination of interfacial tension, charge density, surface excess and double layer capacitance by electro capillary & bridge methods- Helmholtz, Gouy-Chapman and stern models of the double layer with discussion of potential and charge distribution inside the double layer-contact adsorption and its determination.

**UNIT II ELECTRODE KINETICS 9**

Concepts of equilibrium potential, Nernst equation, overpotential and its different types, equilibrium exchange current density-derivation of Butler-Volmer equation –high field and low field approximations – charge transfer resistance and polarizability of the interface – concepts of rate determining step, Stoichiometric number, reaction order – Determination of kinetics parameters [  $i_0$ ,  $k_s, \beta(\alpha)$ ] by Tafel and linear polarization methods.

**UNIT III ELECTROCATALYSIS 9**

Chemical catalysis and electro catalysis – comparison of electrocatalysts – electro catalysis in simple redox reactions involving adsorbed species – electronic and geometric factors in electrocatalysts -Discussion on the mechanisms of hydrogen evolution and oxygen reduction reactions.

**UNIT IV ELECTROCHEMICAL TECHNIQUES I 9**

Ion selective electrodes – Principles of potentiometry and amperometry- determination of dissolved oxygen. Linear sweep voltammetry and cyclic voltammetry derivation of Randles- Sevciks equation – effect of sweep rate-analysis of cyclic voltammograms.

**UNIT V ELECTROCHEMICAL TECHNIQUES II 9**

Potential step method (chronoamperometry) under diffusion control derivation of Cottrell equation for a planar and spherical electrode- significance of spherical diffusion – derivation of Ilkovic equation.- Chronopotentiometry and analysis of chronopotentiograms-derivation of sands equation for constant current input under linear diffusion- concepts of Faradaic impedance –derivation of kinetic parameters from impedance measurements – Nyquist and bode plots for simple redox reactions-principles of scanning probe techniques-STM-AFM and SECM – working principles of electrochemistry.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon completion of the course,

- Understand the concept of electrical double layer
- Understand the concept of electrode kinetics
- Understand the concept of electrocatalysis
- Understand the principles of potentiometry and amperometry
- Understand the principles of various electrochemical techniques.

**TEXT BOOKS:**

- J.O.M Bockris& A.K.N. Reddy, "Modern Electrochemistry", Vol.2, Plenum Press (Chapter 7 for unit I: Chapters 8 & 9 for unit II ; chapter 10 for unit III), 1996.
- A.J.Bard& L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", John Wiley & Sons. 3<sup>rd</sup> Edition, 2001.



**REFERENCES:**

1. Paul Delahay, "Double Layer Structure and Electrode Kinetics", 1965 and publication.
2. James A. Plam Beck , "Electroanalytical Chemistry – Basic Principles and Applications", John Wiley & sons, Wiley Publication, 1982



### CO-PO & PSO MAPPING

Course Outcomes	Program Outcomes															
	Statements	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	P 07	PO 8	P O 9	P O1 0	PO 11	P O1 2	PS O1	P S O 2	P S O 3
<b>CO1</b>	Understand the concept of electrical double layer	3	3	2	3	1	-	-	1	-	-	1	2	3	-	1
<b>CO2</b>	Understand the concept of electrode kinetics	3	3	2	3	1	-	-	1	-	-	1	2	3	3	1
<b>CO3</b>	Understand the concept of electrocatalysis	3	3	2	3	1	-	-	1	-	-	-	2	3	3	1
<b>CO4</b>	Understand the principles of potentiometry and amperometry	3	3	2	3	1	-	-	1	1	-	-	2	3	3	1
<b>CO5</b>	Understand the principles of various electrochemical techniques	3	3	2	3	1	-	-	1	1	-	-	2	3	3	1
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**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

PROGRESS THROUGH KNOWLEDGE

**NCC Credit Course Level 2\***

NX3451

**(ARMY WING) NCC Credit Course Level - II**

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

**PERSONALITY DEVELOPMENT****9**

PD 3 Group Discussion: Change your mindset, Time Management, Social Skills

6

PD 5 Public Speaking

3

**LEADERSHIP****7**

L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965

7

**DISASTER MANAGEMENT****13**

DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation

3

DM 2 Initiative Training, Organising Skills, Do's &amp; Don't's, Natural Disasters, Man Made Disasters

9

DM 3	Fire Service & Fire Fighting	1
<b>ENVIRONMENTAL AWARENESS &amp; CONSERVATION</b>		<b>3</b>
EA 1	Environmental Awareness and Conservation	3
<b>GENERAL AWARENESS</b>		<b>4</b>
GA 1	General Knowledge	4
<b>ARMED FORCES</b>		<b>6</b>
AF 1	Armed Forces, Army, CAPF, Police	6
<b>ADVENTURE</b>		<b>1</b>
AD 1	Introduction to Adventure Activities	1
<b>BORDER &amp; COASTAL AREAS</b>		<b>2</b>
BCA 1	History, Geography & Topography of Border/Coastal areas	2

**TOTAL: 45 PERIODS**

<b>NCC Credit Course Level 2*</b>		
<b>NX3452</b>	<b>(NAVAL WING) NCC Credit Course Level - II</b>	<b>L T P C</b> <b>3 0 0 3</b>
<b>PERSONALITY DEVELOPMENT</b>		<b>9</b>
PD 3	Group Discussion: Change your mindset, Time Management, Social Skills	6
PD 5	Public Speaking	3
<b>LEADERSHIP</b>		<b>7</b>
L 2	Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965	7
<b>DISASTER MANAGEMENT</b>		<b>13</b>
DM 1	Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation	3
DM 2	Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters	9
DM 3	Fire Service & Fire Fighting	1
<b>ENVIRONMENTAL AWARENESS &amp; CONSERVATION</b>		<b>3</b>
EA 1	Environmental Awareness and Conservation	3
<b>GENERAL AWARENESS</b>		<b>4</b>
GA 1	General Knowledge	4
<b>NAVAL ORIENTATION</b>		<b>6</b>
AF 1	Armed Forces and Navy Capsule	3
EEZ 1	EEZ Maritime Security and ICG	3
<b>ADVENTURE</b>		<b>1</b>
AD 1	Introduction to Adventure Activities	1
<b>BORDER &amp; COASTAL AREAS</b>		<b>2</b>
BCA 1	History, Geography & Topography of Border/Coastal areas	2

**TOTAL: 45 PERIODS**

<b>NCC Credit Course Level 2*</b>		<b>L T P C</b>
<b>(AIR FORCE WING) NCC Credit Course Level - II</b>		<b>3 0 0 3</b>
<b>PERSONALITY DEVELOPMENT</b>		<b>9</b>
PD 3	Group Discussion: Change your mindset, Time Management, Social Skills	6
PD 5	Public Speaking	3
<b>LEADERSHIP</b>		<b>7</b>
L 2	Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965	7
<b>DISASTER MANAGEMENT</b>		<b>13</b>
DM 1	Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation	3
DM 2	Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters	9
DM 3	Fire Service & Fire Fighting	1
<b>ENVIRONMENTAL AWARENESS &amp; CONSERVATION</b>		<b>3</b>
EA 1	Environmental Awareness and Conservation	3
<b>GENERAL AWARENESS</b>		<b>4</b>
GA 1	General Knowledge	4
<b>GENERAL SERVICE KNOWLEDGE</b>		<b>6</b>
GSK 1	Armed Forces & IAF Capsule	2
GSK 2	Modes of Entry in IAF, Civil Aviation	2
GSK 3	Aircrafts - Types, Capabilities & Role	2
<b>ADVENTURE</b>		<b>1</b>
AD 1	Introduction to Adventure Activities	1
<b>BORDER &amp; COASTAL AREAS</b>		<b>2</b>
BCA 1	History, Geography & Topography of Border/Coastal areas	2
<b>TOTAL: 45 PERIODS</b>		

<b>EL3411 HEAT AND MASS TRANSFER LABORATORY</b>		<b>L T P C</b>
<b>(Any Ten experiments)</b>		<b>0 0 4 2</b>

**COURSE OBJECTIVES:**

- Enable the students to develop a sound working knowledge on different types of heat transfer equipments and mass transfer equipments.

**LIST OF EXPERIMENTS**

1. Transient state heat conduction
2. Solvent extraction
3. Batch drying
4. Temperature profile of a rod
5. Natural convection
6. Thermal conductivity of composite wall
7. Emissivity measurement
8. Measurement of diffusion coefficient
9. Simple distillation
10. Leaching
11. Adsorption
12. Double pipe heat exchanger

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student would be able to

- Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments
- Estimate the heat transfer rate and heat transfer co-efficient
- To perform heat transfer operation and to compare observed with predicted performance
- Determine the diffusivity practically and compare the results with the empirical correlations
- Evaluate the performance/calculate the parameters in different distillation processes

**REFERENCE:**

1. Laboratory Manual prepared by Faculty



Course Outcomes	Program Outcomes															
	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments	3	3	3	3	3	-	-	-	1	-	1	1	3	3	2
<b>CO2</b>	Estimate the heat transfer rate and heat transfer co-efficient	3	3	3	3	3	-	-	-	1	-	1	1	3	3	2
<b>CO3</b>	To perform heat transfer operation and to compare observed with predicted performance	3	3	3	3	3	-	-	-	1	-	1	1	3	3	2
<b>CO4</b>	Determine the diffusivity practically and compare the results with the empirical correlations	3	3	3	3	3	-	-	-	1	-	1	1	3	3	-
<b>CO5</b>	Evaluate the performance/calculate the parameters in different distillation processes	3	3	3	3	3	-	-	-	1	-	1	1	3	3	2
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE



**COURSE OBJECTIVES:**

- To enable the students to develop a sound working knowledge on different types of electrochemical techniques and electrochemical parameter calculations.

**LIST OF EXPERIMENTS**

- Fabrication of Reference electrode (Ag/AgCl) and its validation
- Fabrication of modified electrodes and calculation of surface excess
- Potentiometric titration of redox couple (Fe/Ce ions)
- Estimation of equilibrium potential of quinhydrone electrode (pH dependence)
- Determination of formal potential and diffusion coefficient for a reversible process using ferricyanide and ferrocyanide
- Distinguish between inner and outer sphere processes using Pt and glassy carbon electrode
- Effect of dissolved oxygen in electrochemical reduction of nitrophenol
- Amperometric method for sensing hydrogen peroxide
- Determination of dihydroxy phenols using cyclic voltammetry
- Investigation of electrochromism using electropolymerisation on a ITO substrate
- Double-layer capacitance measurement using cyclic voltammetry
- Electrode surface area measurement using a redox probe.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

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

- Acquire knowledge on different types of electrochemical techniques and electrochemical parameter calculations
- Fabrication of various types of electrodes and its validation
- Estimation of equilibrium potential and formal potential of electrodes
- Investigation of electrochromism and capacitance measurement
- Calculate electrochemical parameters from various electrochemical techniques

**COURSE ARTICULATION MATRIX**

Course Outcomes	Statements	Program Outcomes															
		P O 1	P O 2	P O 3	PO 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	P O 13	P O 14	P O 15	
CO1	Acquire knowledge on different types of electrochemical techniques and electrochemical parameter calculations	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
CO2	Fabrication of various types of electrodes and its validation	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
CO3	Estimation of equilibrium potential and formal potential of electrodes	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
CO4	Investigation of electrochromism and capacitance measurement	3	2	3	3	3	-	-	-	1	-	1	1	3	2	-	
CO5	Calculate electrochemical parameters from various electrochemical techniques	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	
OVERALL CO		3	2	3	3	3	-	-	-	1	-	1	1	3	2	2	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**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

**OBJECTIVE:**

- To familiarize in the aspects of current-voltage relationships & estimation of mass transfer co-efficient, PFR & CSTR systems model

**UNIT I CURRENT-VOLTAGE RELATIONSHIPS & ESTIMATION OF MASS TRANSFER CO-EFFICIENT 9**

A general view of electrolytic processes; current-voltage relationships in electrolytic reactors; the limiting current plateau; mass & energy balance, and efficiency in electrochemical reactors. The estimation of mass transport coefficients at commonly occurring electrodes. The estimation of mass transport coefficients under enhanced convection conditions.

**UNIT II PLUG FLOW& CSTER SYSTEMS MODEL 9**

A general view of plug flow model of electrolytic reactors: plug flow model of electrochemical reactors employing parallel plate reactor; Plug flow model under constant mass flux conditions; PFM analysis with electrolyte recycling PFM and real electrochemical reactors. General view of simple CSTER systems; CSTER in cascades; CSTER analysis of batch electrochemical reactors, CSTER analysis of semi-continuous electrochemical reactors; CSTER analysis of electrolyte recycling; Batch reactor combined with electrolyte recycling.

**UNIT III THERMAL BEHAVIOR OF REACTORS 9**

General aspects of thermal behavior in electrochemical reactor. Thermal behavior under CSTER conditions. The estimation of heat losses; the thermal behavior under PFR conditions; Thermal behavior of batch electrochemical reactors.

**UNIT IV CONVECTIVE DIFFUSION EQUATION & CURRENT DISTRIBUTION 9**

Convective diffusion equation and migration effects –derivation of convective diffusion equation theory – scope and limitation – migration effects – Electroneutrality conditions – supporting electrolyte effect – fundamental of Nernst layer model – Estimation of true limiting current

## **UNIT V          DISPERSION MODELS & OPTIMIZATION OF ELECTROCHEMICAL REACTOR 9**

General aspects of dispersion models-tracer input signal/output signal - axial dispersion in electrochemical reactors - axial dispersion and reactor performance - axial dispersion analysis via tank-in-series model - general notions on optimization of electrochemical reactor – elementary process optimization – IBL formula – optimization of electro refining process – Jaskula formula – optimization of a general electrolytic process – The Beck formula.

**TOTAL :45 PERIODS**

### **OUTCOME:**

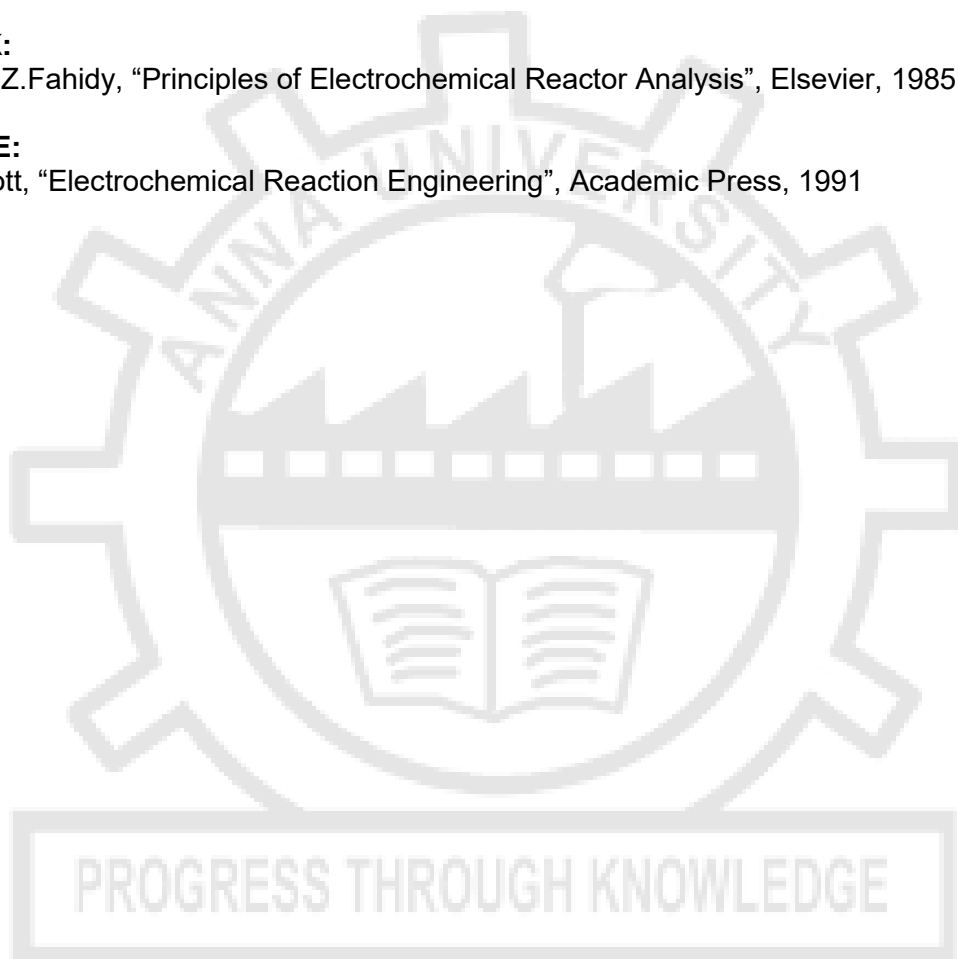
- Understand current-voltage relationships & estimation of mass transfer co-efficient the kinetics of homogenous reaction
- Acquire knowledge on plug flow& cster systems m
- Understand the general aspects of thermal behavior in electrochemical reactor
- Understand Convective diffusion equation and migration
- Understand dispersion models & optimization of electrochemical reactor

### **TEXT BOOK:**

1. T.Z.Fahidy, "Principles of Electrochemical Reactor Analysis", Elsevier, 1985.

### **REFERENCE:**

1. K.Scott, "Electrochemical Reaction Engineering", Academic Press, 1991



## COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	P 07	PO 8	P 09	P 010	PO 11	P 012	PS 01	P 02	P 03
<b>CO1</b>	Understand current-voltage relationships & estimation of mass transfer co-efficient the kinetics of homogenous reaction	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO2</b>	Acquire knowledge on plug flow & cster systems m	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO3</b>	Understand the general aspects of thermal behavior in electrochemical reactor	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO4</b>	Understand Convective diffusion equation and migration	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO5</b>	Understand dispersion models & optimization of electrochemical reactor	3	2	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

- Students develop a sound working knowledge on different types of reactors. its also students to experimentally determine the kinetic constant and conversion of a given electrochemical, reactor in a batch reactor, tubular reactor and mixed flow reactor and compare with the theoretically predicted conversions.

**LIST OF EXPERIMENTS**

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a PFR followed by a CSTR
5. RTD studies in a PFR
6. RTD studies in a CSTR
7. Study of temperature dependence of rate constant using CSTR.

**OUTCOMES:**

- Acquire knowledge on kinetics of reactors
- Understand rate equation for different types of reactors
- Assess the performance of Plug flow Mixed flow and Packed bed by studying the residence time distribution.
- Determine the kinetic constant and conversion of a given electrochemical reaction in a reactor
- Compare experimentally determined results with the theoretically predicted conversion

**ELECTROCHEMICAL REACTION ENGINEERING**

**OBJECTIVE:**

- To make the students to experimentally determine the kinetic constant and conversion of a given electrochemical, reaction in a batch reactor, tubular reactor and mixed flow reactor and compare with the theoretically predicted conversions

**LIST OF EXPERIMENTS**

1. Electrochemical batch reactor-constant current operation / constant potential operation.
2. Factorial design for investigating the current efficiency of copper deposition.
3. Monopolar and bipolar cells.
4. Electrochemical batch reactor – Constant current operations for Copper/Titanium/Stainless steel electrode.
5. Continuous flow stirred tank electrochemical reactor (CSTER)
6. Axial flow electrochemical reactor (PFER) – Single out let
7. Packed bed reactor – Flow through configuration (Copper bed)

**TOTAL: 60 PERIODS**

**REFERENCE:**

1. Laboratory Manual prepared by Faculty

### CO-PO & PSO MAPPING

Course Outcomes	Program Outcomes															
	Statements	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	P 07	PO 8	P O 9	P O1 0	PO 11	P O1 2	PS O1	P S O 2	PS O3
<b>CO1</b>	Acquire knowledge on kinetics of reactors	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
<b>CO2</b>	Understand rate equation for different types of reactors	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
<b>CO3</b>	Assess the performance of Plug flow Mixed flow and Packed bed by studying the residence time distribution.	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
<b>CO4</b>	Determine the kinetic constant and conversion of a given electrochemical reaction in a reactor	3	2	3	3	3	-	-	-	1	-	1	1	3	2	-
<b>CO5</b>	Compare experimentally determined results with the theoretically predicted conversion	3	2	-	-	-	-	-	-	1	-	1	1	3	-	2
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>2</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

The course is aimed to

- Determine possible control objectives, input variables (manipulated variables and disturbances), model the dynamic behavior of a process, design PID controllers, frequency response and analyze stability of closed loop and open loop systems.

**UNIT I****9**

Introduction to Chemical Process Control, Mathematical description of chemical processes, Formulating Process Models, Laplace Transforms, Properties of Laplace Transforms, Solution of ODE using Laplace Transforms, Standard input forcing functions, State – Space representation, transform domain models, Impulse response models, Inter relationship between process model forms

**UNIT II****9**

Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag, FOPDT Model, Skogestad's rule for FOPDT and SOPDT, Lead- Lag systems

**UNIT III****9**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, control valves, transient response of closed-loop control systems and their stability, Root locus diagram.

**UNIT IV****9**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion

**UNIT V****9**

Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

**TOTAL: 45 PERIODS****OUTCOMES:**

On the completion of the course students are expected to

- CO1: Understand the need to develop mathematical description of a chemical process as a Prerequisite to process design and to control the process.
- CO2: Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.
- CO3: Represent a physical system using FOPDT model and estimate parameters in FOPDT model.
- CO4: Convert a process and instrumentation diagram to a control block diagram
- CO5: Understand Frequency response of control systems and tune the PID controllers and Appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.

**TEXT BOOKS:**

1. Stephanopoulos, G. (2015). Chemical process control, 3<sup>rd</sup> Ed New Jersey: Prentice hall.
2. Ogunnaike, B. A., & Ray, W. H. (1997). Process dynamics, modeling, and control (Vol. 1).

- New York: Oxford University Press.
3. Coughanowr, D. R., & Leblanc, S. E. (2017). Introductory concepts. *Process Systems Analysis and Control, 3rd Ed*, 1-6.

**REFERENCES:**

1. Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle IV, F. J. (2016). Process dynamics and control. John Wiley & Sons.
2. Bequette, B. W. (2003). Process control: modeling, design, and simulation. Prentice Hall Professional.
3. Riggs, J. B., & Karim, M. N. (2007). Chemical and Bio-process Control: James B. Riggs, M. Nazmul Karim. Prentice Hall.
4. Luyben, W. L., Tyréus, B. D., & Luyben, M. L. (1998). Plantwide process control (Vol. 43). New York: McGraw-Hill.





### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	Understand the need to develop mathematical description of a chemical process as a prerequisite to process design and to control the process.	3	3	3	2	2	1	-	-	2	2	2	2	3	3	2
<b>CO2</b>	Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.	3	3	3	2	2	1	-	-	-	-	2	2	3	3	-
<b>CO3</b>	Represent a physical system using FOPDT model and estimate parameters in FOPDT model.	3	3	3	2	2	1	-	-	-	-	2	2	3	3	-
<b>CO4</b>	Convert a process and instrumentation diagram to a control block diagram	3	3	3	2	2	-	-	-	-	-	2	2	3	3	-
<b>CO5</b>	Understand Frequency response of control systems and tune the PID controllers and appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.	3	3	3	2	2	-	-	-	-	2	2	3	3	-	
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

<b>NCC Credit Course Level 3*</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>(ARMY WING) NCC Credit Course - III</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>NX3651</b>					
<b>PERSONALITY DEVELOPMENT</b>					<b>9</b>
PD 3	Group Discussion: Team Work				2
PD 4	Career Counselling, SSB Procedure & Interview Skills				3
PD 5	Public Speaking				4
<b>BORDER &amp; COASTAL AREAS</b>					<b>4</b>
BCA 2	Security Setup and Border/Coastal management in the area				2
BCA 3	Security Challenges & Role of cadets in Border management				2
<b>ARMED FORCES</b>					<b>3</b>
AF 2	Modes of Entry to Army, CAPF, Police				3
<b>COMMUNICATION</b>					<b>3</b>
C 1	Introduction to Communication & Latest Trends				3
<b>INFANTRY</b>					<b>3</b>
INF 1	Organisation of Infantry Battalion & its weapons				3
<b>MILITARY HISTORY</b>					<b>23</b>
MH 1	Biographies of Renowned Generals				4
MH 2	War Heroes - PVC Awardees				4
MH 3	Study of Battles - Indo Pak War 1965, 1971 & Kargil				9
MH 4	War Movies				6
<b>TOTAL: 45 PERIODS</b>					

<b>NCC Credit Course Level 3*</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>(NAVAL WING) NCC Credit Course - III</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>NX3652</b>					
<b>PERSONALITY DEVELOPMENT</b>					<b>9</b>
PD 3	Group Discussion: Team Work				2
PD 4	Career Counselling, SSB Procedure & Interview Skills				3
PD 5	Public Speaking				4
<b>BORDER &amp; COASTAL AREAS</b>					<b>4</b>
BCA 2	Security Setup and Border/Coastal management in the area				2
BCA 3	Security Challenges & Role of cadets in Border management				2
<b>NAVAL ORIENTATION</b>					<b>6</b>
NO 3	Modes of Entry - IN, ICG, Merchant Navy				3
AF 2	Naval Expeditions & Campaigns				3
<b>NAVAL COMMUNICATION</b>					<b>2</b>
NC 1	Introduction to Naval Communications				1
NC 2	Semaphore				1
<b>NAVIGATION</b>					<b>2</b>
N 1	Navigation of Ship - Basic Requirements				1
N 2	Chart Work				1
<b>SEAMANSHIP</b>					<b>15</b>
MH 1	Introduction to Anchor Work				2
MH 2	Rigging Capsule				6
MH 3	Boatwork - Parts of Boat				2
MH 4	Boat Pulling Instructions				2
MH 5	Whaler Sailing Instructions				3
<b>FIRE FIGHTING FLOODING &amp; DAMAGE CONTROL</b>					<b>4</b>
FFDC 1	Fire Fighting				2
FFDC 2	Damage Control				2
<b>SHIP MODELLING</b>					<b>3</b>
SM	Ship Modelling Capsule				3
<b>TOTAL : 45 PERIODS</b>					

**NCC Credit Course Level 3\***

<b>NX3653 (AIR FORCE WING) NCC Credit Course Level - III</b>		<b>L T P C</b>
		<b>3 0 0 3</b>
<b>PERSONALITY DEVELOPMENT</b>		<b>9</b>
PD 3	Group Discussion: Team Work	2
PD 4	Career Counselling, SSB Procedure & Interview Skills	3
PD 5	Public Speaking	4
<b>BORDER &amp; COASTAL AREAS</b>		<b>4</b>
BCA 2	Security Setup and Border/Coastal management in the area	2
BCA 3	Security Challenges & Role of cadets in Border management	2
<b>AIRMANSHIP</b>		<b>1</b>
A 1	Airmanship	1
<b>BASIC FLIGHT INSTRUMENTS</b>		<b>3</b>
FI 1	Basic Flight Instruments	3
<b>AERO MODELLING</b>		<b>3</b>
AM 1	Aero Modelling Capsule	3
<b>GENERAL SERVICE KNOWLEDGE</b>		<b>2</b>
GSK 4	Latest Trends & Acquisitions	2
<b>AIR CAMPAIGNS</b>		<b>6</b>
AC 1	Air Campaigns	6
<b>PRINCIPLES OF FLIGHT</b>		<b>6</b>
PF 1	Principles of Flight	3
PF 2	Forces acting on Aircraft	3
<b>NAVIGATION</b>		<b>5</b>
NM 1	Navigation	2
NM 2	Introduction to Met and Atmosphere	3
<b>AERO ENGINES</b>		<b>6</b>
E 1	Introduction and types of Aero Engine	3
E 2	Aircraft Controls	3
<b>TOTAL : 45 PERIODS</b>		

<b>EL3611</b>	<b>PROCESS DYNAMICS AND CONTROL LABORATORY</b>	<b>L T P C</b>
		<b>0 0 4 2</b>

**OBJECTIVE:**

- To train the students to determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

**LIST OF EXPERIMENTS**

- Response of first order system
- Response of second order system
- Response of Non-Interacting level System
- Response of Interacting level System
- Open loop study on a thermal system
- Closed loop study on a level system
- Closed loop study on a flow system
- Closed loop study on a thermal system
- Tuning of a level system
- Tuning of a pressure system
- Tuning of a thermal system
- Flow co-efficient of control valves

13. Characteristics of different types of control valves
  14. Closed loop study on a pressure system
  15. Tuning of pressure system
  16. Closed loop response of cascade control system
- \*Minimum 10 experiments shall be offered.

**TOTAL:60 PERIODS**

**OUTCOME:**

- Able to determine the response of a first order and second order system for various input
- Able to determine the response of a interacting and non- interacting system for various input
- Understand the difference between an open loop and closed loop system
- Understand the concept of three classical controller P, PI, PID controller
- Understand the concept of stability and tuning of a system



### COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	Able to determine the response of a first order and second order system for various input	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
<b>CO2</b>	Able to determine the response of a interacting and non- interacting system for various input	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
<b>CO3</b>	Understand the difference between an open loop and closed loop system	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
<b>CO4</b>	Understand the concept of three classical controller P, PI, PID controller	3	2	3	3	3	-	-	-	1	-	1	1	3	2	-
<b>CO5</b>	Understand the concept of stability and tuning of a system	3	2	3	3	3	-	-	-	1	-	1	1	3	-	2
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>2</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVE:**

- To train the students to understand the techniques to measure the corrosion rate, to provide hands-on experience in metal finishing and to train the students on the concepts of electrometallurgy

**LIST OF EXPERIMENTS****CORROSION**

- Determination of efficiency of the given inhibitor by gravimetric method
- Efficiency of cathodic protection by impressed current method
- Determination of anode efficiency in sacrificial anode system
- Standard Test Methods for specific gravity of pigments (3 pigments)
- Determination of corrosion rate by galvanostatic polarization method [Tafel and linear Polarization methods]

**METAL FINISHING  
(Any Five experiments)**

- Anodizing of Aluminium
- Electroforming of Metal Foil
- Hull Cell Studies in Electroplating Bath
- Throwing Power Studies in Electroplating Bath
- Nickel Plating & Analysis of nickel plating solution
- Electrophoretic deposition
- Electroless Plating

**TOTAL: 60 PERIODS****OUTCOME:**

- Understand the techniques to measure the corrosion rate
- Acquire knowledge on efficiency of inhibitor
- Acquire knowledge on cathodic protection
- Acquire knowledge on metal finishing
- Acquire knowledge on concepts of electrometallurgy

**REFERENCE:**

- Laboratory Manual prepared by Faculty.

**COURSE ARTICULATION MATRIX**

Course Outcomes	Program Outcomes															
	Statements	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 13	PO 14	PO 15
CO1	Understand the techniques to measure the corrosion rate	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
CO2	Acquire knowledge on efficiency of inhibitor	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
CO3	Acquire knowledge on cathodic protection	3	2	3	3	3	-	-	-	1	-	1	1	3	2	2
CO4	Acquire knowledge on metal finishing	3	2	3	3	3	-	-	-	1	-	1	1	3	2	-
CO5	Acquire knowledge on concepts of electrometallurgy	3	2	3	3	3	-	-	-	1	-	1	1	3	-	2
OVERALL CO		3	2	3	3	3	-	-	-	1	-	1	1	3	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**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

**OBJECTIVE:**

- To enable the students to gain the knowledge of principle, applications of lead acid batteries

**UNIT I**

Invention and development of lead acid batteries, working principle of lead acid batteries, secondary reactions, active material in positive electrode, active material in negative electrode, grid alloys. Manufacturing process of lead acid batteries, formation technology, batteries with tubular plates.

**UNIT II**

Charging techniques: Constant voltage-charging, constant current charging, taper charging, and boost charging. Valve regulated lead acid batteries: Design, temperature influence, influence of overcharging voltage, heat effects, and thermal run away.

**UNIT III**

Capacity, capacity as current scale, discharge parameters, temperature influence on capacity, charge parameters, cycling, depth of discharge, internal resistance, service life expectancy. Lead acid batteries for SLI, solar, telecom, and inverter applications. Failure modes analysis.

**UNIT IV**

Advanced battery concepts: Tubular gel batteries, lead-carbon batteries, bi-polar design, start-stop batteries, e-Rickshaw battery, battery monitoring and management.

**UNIT V**

Introduction to battery standards, Indian and International standards for the performance evaluation of flooded and valve regulated lead acid systems used in stationary, solar and automotive applications. Recycling of lead acid batteries.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Understand current-voltage relationships & estimation of mass transfer co-efficient the kinetics of homogenous reaction
- Acquire knowledge on plug flow & CSTR systems
- Understand the general aspects of thermal behavior in electrochemical reactor
- Understand convective diffusion equation and migration
- Understand dispersion models & optimization of electrochemical reactor

**TEXT BOOKS**

1. D.Pavlov, "Lead – Acid Batteries: Science and Technology", Elsevier, Amsterdam, 2011
2. D.A.J. Rand, P.T.Mosley, J. Garche, C.D.Parker, Valve-Regulated lead acid batteries, Elsevier, Amsterdam, 2011

**REFERENCES**

1. D. Berndt, Maintenance-free batteries: Lead-acid, Nickel/cadmium, Nickel/metal Hydride : a Handbook of Battery Technology, Research Studies Press, 1997





### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	Understand current-voltage relationships & estimation of mass transfer co-efficient the kinetics of homogenous reaction	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO2</b>	Acquire knowledge on plug flow & CSTR systems	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO3</b>	Understand the general aspects of thermal behavior in electrochemical reactor	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO4</b>	Understand convective diffusion equation and migration	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>CO5</b>	Understand dispersion models & optimization of electrochemical reactor	3	3	3	2	2	1	1	1	-	-	1	1	3	3	2
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**COURSE DESCRIPTION**

This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

**COURSE OBJECTIVES:**

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

**UNIT I DEMOCRATIC VALUES****6**

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.

Reading Text: Excerpts from John Stuart Mills' *On Liberty*

**UNIT II SECULAR VALUES****6**

Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.

Reading Text: Excerpt from *Secularism in India: Concept and Practice* by Ram Puniyani

**UNIT III SCIENTIFIC VALUES****6**

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.

Reading Text: Excerpt from *The Scientific Temper* by Antony Michaelis R

**UNIT IV SOCIAL ETHICS****6**

Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.

Reading Text: Excerpt from *21 Lessons for the 21<sup>st</sup> Century* by Yuval Noah Harari

**UNIT V SCIENTIFIC ETHICS****6**

Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

Reading Text: Excerpt from *American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer* by Kai Bird and Martin J. Sherwin.

**TOTAL: 30 PERIODS****REFERENCES:**

1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

**COURSE OUTCOMES**

Students will be able to

CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life

CO2 : Practice democratic and scientific values in both their personal and professional life.

CO3 : Find rational solutions to social problems.



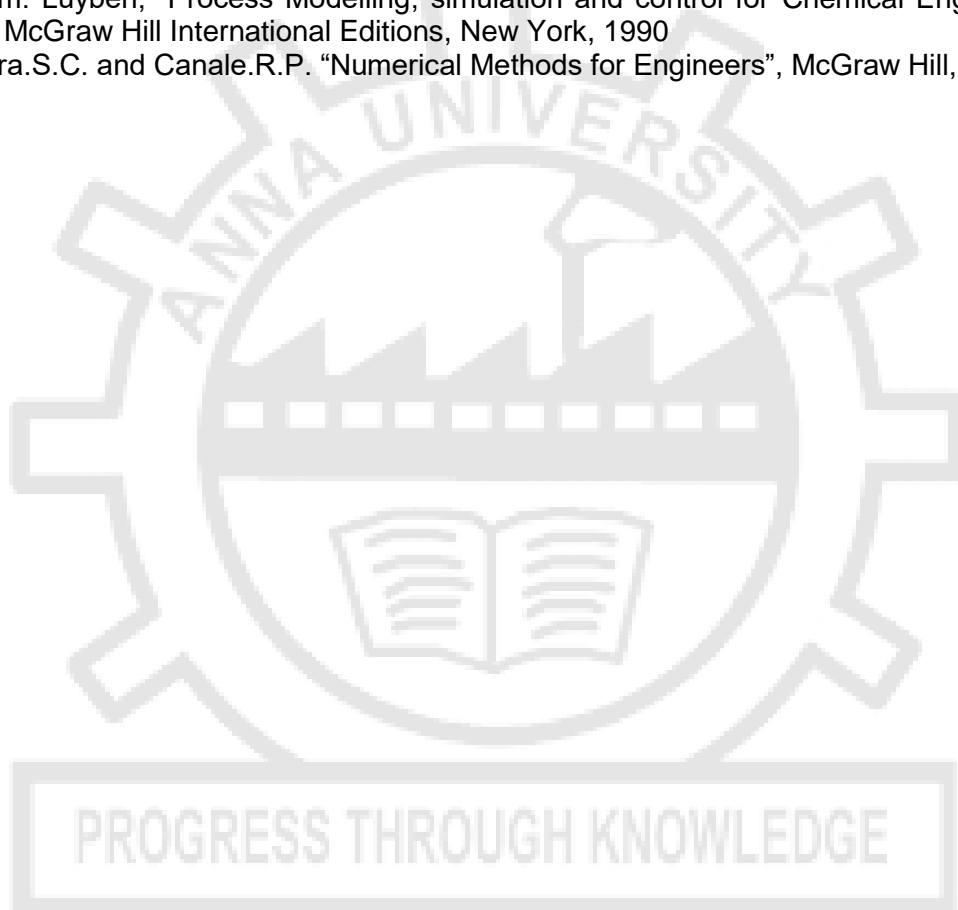
methods

- Create the mathematical models for different unit operations equipments such as stirred tank heaters, Heat exchangers, Evaporators, Reactors, distillation Columns
- Analyze the principles of steady state/unsteady state lumped systems and steady state/unsteady statedistributed systems
- Apply relevant solution methods for the mathematical models with relevant initial and / or boundaryconditions

**Minimum 10 experiments to be offered**

**TEXT BOOKS:**

1. Bequette. B.W, "Process Dynamics": Modelling, Analysis and Simulation," Prentice Hall (1998)
2. Himmelblau. D.M. and Bischoff. K.B, "Process Analysis and Simulation", Wiley, 1988.
3. Strang.G. ,"Introduction to Linear Algebra", Cambridge Press, 4th edition,2009.
4. William. Luyben, "Process Modelling, simulation and control for Chemical Engineers, 2nd Edn., McGraw Hill International Editions, New York, 1990
5. Chapra.S.C. and Canale.R.P. "Numerical Methods for Engineers", McGraw Hill, 2001.



### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	P O 9	PO 10	PO 11	PO 12	PS O1	P S O 2	P S O 3
<b>CO1</b>	Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics	3	3	3	1	-	-	-	-	3	3	3	3	3	3	-
<b>CO2</b>	Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods	3	3	3	3	3	-	-	-	3	3	-	3	3	3	1
<b>CO3</b>	Create the mathematical models for different unit operations equipments such as stirred tank heaters, Heat exchangers, Evaporators, Reactors, distillation columns	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
<b>CO4</b>	Analyze the principles of steady state/unsteady state lumped systems and steady state/unsteady statedistributed systems	3	3	3	3	3	-	-	-	3	3	1	3	3	3	1
<b>CO5</b>	Apply relevant solution methods for the mathematical models with relevant initial and / or boundary conditions	3	3	3	3	3	-	-	-	3	3	2	3	3	3	1
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

EL3811

**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:**

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

**REFERENCES:**

- Luis R., Gomez-Mejia, David B. Balkin and Robert L. Cardy, "Managing Human Resources", 7th Edition, PHI, 2012.
- 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
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1
4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	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

**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:**

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

**REFERENCE:**

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

PROGRESS THROUGH KNOWLEDGE

**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", 8<sup>th</sup> Edition, Tata McGrawhill, New Delhi, 2010.

**REFERENCES:**

- 1 Joseph J, Massie, "Essentials of Management", 4<sup>th</sup> 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, 11<sup>th</sup> 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

#### PROFESSIONAL ELECTIVES

**EL3001 ELECTROCHEMICAL PROCESS TECHNOLOGY L T P C**  
**3 0 0 3**

##### OBJECTIVE:

- To provide an adequate mastery in the principles involved in the electrochemical process and its applications.

##### UNIT I ELECTRODES AND SEPARATORS 9

Electrodes and separators for the electrolytic production of chemicals – preparation, characteristics and applications of graphite, magnetite, lead dioxide coated anodes, noble metal coated anodes, noble metal oxide coated anodes, spinal anodes, Perovskite platinum and nickel anodes, steel cathodes, coated cathodes, diaphragms and ion exchange membranes.

##### UNIT II ELECTROLYTIC PRODUCTION OF IN-ORGANIC CHEMICALS 9

Electrolytic production of sodium hypochlorite, sodium and potassium chlorates, bromates and iodates. Sodium, potassium and ammonium perchlorates, perchloric acid. Potassium, and ammonium persulphates, hydrogen peroxide, potassium permanganate, cuprous oxide and manganese dioxide – Basic principles, reaction mechanisms, effect of operating variables, cell design and operating characteristics of industrial cells.

##### UNIT III ELECTRO ORGANIC CHEMISTRY AND ELECTRODIALYSIS 9

Production of hydrogen by water electrolysis. Electrodialysis and its application to desalination of water electrolysis and waste recovery. Basic principles of Electro organic chemistry, constant current electrolysis, controlled potential electrolysis, material yield, current efficiency, selectivity and energy consumption for electro organic synthesis. Paired synthesis with example.

##### UNIT IV ELECTROCHEMICAL REDUCTION AND OXIDATION OF FUNCTIONAL GROUPS 9

Cathodic reduction of carbonyl compounds, nitro compounds, unsaturated compounds, nitriles and oximes. Electrohydrodimerization and cathodic coupling reactions, cathodic reactions using mediators. Anodic halogenation, oxidation through redox carriers – metal ion, non-metal ion and organic mediators. Anodic coupling reactions. Kolbe synthesis, mechanism and applications. Anodic oxidation of aromatic hydrocarbons and phenol. Anodic substitution reactions: alkoxylation, acetoxylation, cyanation and acetamidation.

**UNITV ELECTRO POLYMERIZATION AND ELECTRO ORGANIC PROCESSES 9**

Electro polymerization. Anodic and cathodic polymerization. Electrochemical preparation of conducting polymers - polyacetylene, polypyrrole, polythiophene, polyaniline and their applications. Industrial Electro organic processes - adiponitrile from acrylonitrile, dimethyl sebacate from monomethyladipate, tetra alkyl lead from alkyl chloride, perfluorooctanoic acid from octanoylchloride, aromatic aldehydes from toluenes. Electrochemical fluorination of organic compounds.

**TOTAL: 45 PERIODS****OUTCOME:**

- Acquire knowledge on electrodes and separators for the electrolytic production of chemicals
- Acquire knowledge on electrolytic production of in-organic chemicals
- Understand electro organic chemistry, electro dialysis and its applications
- Acquire knowledge on electrochemical reduction and oxidation of functional groups
- Understand electro polymerization and electro organic processes

**TEXT BOOKS:**

1. D.Pletcher and F.C.Walsh, "Industrial Electrochemistry", II Edition Chapman and Hall, London,1990.
2. M.M.Baizer, "Organic Electrochemistry", II Edition, Dekker Inc, Newyork, 1983.

**REFERENCES:**

1. M.R. Rifi and F. H. Covitz, "Introduction to Organic Electrochemistry", Marcel Dekker Inc. NewYork, 1994.
2. D. Kyriacou, "Modern Electro Organic chemistry" Springer, New York, 1994.

**Course articulation matrix**

Course Outcomes	Statements	PO	PO	PO	PO	PO	PO	P	PO	P	P	PO	P	P	P	P
		1	2	3	4	5	6	O	O	O	O	O	O	O	O	O
CO1	Acquire knowledge on electrodes and separators for the electrolytic production of chemicals	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
CO2	Acquire knowledge on electrolytic production of in-organic chemicals	3	2	2	2	1	1	1	-	1	-	1	1	2	2	1
CO3	Understand electro organic chemistry, electro dialysis and its applications	3	2	2	2	1	1	1	-	1	-	-	1	2	2	1
CO4	Acquire knowledge on electrochemical reduction and oxidation of functional groups	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
CO5	Understand electro polymerization and electro organic processes	3	2	2	2	1	1	1	-	1	-	1	1	2	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVE:**

- To provide fundamental understanding on aspects of electrochemistry and materials science relevant to corrosion phenomena and Identify practices for the prevention and remediation of corrosion.

**UNIT I BASIC ASPECTS OF CORROSION 9**

Introduction, classification, economics, emf series, Galvanic series. Corrosion theories: derivation of potential – current relationships of activation controlled and diffusion controlled corrosion processes. Potential – pH diagrams Fe-H<sub>2</sub>O system, application and limitations. Passivation-definition, anodic passivation theory of Passivation.

**UNIT II FORMS OF CORROSION 9**

Definition, factors and control methods of various forms of corrosion: uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement.

**UNIT III ATMOSPHERIC CORROSION AND PROTECTIVE COATINGS 9**

Atmospheric corrosion – classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods ; organic coating – surface preparation, natural, synthetic resin, paint formulation and applications. Paint testing and evaluation.

**UNIT IV IMMERSION CORROSION AND ELECTROCHEMICAL PROTECTION 9**

Corrosion in immersed condition: effect of dissolved gases, salts, pH, temperature and flow rates on corrosion; marine corrosion. Underground corrosion – corrosion process in the soil, factors influencing soil corrosion, Biological corrosion definition, mechanism of biological corrosion control of bio corrosion. Electrochemical methods of protection theory of cathodic protection, design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - boiler water system. Corrosion resistant alloys.

**UNIT V CORROSION MONITORING 9**

Laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by Gravimetric, Tafel polarization, linear polarization, cyclic polarization, impedance spectroscopy, harmonics and NDT techniques-ultrasonics, radiography eddy current.

**TOTAL: 45 PERIODS****OUTCOME:**

- Understand basic aspects of corrosion
- Understand factors and control methods of various forms of corrosion
- Understand the concepts of atmospheric corrosion and protective coatings
- Acquire knowledge on Corrosion in immersed condition and Electrochemical methods of protection
- Acquire knowledge on chemical tests for studying different forms of corrosion

**TEXT BOOKS:**

1. S.N.Banerjee, "An Introduction to Corrosion Science and Corrosion Inhibition", Oxonian Press, P.Ltd., New Delhi, 1985.
2. Zaki Ahmad, "Principles of Corrosion Engineering & Corrosion Control", Butterworth Heinemann, London, 2006

**REFERENCES:**

1. E.E. Stansbury, R.A. Buchanan, "Fundamentals of electrochemical corrosion", ASM International, 2000.
2. M.G.Fontana & N.D. Greene, "Corrosion Engineering", III Edition, McGraw Hill, New York, 1978.



### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand basic aspects of corrosion	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
CO2	Understand factors and control methods of various forms of corrosion	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
CO3	Understand the concepts of atmospheric corrosion and protective coatings	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
CO4	Acquire knowledge on Corrosion in immersed condition and Electrochemical methods of protection	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
CO5	Acquire knowledge on chemical tests for studying different forms of corrosion	3	2	2	2	1	1	1	-	-	-	-	1	2	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

- To enable the students to gain the knowledge of principle and applications of batteries and fuel cells.

**UNIT I FUNDAMENTALS****9**

EMF, reversible and irreversible cells, free energy, effect of cell temperature, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells.

**UNIT II FACTORS AFFECTING BATTERY PERFORMANCE****9**

Factors affecting battery capacity, voltage level, current drain of discharge, types of discharge: continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, charging methods, battery age & storage condition.

**UNIT III STORAGE BATTERIES****9**

Principle, design, construction, performance characteristics, advantage and disadvantages. Primary batteries - Zn-MnO<sub>2</sub> carbon-zinc, carbon-zinc chlorides, and zinc-silver oxide. Secondary batteries – lead-acid, nickel-cadmium, nickel-metal hydride, silver oxide-zinc system, lithium-ion, lithium- polymer. Batteries for electric vehicle applications, Micro batteries.

**UNIT IV TESTING & EVALUATION****9**

Evaluation of active mass, surface area measurement - BET method. Internal resistance of cells - A.C. methods impedance method. Testing of capacity, retention of charge, vibration, life, efficiency, leakage for sealed cells, High rate discharge, testing of separators.

**UNIT V FUEL CELLS & SUPERCAPACITOR****9**

Introduction to super capacitors, types of super capacitors. Introduction to fuel cells, types of fuel cells and technology development. Polymer electrolyte and solid oxide fuel cells. Material related challenges. Stack engineering. Microbial fuel cells.

**TOTAL: 45 PERIODS****OUTCOME:**

- Understand fundamentals of electrochemical cell
- Understand Factors affecting battery performance
- Acquire knowledge on the principle, design, construction, performance characteristics and applications of storage batteries
- Acquire knowledge on testing & evaluation of electrochemical cell
- Acquire knowledge on fuel cells & supercapacitor

**TEXT BOOKS:**

- M. Mench, "Fuel Cell Engines", John Wiley, New York, 2008.
- B. E. Conway, "Electrochemical Supercapacitors : Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum publishers, New York, 1999.

**REFERENCES:**

- Gholam Abbas Nazri, "Lithium Batteries – Science and Technology", Springer, New York, 2009.
- D.Pavlov, "Lead – Acid Batteries: Science and Technology", Elsevier, Amsterdam, 2011.

### CO-PO & PSO MAPPING

Course Outcome	Program Outcomes															
	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	Understand fundamentals of electrochemical cell	2	2	2	2	2	1	1	-	-	-	-	1	2	2	1
<b>CO2</b>	Understand Factors affecting battery performance	2	2	2	-	1	1	1	-	-	-	-	1	2	2	1
<b>CO3</b>	Acquire knowledge on the principle, design, construction, performance characteristics and applications of storage batteries	2	2	2	2	1	1	1	-	-	-	-	1	2	2	1
<b>CO4</b>	Acquire knowledge on testing & evaluation of <b>electrochemical</b> cell	2	2	2	2	1	1	1	-	-	-	-	1	2	2	1
<b>CO5</b>	Acquire knowledge on fuel cells & supercapacitor	2	2	2	2	1	1	1	-	-	-	-	1	2	2	1
<b>OVERALL CO</b>		<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**UNIT I      LITHIUM-ION ENERGY STORAGE SYSTEMS      9**

Working principle: lithium-ion battery, Lithium-ion battery cathodes (LFP, NMC, NCA). Lithium-ion battery anodes (Intercalation- graphite, LTO; conversion-  $\text{Fe}_3\text{O}_4$ ,  $\text{SnO}_2$ ; alloying- Sn, Sb). Lithium-ion battery electrolytes (1 M  $\text{LiPF}_6$ / 1M  $\text{LiBF}_4$  in organic carbonate solvents, ionic liquid electrolytes, polymer electrolytes, solid electrolytes).

Performance parameters: (C-rate, galvanostatic cycling stability (capacity retention), energy density, power density. Design aspects (electrode preparation, thickness of the electrode, electrode material crystal structure and the influence on electrochemical performance, cell stacking). Safety aspects: BMS, thermal runaway, gas evolution.

Recycling and refurbishing: of lithium metal and other expensive transition metals.

**UNIT II      FUTURISTIC ENERGY STORAGE SYSTEMS      9**

Working Principle: sodium-ion battery, Multivalent-ion batteries (Calcium-ion, Mg-ion, Al-ion), lithium-sulfur battery, metal-air battery. -Cell Components (cathode, anode, electrolyte and examples): sodium-ion battery, Multivalent-ion batteries (Calcium-ion, Mg-ion, Al-ion), lithium-sulfur battery, metal-air battery- Advantages and Limitations in comparison with Lithium-ion batteries- Technology development (state-of-the-art)

**UNIT III      REDOX FLOW BATTERY      9**

Properties of redox flow batteries. Merits and demerits in commercial application, design and development of flow battery, international status of flow batteries, coupling the flow batteries with solar power systems. Flow management for various electrode design merits and demerits. Solar power integrated flow batteries and requirements.

**UNIT IV      SOLID STATE AND 3D PRINTABLE BATTERIES      9**

Micro battery systems and macro battery design using 3D printing, material usage in 3D printing and properties of material in 3D printable batteries. properties of material selection and design. Design and commercial requirement related to different type of application. Industrial requirement for bulk production of solid state batteries.

**UNIT V      SUPERCAPACITORS      9**

Electrochemical double layer capacitors, pseudocapacitor and hybrid capacitors. Electrode materials for supercapacitors, design and fabrication. Carbon Materials in Supercapacitor: Activated Carbon, Mesoporous Carbon, Carbide-derived Carbon. Factors Influencing the Capacitance, Energy density and power density. Hybrid devices: advantages, working principle and applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Understand the principle of lithium-ion energy storage systems
- Acquire knowledge on futuristic energy storage systems
- Understand Properties of redox flow batteries
- Acquire knowledge on solid state and 3d printable batteries
- Acquire knowledge on various supercapacitors

**TEXT BOOKS**

1. "Understanding Batteries" by R. M. Dell and D. A. J. Rand, edition 2001, RSC
2. "Hand Books of Batteries" by David Linden and Thomas B. Reddy, 3rd Edition.
3. B.E. Conway, "Electrochemical Supercapacitors: Scientific fundamentals and Technological Applications" Kluwer Academic / Plenum publishers, New York, 1999.
4. Doran Aurbach, "Non Aqueous electrochemistry" - Marcel Dekker, Inc., New York 1999

**REFERENCES**

1. Gholam Abbas Nazri, "Lithium Batteries - Science and Technology", Elsevier, Amsterdam, 2011.
2. D. Bernt, Maintenance free batteries, Third Edition, Overseas Press India (P) Ltd, India.

### CO-PO & PSO MAPPING

Course Outcomes	Program Outcomes															
	Statements	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	P O7	PO 8	P O 9	P O1 0	PO 11	P O1 2	PS O1	P S O 2	P S O 3
<b>CO1</b>	Understand the principle of lithium-ion energy storage systems	3	2	2	1	1	1	1	-	-	-	-	1	2	2	1
<b>CO2</b>	Acquire knowledge on futuristic energy storage systems	3	2	2	1	1	1	1	-	-	-	-	1	2	2	1
<b>CO3</b>	Understand Properties of redox flow batteries	3	2	2	1	1	1	1	-	-	-	-	1	2	2	1
<b>CO4</b>	Acquire knowledge on solid state and 3d printable batteries	3	2	2	1	1	1	1	-	-	-	-	1	2	2	1
<b>CO5</b>	Acquire knowledge on various supercapacitors	3	2	2	1	1	1	1	-	-	-	-	1	2	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

To enable the students

- To differentiate between the electroplating and anodizing process and
- To compare the various engineering aspects and electroplating process.

**UNIT I ELECTROPLATING OF METALS 9**

Fundamental principles – Faradays laws, mechanism of deposition, surface preparation for electroplating, electroplating of copper, nickel, chromium, zinc, tin and precious metals (gold and silver)

**UNIT II EVALUATION & TESTING 9**

Measurements of pH, specific gravity, surface tension, conductivity, throwing power and current efficiency of electroplating electrolytes. Testing of Electro deposits for thickness, adhesion, stress, corrosion, porosity, hardness, ductility and solderability. The use of Hull-cell in plating.

**UNIT III ELECTROPLATING OF ALLOYS AND OTHER PLATING METHODS 9**

Principles of alloy deposition, barrel finishing and plating, electroforming of copper and nickel, electroless deposition of copper and nickel, brush plating, continuous plating, PCB plating.

**UNIT IV ENGINEERING ASPECTS 9**

Equipment selection, rectifier, pre-treatment equipment-mechanical - chemical, automation, flooring, materials for tanks and linings, ventilation, bus bar, filtration and purification, agitation, heating and cooling arrangement for electrolytes.

**UNIT V ANODIZING 9**

Anodizing of aluminium, principles, pre-treatment, jigging. Sulphuric acid process, operating conditions for decorative and protective anodizing, effect of impurities, analysis for free acid and aluminium content, chromic acid process, operating conditions, effect of impurities, coloring of anodized aluminium with organic dyes. Sealing in hot water and dichromate solution. Testing of anodic film thickness by Eddy current method and stripping method, coating weight – coating ratio.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Understand the fundamental principles of electroplating of metals
- Understand evaluation & testing of electroplating process
- Understand electroplating of alloys and other plating methods
- Acquire knowledge on engineering aspects of electroplating techniques
- Acquire knowledge on anodizing concepts

**TEXT BOOKS:**

1. F.A.Lowenheim, "Modern Electroplating", John Wiley and Sons INC. USA, 3<sup>rd</sup> Edition, 1974.
2. N.V.Parthasarathy, "Practical Electroplating Handbook", Prentice Hall Inc., 1989

**REFERENCES:**

1. L.J.Durney, "Electroplating Engineering Handbook", V Edition, Van Nostrand Reinhold, New York, 1984.
2. V.F. Henley, "Anodic Oxidation of Metals", Pergamon, 1<sup>st</sup> edition, 1982

**COURSE ARTICULATION MATRIX**

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	P 07	PO 8	P O 9	P O1 0	PO 11	P O1 2	PS O1	P S O 2	P S O 3
<b>CO1</b>	Understand the fundamental principles of electroplating of metals	3	2	2	1	1	-	1	-	-	-	-	1	2	2	1
<b>CO2</b>	Understand evaluation & testing of electroplating process	3	2	2	1	1	-	1	-	-	-	-	1	2	2	1
<b>CO3</b>	Understand electroplating of alloys and other plating methods	3	2	2	1	1	-	1	-	-	-	-	1	2	2	1
<b>CO4</b>	Acquire knowledge on engineering aspects of electroplating techniques	3	2	2	1	1	-	1	-	-	-	-	1	2	2	1
<b>CO5</b>	Acquire knowledge on anodizing concepts	3	2	2	1	1	-	1	-	-	-	-	1	2	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

<b>EL3006</b>	<b>CATHODIC PROTECTION AND ELECTROPHORETIC COATINGS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE:**

- To familiarize the students with the basics of cathodic protection and electrophoretic coatings.

**UNIT I BASICS OF CATHODIC PROTECTION 9**

Basics of cathodic protection. Electrical basis of cathodic protection. Electrochemical theory of cathodic protection. Definition of cathodic protection using Evans diagram and Pourbiac diagram, derivation of protective potential for steel. Protective potentials for different methods.

**UNIT II SACRIFICIAL ANODE SYSTEM & IMPRESSED CURRENT SYSTEM 9**

Cathodic protection system, components of galvanic systems, galvanic anodes, fields of application and backfills for sacrificial anodes. Advantages and disadvantages of sacrificial anode system. Impressed current system, impressed current anodes, fields of application and backfills for impressed current anodes.

**UNIT III DESIGNING OF CP SYSTEM 9**

Design parameters in cathodic protection, soil resistivity measurement, pipe to soil potential data, pH determination, redox potential measurement, coating resistance, stray current measurement and cathodic protection interferences designing of sacrificial anode system - designing of impressed current system - designing of cathodic protection to ship hull

**UNIT IV BASIC CONCEPTS OF ELECTROPHORETIC COATINGS 9**

Electrical Constitution of Aqueous Solutions, Dispersions and Suspensions of Paint Binders- Electrokinetic Effects-Electrochemical Parameters of Colloid Particles- Electro-osmosis- Voltage and current Relations in Electro-painting-Throwing power & other factors in Electro-painting- Pretreatment for Electro-painting-Synthetic resins used for Electro-painting.

**UNIT V APPLIED ASPECTS OF ELECTROPHORETIC COATINGS 9**

Installations for Electro-painting- Paint bath stability, Control, & Replenishment-Testing of paint bath-Effluent treatment-Process involved in Electro-painting installations-Economics.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Understand the basics of cathodic protection
- Understand sacrificial anode system & impressed current system
- Understand designing of cp system  
electroplating of alloys and other plating methods
- Acquire knowledge on basic concepts of electrophoretic coatings
- Apply aspects of electrophoretic coatings

**TEXT BOOKS:**

- Zaki Ahmad, "Principles of Corrosion Engineering and Corrosion Control", Butterworth - Heinemann, London, 2006.
- Willibald Machu, "Hand book of Electro Painting Technology" Electrochemical Publications Limited, 1978.

**REFERENCE:**

- Peabody A.N and Blanchetti R.L. , "Control of Pipeline Corrosion", NACE Int., Texas, 2001.



### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	Understand the basics of cathodic protection	3	2	3	1	1	-	1	-	-	-	-	2	3	2	1
<b>CO2</b>	Understand sacrificial anode system & impressed current system	3	2	3	1	1	-	1	-	-	-	-	2	3	2	1
<b>CO3</b>	Understand designing of cp system electroplating of alloys and other plating methods	3	2	3	1	1	-	1	-	-	-	-	2	3	2	1
<b>CO4</b>	Acquire knowledge on basic concepts of electrophoretic coatings	3	2	3	1	1	-	1	-	-	-	-	2	3	2	1
<b>CO5</b>	Apply aspects of electrophoretic coatings	3	2	3	1	1	-	1	-	-	-	-	2	3	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVE:**

- This course aims to provide the basics of hydrometallurgy and electrometallurgy techniques that are used in the processing of minerals

**UNIT I INTRODUCTION 9**

Metallurgical industries in India with special reference to electrometallurgical industries. Preparation of cell feed for copper, zinc, aluminium, magnesium and electrolytic cells. Principles of solvent extraction/ ion exchange for the recovery of metallic values. Pollution and control measures adopted/recommended in electrometallurgical Industries like Al, Cr.

**UNIT II ELECTROCHEMICAL PRINCIPLES 9**

Cell voltage and its components- types of anodes and cathodes-necessity of diaphragms. Physicochemical properties of molten & aqueous electrolytes like conductivity, decomposition potential, density etc. Current and energy efficiency- features of aqueous and molten salt electrolysis distinction between electro winning and refining. Anode effect.

**UNIT III AQUEOUS SYSTEM 9**

Electro winning of zinc, copper and nickel. Operating conditions for electro winning of copper and Nickel. Electro refining of silver, lead and copper- periodic current reversal technique. Electrolytic metal powders-principles, preparation and characterization. Secondary recovery of metals-Importance and approaches with examples of lead and silver.

**UNIT IV MOLTEN SALT ELECTROLYSIS 9**

Hall-Heroult cell for electrowinning of Aluminium-composition and structure of cryolite electrolyte, Brief discussion on (anodes and) cathode pot construction, and reactions. Start up and operation of Cell- anode effect. Koope's three layer process. Dow, I.G. and other types cells for production of Magnesium. Interference of impurities like moisture and sludge formation. Electrowinning of sodium, calcium, misch metal and titanium. Operating data for production of lithium and zirconium.-refining of titanium.

**UNIT V THERMICS 9**

Modes of electrical heating. Design criteria of arc furnaces. Description of furnaces used and the process for production of calcium carbide. Calcium silicide, Calcium cyanamide, fused alumina, ferroalloys, phosphorous, graphite and Silicon carbide.

**TOTAL: 45 PERIODS****OUTCOME:**

- Understand the basics electrometallurgy techniques
- Understand electrochemical principles
- Understand concepts of electro winning and electro refining
- Acquire knowledge on molten salt electrolysis
- Acquire knowledge on different modes of electrical heating.

**TEXT BOOKS:**

1. K. I. Popov, S. S. Djokic and B. N. Grgur. "Fundamentals of Electrometallurgy", Kluwer Academic Publishing, 2002
2. H.S. Ray, Sridar and K.P. Abraham, "Extraction of Non-ferrous metals", Affiliated East-West press, New Delhi, 1985.

**REFERENCES:**

1. Grjotheim K and Welch B.J., "Aluminium Smelter Technology", Aluminium Verlag, 1982.
2. Strelets Kh.L., "Electrolytic Production of Magnesium", Israel Program of Scientific Translation 1977.

## 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 13	PO 14	PO 15
CO1	Understand the basics electrometallurgy techniques	3	1	2	1	1	-	1	-	-	-	-	2	3	2	1
CO2	Understand electrochemical principles	3	1	2	1	1	-	1	-	-	-	-	2	3	2	1
CO3	Understand concepts of electro winning and <b>electro</b> refining	3	1	2	1	1	-	1	-	-	-	-	2	3	2	1
CO4	Acquire knowledge on molten salt electrolysis	3	1	-	1	1	-	1	-	-	-	-	2	3	2	1
CO5	Acquire knowledge on different modes of electrical heating.	3	1	-	1	1	-	1	-	-	-	-	2	3	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**EL3008**

**ELECTROCHEMICAL MATERIALS SCIENCE**

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

**OBJECTIVE:**

- This course will give an introduction to basic electrochemistry, principles of electrochemical devices, electroactive materials used in such devices, and case studies of batteries and sensors.

**UNIT I THIN FILMS: PHYSICAL METHODS OF PREPARATION 9**

Thin films-preparation-vacuum pumps-measurement of vacuum-gauges-physical methods-thermal evaporation-electron beam evaporation-sputtering mechanism and methods-ion plating—laser ablation -Epitaxy-Molecular Beam Epitaxy-Hot Wall Epitaxy-Liquid Phase Epitaxy-Atomic layer deposition-Plasma spray

**UNIT II THIN FILMS: CHEMICAL METHODS OF PREPARATION 9**

Chemical methods-chemical vapor deposition-MOCVD-PECVD--etching process-dry and wet etching-micro contact printing-electrodeposition- templated synthesis- electroless-spray pyrolysis-spin coating-Langmuir Blodgett films-sol-gel synthesis-self assembled monolayers-hydrothermal-screen printing

**UNIT III PROPERTIES OF THIN FILMS 9**

Thickness measurements-multiple beam interference-quartz crystal-ellipsometric-stylus techniques-optical-reflection-absorbance-transmittance-band gap measurement- electrical (hot probe and four probe techniques) and dielectric behavior of thin films-mechanical properties-testing methods-adhesion-surface and tribological coatings-electrochemical characterization-potentiodynamic polarization-electrochemical impedance spectroscopy

**UNIT IV ADVANCED FUNCTIONAL MATERIALS 9**

Thin film metallic glasses-preparation-properties and applications- smart materials-piezoelectric materials-thermoelectric materials-self-cleaning materials-chromogenic materials-solar cells-single crystalline silicon solar cells- amorphous silicon solar cells- thin film polycrystalline solar cells-photoelectrochemical cells- Dye-sensitized solar cells - pervoskite solar cells- supercapacitors.

**UNIT V BIOMATERIALS****9**

Biomaterials-introduction-different generation of biomaterials-general characteristics-examples and uses-naturally occurring biomaterials-pure metals-alloys-ceramics-polymer-composites-bioactive and biodegradable ceramics-biodegradable polymers-hydrogels-orthopaedic materials-bone composition and properties-biomaterials used in bone and joint replacement-dental materials-biomaterials in ophthalmology-intracocular lens materials-tissue grafts-skin grafts-suture materials-drug delivery: methods and materials

**TOTAL: 45 PERIODS****OUTCOME:**

- Understand the physical methods of preparation of thin films
- Understand the chemical methods of preparation of thin films
- Acquire knowledge on properties of thin films
- Acquire knowledge on thin film metallic glasses-preparation-properties and applications molten salt electrolysis
- General characteristics of Biomaterials

**TEXT BOOKS:**

1. K.L. Chopra and S.R. Das, Thin Film Solar Cells, Plenum NewYork, 1983.
2. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London, 1983.
3. J. Kilner, S. Skinner, S. Irvine, P. Edwards, Functional Materials for Sustainable Energy Applications, Woodhead Publishing Ltd., London, 2012.
4. D.F. Williams, Materials Science and Technology: A comprehensive treatment, Vol 14, Medical and Dental materials, VCH Publishers Inc, New York, 1992.
5. A.J. Bard and L.R. Faulkner, Electrochemical methods: fundamentals and applications, John Wiley and Sons, 2006.

**REFERENCES:**

1. Vijayamohan K. Pillai and Meera Parthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).
2. Milton Ohring, The Materials of Thin Films, Academic press, 2001.
3. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**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 13	PO 14	PO 15
CO1	Understand the physical methods of preparation of thin films	2	1	2	1	1	-	1	-	-	-	-	2	3	2	1
CO2	Understand the chemical methods of preparation of thin films	2	1	2	1	1	-	1	-	-	-	-	2	3	2	1
CO3	Acquire knowledge on properties of thin films	2	1	2	1	1	-	1	-	-	-	-	2	3	2	1
CO4	Acquire knowledge on thin film metallic glasses-preparation-properties and applications molten salt electrolysis	2	1	-	1	1	-	1	-	-	-	-	2	3	2	1
CO5	General characteristics of Biomaterials	2	1	-	1	1	-	-	-	-	-	-	-	3	2	1
<b>OVERALL CO</b>		<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVE:**

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

**UNIT I INTRODUCTION****9**

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.

**UNIT II METEOROLOGY****9**

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

**UNIT III CONTROL OF PARTICULATE CONTAMINANTS****9**

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

**UNIT IV CONTROL OF GASEOUS CONTAMINANTS****9**

Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

**UNIT V INDOOR AIR QUALITY MANAGEMENT****9**

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

**TOTAL: 45 PERIODS****OUTCOMES:**

The students completing the course will have

- Understand the structure and composition of atmosphere
- Understand the effects of meteorology on air pollution
- Understand the factors affecting selection of particulate control equipment
- Understand the factors affecting selection of gaseous control equipment
- Acquire knowledge on sources, types and control of indoor air pollutants

**TEXTBOOKS:**

- Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science + science media LLC,2004.
- Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
- Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.

**REFERENCES:**

- David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000

### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Understand the structure and composition of atmosphere	2	2	-	1	1	3	3	-	1	-	-	2	3	2	1
CO2	Understand the effects of meteorology on air pollution	2	2	2	1	1	3	3	-	1	-	-	2	3	2	1
CO3	Understand the factors affecting selection of particulate control equipment	2	2	2	1	1	3	3	-	1	-	-	2	3	2	1
CO4	Understand the factors affecting selection of gaseous control equipment	2	2	2	1	1	3	3	-	1	-	-	2	3	2	1
CO5	Acquire knowledge on sources, types and control of indoor air pollutants	2	2	3	1	1	3	3	-	1	-	-	2	3	2	1
<b>OVERALL CO</b>		2	2	2	1	1	3	3	-	1	-	-	2	3	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**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: Understand and analyze the energy data of industries

CO2: Carryout energy accounting and balancing

CO3: Understand the principles in thermal systems

CO4: Conduct energy audit and suggest methodologies for energy savings

CO5: Utilize the available resources in optimal ways

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://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.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

## 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 13	PO 14	PO 15
CO1	Understand and analyze the energy data of industries	2	2	1	1	1	-	3	1	1	-	-	2	3	2	1
CO2	Carryout energy accounting and balancing	2	2	-	1	1	-	3	1	1	-	-	2	3	2	1
CO3	Understand the principles in thermal systems	2	2	1	1	1	-	3	1	1	-	-	2	3	2	1
CO4	Conduct energy audit and suggest methodologies for energy savings	2	2	1	1	1	-	3	1	1	-	-	2	3	2	1
CO5	Utilize the available resources in optimal ways	2	2	1	1	1	-	3	1	1	-	-	2	3	2	1
<b>OVERALL CO</b>		<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**EL3010**

**DESIGN OF EXPERIMENTS**

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

**OBJECTIVE:**

- To impart knowledge on various types of experimental designs conduct of experiments and data analysis techniques.

**UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS**

**9**

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testing using Analysis of variance.

**UNIT II SINGLE FACTOR EXPERIMENTS**

**9**

Completely Randomized Design- effect of coding the observations- model adequacy checking- estimation of model parameters, residuals analysis- treatment comparison methods-Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design –Applications.

**UNIT III FACTORIAL DESIGNS**

**9**

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- 2 K Design with two and three factors- Yate's Algorithm- fitting regression model- Randomized Block Factorial Design - Practical applications.

**UNIT IV SPECIAL EXPERIMENTAL DESIGN**

**9**

Blocking and Confounding in 2K Designs- blocking in replicated design- 2 K Factorial Design in two blocks- Complete and partial confounding- Confounding 2K Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of 2K Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of 2K Design



**UNIT V TAGUCHI METHODS****9**

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments- Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design.

**TOTAL: 45 PERIODS****OUTCOME:**

- Understand the fundamentals of experimental designs
- Understand the concept of single factor experiments
- Understand the concept of factorial designs
- Acquire knowledge on various data analysis techniques
- Acquire knowledge on Taguchi methods

**TEXT BOOK:**

1. Krishnaiah K, and Shahabudeen P, "Applied Design of Experiments and Taguchi Methods", PHI, India, 2011.

**REFERENCES:**

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley & sons, 2005
2. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005.

**COURSE ARTICULATION MATRIX**

Course Outcomes	Program Outcomes															
	Statements	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 13	PO 14	PO 15
CO1	Understand the fundamentals of experimental designs	3	2	-	-	-	1	-	-	1	-	1	2	3	2	1
CO2	Understand the concept of single factor experiments	3	2	2	2	2	1	-	-	1	-	1	2	3	2	1
CO3	Understand the concept of factorial designs	3	2	2	2	2	1	-	-	1	-	1	2	3	2	1
CO4	Acquire knowledge on various data analysis techniques	3	2	2	2	2	1	-	-	1	-	1	2	3	2	1
CO5	Acquire knowledge on Taguchi methods	3	2	2	2	2	1	-	-	1	-	1	2	3	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**EL3011****INDUSTRIAL SAFETY IN CHEMICAL INDUSTRIES****LT PC  
3 0 0 3****OBJECTIVES:**

- To impart knowledge on safety engineering fundamentals and safety management practices.

**UNIT I INTRODUCTION****9**

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

**UNIT II CHEMICAL HAZARDS****9**

Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation – Industrial Hygiene – Industrial Toxicology.

**UNIT III ENVIRONMENTAL CONTROL****9**

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

**UNIT IV HAZARD ANALYSIS****9**

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment

**UNIT V SAFETY REGULATIONS****9**

Explosions – Disaster management – catastrophe control, hazard control, Safety education and training - Factories Act, Safety regulations Product safety – case studies.

**TOTAL: 45 PERIODS****OUTCOMES:**

- Understand modern safety concepts to prevent chemical, environmental mechanical, fire hazards
- Identify and apply proper safety techniques for chemical hazard
- Understand industrial health hazards and environmental control
- Acquire knowledge on hazard analysis techniques
- Acquire knowledge on safety Management practices

**TEXT BOOK:**

1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003.

**REFERENCES:**

1. Safety Manual, "EDEL Engineering Consultancy", 2000.
2. David L.Goetsch, "Occupational Safety and Health for Technologists", 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.

**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 13	PO 14	PO 15
CO1	Understand modern safety concepts to prevent chemical, environmental mechanical, fire hazards	1	3	1	2	1	-	3	1	1	-	1	2	3	2	1
CO2	Identify and apply proper safety techniques for chemical hazard	1	3	2	2	1	-	3	1	1	-	1	2	3	2	1
CO3	Understand industrial health hazards and environmental control	1	3	-	2	1	-	3	1	1	-	1	2	3	2	1
CO4	Acquire knowledge on hazard analysis techniques	1	3	-	2	1	-	3	1	1	-	1	2	3	2	1
CO5	Acquire knowledge on safety Management practices	1	3	-	2	1	-	3	1	1	-	1	2	3	2	1
<b>OVERALL CO</b>		1	3	1.5	2	1	-	3	1	1	-	1	2	3	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES:**

The subject exposes students to the basic parameter for selection of materials and different classes of materials, manufacturing processes and their properties, applications of materials.

**UNIT I ENGINEERING MATERIALS****9**

Introduction – classification of engineering materials – selection of materials for engineering purposes –selection of materials and shape –classification metal and alloys, polymers, ceramics and glasses, composites, natural materials,-non metallic materials- smart materials - physical, metrical properties of metals

**UNIT II MATERIAL PROPERTIES****9**

Mechanical properties – fatigue strength – fracture Toughness - Thermal Properties – Magnetic Properties - Fabrication Properties –electrical , optical properties - Environmental Properties , Corrosion properties –shape and size - Material Cost and Availability– failure analysis

**UNIT III MANUFACTURING PROCESSING AND ECONOMIC ANALYSIS****9**

Interaction of Materials Selection, Design, and Manufacturing Processes - Production Processes and Equipment for Metals - Metal Forming, Shaping, and Casting - Plastic Parts Processing - Composites Fabrication Processes - Advanced Ceramics Processing – surface treatment - Resource -The Price and Availability of Materials

**UNIT IV MATERIALS SELECTION CHARTS AND TESTING****9**

Ashby material selection charts-Testing of Metallic Materials - Plastics Testing – Characterization and Identification of Plastics - Professional and Testing Organizations - Ceramics Testing - Nondestructive Inspection.

**UNIT V APPLICATIONS AND USES****9**

Selection of Materials for Biomedical Applications - Medical Products - Materials in Electronic Packaging - Advanced Materials in Sports Equipment - Materials Selection for Wear Resistance - Advanced Materials in Telecommunications - Using Composites - Manufacture and Assembly with Plastics, fiber and Diamond Films.

**TOTAL: 45 PERIODS****OUTCOMES:**

- Understand the basic parameters for different classes of materials and selection of materials
- Ability to identify the material properties
- Understand manufacturing processing and economic analysis
- Acquire knowledge on materials selection charts and testing
- Acquire knowledge on applications of materials

**TEXT BOOKS:**

1. Ashby, M. F. Materials selection in mechanical design, 3rd edition. Elsevier, 2005.
2. Ashby, M. F. and Johnson, K. Materials and design – the art and science of material selection in product design. Elsevier, 2002.

## 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 13	PO 14	PO 15
CO1	Understand the basics parameters for different classes of materials and selection of materials	2	1	-	-	1	1	-	-	-	-	1	2	3	2	1
CO2	Ability to identify the material properties	2	1	1	1	-	1	-	-	-	-	1	2	3	2	1
CO3	Understand manufacturing processing and economic analysis	2	1	1	1	1	1	-	-	-	-	1	2	3	2	1
CO4	Acquire knowledge on materials selection charts and testing	2	1	1	1	1	1	-	-	-	-	1	2	3	2	1
CO5	Acquire knowledge on applications of materials	2	1	1	1	1	1	-	-	-	-	1	2	3	2	1
<b>OVERALL CO</b>		<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**EL3013**

### TESTING OF MATERIALS

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

**OBJECTIVE:**

- To understand the various destructive and non-destructive testing methods of materials and its industrial applications.

**UNIT I INTRODUCTION TO MATERIALS TESTING**

**9**

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

**UNIT II MECHANICAL TESTING**

**9**

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.

**UNIT III NON DESTRUCTIVE TESTING**

**9**

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

**UNIT IV MATERIAL CHARACTERIZATION TESTING**

**9**

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

**UNIT V OTHER TESTING****9**

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo-mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

**TOTAL: 45 PERIODS****OUTCOMES:**

- Understand the Classification of material testing, Purpose of testing
- Understand the various destructive testing methods
- Understand the various non-destructive testing methods
- Acquire knowledge on material characterization testing
- Identify suitable testing technique to inspect industrial component

**TEXT BOOKS:**

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., New York, 2000. 3. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2007.

**REFERENCES:**

1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.

**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 13	PO 14	PO 15
CO1	Understand the Classification of material testing, Purpose of testing	2	2	-	-	3	1	-	-	-	-	1	2	3	2	1
CO2	Understand the various destructive testing methods	2	2	1	1	3	1	-	-	-	-	1	2	3	2	1
CO3	Understand the various non-destructive testing methods	2	2	1	1	3	1	-	-	-	-	1	2	3	2	1
CO4	Acquire knowledge on material characterization testing	2	2	1	1	3	1	-	-	-	-	1	2	3	2	1
CO5	Identify suitable testing technique to inspect industrial component	2	2	1	1	3	1	-	-	-	-	1	2	3	2	1
<b>OVERALL CO</b>		<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES:**

- To get exposure on solar radiation and its environmental impact to power.
- To know about the various collectors used for storing solar energy.
- To know about the various applications in solar energy.
- To learn about the wind energy and biomass and its economic aspects.
- To know about geothermal energy with other energy sources.

**UNIT I PRINCIPLES OF SOLAR RADIATION 9**

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data.

**UNIT II SOLAR ENERGY COLLECTION 9**

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

**UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS 9**

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

**UNIT IV WIND ENERGY 9**

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

**UNIT V GEOTHERMAL ENERGY 9**

Resources, types of wells, methods of harnessing the energy, potential in India. OCEANENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, and principles of DEC.

**TOTAL: 45 PERIODS****OUTCOMES:**

- Gain exposure on solar radiation and its environmental impact to power
- Ability to classify the solar energy collectors and methodologies of storing solar energy
- Gain Knowledge in applying solar energy in a useful way
- Acquire knowledge on the wind energy and biomass and its economic aspects.
- Acquire knowledge on geothermal energy and other energy sources

**TEXT BOOKS:**

1. Rai G.D. , "Non-Conventional Energy Sources", Khanna Publishers, 2011
2. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011

**REFERENCES:**

1. Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing House, 2007
2. Ramesh R & Kumar K.U , "Renewable Energy Technologies", Narosa Publishing House, 2004
3. Mittal K M , "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003
4. Kothari D.P, Singhal ., K.C., "Renewable energy sources and emerging technologies", P.H.I, New Delhi, 2010

### COURSE ARTICULATION MATRIX

Course Outcome s	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	P O 9	PO 10	PO 11	PO 12	PS O1	P S O 2	P S O 3
<b>CO1</b>	Gain exposure on solar radiation and its environmental impact to power	2	2	1	1	1	-	2	1	1	-	-	2	3	2	1
<b>CO2</b>	Ability to classify the solar energy collectors and methodologies of storing solar energy	2	2	1	1	1	-	-	1	1	-	-	2	3	2	1
<b>CO3</b>	Gain Knowledge in applying solar energy in a useful way	2	2	1	1	1	-	2	1	1	-	-	2	3	2	1
<b>CO4</b>	Acquire knowledge on the wind energy and biomass and its economic aspects.	2	2	1	1	1	-	2	1	1	-	-	2	3	2	1
<b>CO5</b>	Acquire knowledge on geothermal energy and other energy sources	2	2	1	1	1	-	2	1	1	-	-	2	-	2	1
<b>OVERALL CO</b>		2	2	1	1	1	-	2	1	1	-	-	2	3	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**OBJECTIVES:**

- To introduce the components and their representation of control systems
- To learn various methods for analyzing the time response, frequency response and stability of the systems.
- To learn the various approach for the state variable analysis.

**UNIT I            SYSTEMS COMPONENTS AND THEIR REPRESENTATION            9**

Control System: Terminology and Basic Structure-Feed forward and Feedback control theory- Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and ACservo Systems-Synchros -Multivariable control system

**UNIT II            TIME REPOSE ANALYSIS            9**

Transient response-steady state response-Measures of performance of the standard first order andsecond order system-effect on an additional zero and an additional pole-steady error constant andsystem- type number-PID control-Analytical design for PD,PI,PID control systems

**UNIT III            FREQUENCY RESPONSE AND SYSTEM ANALYSIS            9**

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots-Design of compensators using Bodeplots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation

**UNIT IV            CONCEPTS OF STABILITY ANALYSIS            9**

Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability- Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

**UNIT V            CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS            9**

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability andObservability-Stability of linear systems-Equivalence between transfer function and state variablerepresentations-State variable analysis of digital control system-Digital control design using statefeedback.

**TOTAL: 45 PERIODS****OUTCOMES:**

- Identify the various control system components and their representations.
- Analyze the various time domain parameters
- Analyze the various frequency response plots and its system
- Apply the concepts of various system stability criterions
- Design various transfer functions of digital control system using state variable models

**TEXT BOOK:**

1. M.Gopal, "Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012.

**REFERENCES**

1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5 the Edition, 2007.
2. K. Ogata, 'Modern Control Engineering', 5th edition, PHI, 2012.
3. S.K.Bhattacharya, Control System Engineering, 3rd Edition, Pearson, 2013.
4. Benjamin.C.Kuo, "Automatic control systems", Prentice Hall of India, 7th Edition,1995.



### COURSE ARTICULATION MATRIX

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	Identify the various control system components and their representations.	3	3	3	2	1	-	-	-	1	-	-	2	3	2	1
<b>CO2</b>	Analyze the various time domain parameters	3	3	3	2	1	-	-	-	1	-	-	2	3	2	1
<b>CO3</b>	Analyze the various frequency response plots and its system	3	3	3	2	1	-	-	-	1	-	-	2	3	2	1
<b>CO4</b>	Apply the concepts of various system stability criterions	3	3	3	2	1	-	-	-	1	-	-	2	3	2	1
<b>CO5</b>	Design various transfer functions of digital control system using state variable models	3	3	3	2	1	-	-	-	1	-	-	2	3	2	1
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

## 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**

**MX3082**

**ELEMENTS OF LITERATURE**

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

### **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**

- a) Enhances Reading, thinking, discussing and writing skills.
- b) Develops finer sensibility for better human relationship.
- c) Increases understanding of the problem of humanity without bias.
- d) Providing space to reconcile and get a cathartic effect.

#### **2. Elements of fiction**

- a) Fiction, fact and literary truth.
- b) Fictional modes and patterns.
- c) Plot character and perspective.

### **3. Elements of poetry**

- a) Emotions and imaginations.
- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

### **4. Elements of drama**

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) 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 Unv 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.

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; Auteurs
- 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.

PROGRESS THROUGH KNOWLEDGE

### 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
<b>AVG</b>	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

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

### 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%20cook.>
  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.tkdl.res.in/tkdl/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdl.res.in/tkdl/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 1<sup>st</sup> 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.
- viii.

**TOTAL : 45 PERIODS**

PROGRESS THROUGH KNOWLEDGE

**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 LimitValue (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**

## **COURSE 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 ARTICULATION MATRIX

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
<b>Industrial safety</b>		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3

PROGRESS THROUGH KNOWLEDGE

## 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 : 60 PERIODS**

## 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 Intelligencell, 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](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**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**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 : 60 PERIODS**

## 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 :60 PERIODS****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	
<b>1</b>	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2	
<b>2</b>	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2	
<b>3</b>	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2	
<b>4</b>	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2	
<b>5</b>	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3	
<b>AVg.</b>	<b>3.00</b>	<b>2.60</b>	<b>2.40</b>	<b>2.00</b>	<b>3.00</b>	-	-	-	<b>2.80</b>	<b>2.20</b>	<b>1.80</b>	<b>2.60</b>	<b>2.80</b>	<b>1.80</b>	<b>2.20</b>	

### 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/>

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.

**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., and Tzortzopoulos, 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.

**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 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	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)

1-low, 2-medium, 3-high, ‘-’- no correlation

**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.ideou.com/pages/design-thinking#process>
2. [https://blog.forgefor ward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86\\_24](https://blog.forgefor ward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86_24)
3. <https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356>
4. <https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e>
5. <https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd>
6. <https://blog.forgefor ward.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, Emper, 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 MAPPING

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
<b>Avg.</b>	1	1	2	1		3	2					2		1	3

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

**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, &quot; Introduction to Aeronautics: A design perspective &quot;; American Institute of Aeronautics & amp; Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

**OIM351**

**INDUSTRIAL MANAGEMENT**

**LT P C  
3 0 0 3**

**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 GROUPODYNAMICS**

**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		
<b>AVg.</b>	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			
	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	
<b>AVg.</b>	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: 45 PERIODS****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**

1. Roytman, M. Y, "Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975
2. John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK, 2009.

**REFERENCES:**

1. 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.
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.
3. Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010.
4. Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition, 1999
4. 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	-	-	-	-

**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.

**TEXT BOOKS**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.  
Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085"
2. 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. Histan, "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.

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															

**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.

**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 2<sup>ND</sup> 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.

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

**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 Kataria & sons, 2015
2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989

**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	1	2	1	1	2	1

	approach in agriculture with proper knowledge and skill						
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

**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.

**UNITV 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.

**REFERENCES:**

- 1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7<sup>th</sup> 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", 3<sup>rd</sup> Edition, Wiley-IEEE Press, 2013.
- 4 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10<sup>th</sup> 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

	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

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 Petruzzola, 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

OFD352

TRADITIONAL INDIAN FOODS

L T P C  
3 0 0 3

### OBJECTIVE:

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

### UNIT I HISTORICAL AND CULTURAL PERSPECTIVES 9

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

### UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

### UNIT III TRADITIONAL FOOD PATTERNS 9

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

### UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

### UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS 9

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments / illnesses.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

- CO1 To understand the historical and traditional perspective of foods and food habits  
CO2 To understand the wide diversity and common features of traditional Indian foods and meal

patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor "Food Culture in India" Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353**

**INTRODUCTION TO FOOD PROCESSING**

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

**OBJECTIVE:**

• The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

CO1 Be aware of the different methods applied to processing foods.

CO2 Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice".Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**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

<b>CO – PO MAPPING</b>												
<b>IPR FOR PHARMA INDUSTRY</b>												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>C1</b>	3	3		2					2	2		
<b>C2</b>		3	3				2	2				
<b>C3</b>	3	3					2	2				1
<b>C4</b>					2		3	3		2	2	
<b>C5</b>		3					3			2		1
<b>C6</b>	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

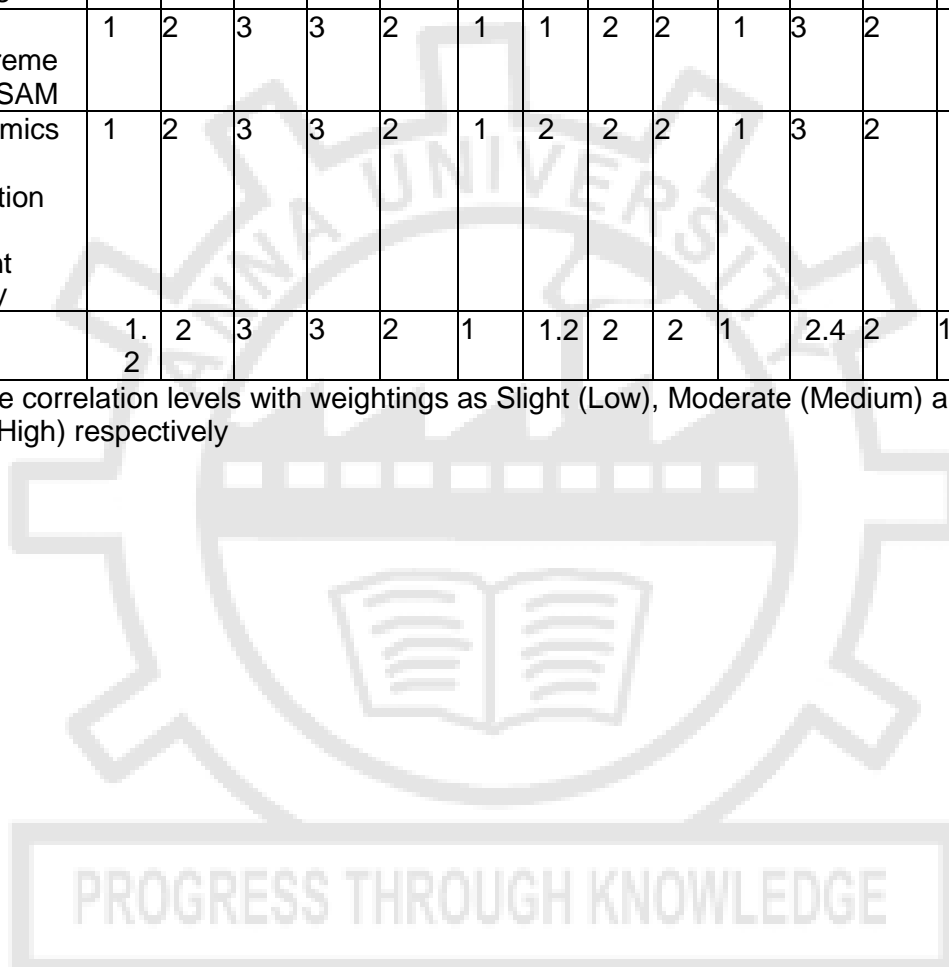
#### **REFERENCES**

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	-
<b>Overall CO</b>		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



**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 Ajaonkar. 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														
		P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	P O10	P O11	P O12	P S O1	P S O2	PS O3
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	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PROGRESS THROUGH KNOWLEDGE

**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](http://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



**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 : 45 HOURS**

## 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”, 2<sup>nd</sup> 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
<b>C</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>

**OEC352 FUNDAMENTALS Of ELECTRONIC DEVICES AND CIRCUITS L T P C 3 0 0 3**

**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

**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.															

**CBM333****ASSISTIVE TECHNOLOGY****L T P C  
3 0 0 3****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.

<b>UNIT I</b>	<b>LINEAR PROGRAMMING</b>	<b>9</b>
Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.		
<b>UNIT II</b>	<b>TRANSPORTATION AND ASSIGNMENT PROBLEMS</b>	<b>9</b>
Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .		
<b>UNIT III</b>	<b>INTEGER PROGRAMMING</b>	<b>9</b>
Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.		
<b>UNIT IV</b>	<b>DYNAMIC PROGRAMMING PROBLEMS</b>	<b>9</b>
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 .		
<b>UNIT V</b>	<b>NON - LINEAR PROGRAMMING PROBLEMS</b>	<b>9</b>
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 O1	PS O2	PS O3
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, 5<sup>th</sup> 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, 2<sup>nd</sup> 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
<b>CO1</b>	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
<b>CO2</b>	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
<b>CO3</b>	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
<b>CO4</b>	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
<b>CO5</b>	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
<b>Avg</b>	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

**OMA354****LINEAR ALGEBRA****L T P C  
3 0 0 3****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, 5<sup>th</sup> Edition, 2019.

**REFERENCES:**

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8<sup>th</sup> Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7<sup>th</sup> 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, 4<sup>th</sup> 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
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	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; 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.

**TOTAL: 45 PERIODS**

### **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.

## 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**

Physicochemical properties of cell membranes. Molecular constitution 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" 11nd Edition, Tata McGraw-Hill, 2003.

## REFERENCES:

1. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", 11rd Edition, Pearson International, 2007.
4. 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 OBJECTIVES:

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%20iwrM/Tutorial\\_text.pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrM/Tutorial_text.pdf)
4. Pramod R. Bhawe, 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
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	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 ", 1<sup>st</sup> Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.

**REFERENCES**

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> 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, 3<sup>rd</sup> Edition, 2002.

5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> 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 01	PS 02	PS 03
<b>CO1</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO2</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO4</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>CO5</b>	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
<b>Avg</b>	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<sub>k</sub>/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", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> 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 know 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”. 3<sup>rd</sup> 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**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES**

- 1 To introduce the fundamental concepts of the new product development





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 MAPPING**

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 & 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](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010****MICRO AND PRECISION ENGINEERING****LT P C  
3 0 0 3****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.

**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 INDUTANCE 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 these 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.

<b>OAS353</b>	<b>SPACE VEHICLES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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, 6<sup>th</sup> 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 OBJECTIVES:

- 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											
<b>AVg.</b>	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, 12<sup>th</sup> Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**

1. William J Stevenson, Operations Management, Tata McGraw Hill, 9<sup>th</sup> Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

**COURSE OBJECTIVES:**

1. Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
2. Compare and contrast the roles of environmental and biological monitoring in work health and safety
3. Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
4. Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
5. 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		-	-	-

**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	PSO1	PSO2	PSO3
<b>C01</b>	3	2	2	3								2	2	2	1
<b>C02</b>	3	1	2	2								2	2	2	1
<b>C03</b>	3	2	1	2								2	2	2	1
<b>CO4</b>	3	2	1	2								2	2	2	2
<b>CO5</b>	3	2	2	2								2	2	2	1
<b>Avg</b>	3	1.8	1.6	2.2								2	2	2	1.2

**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. Histan, "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 Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

9

### UNIT – II KINEMATICS

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

9

### UNIT – III PERCEPTION

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.

9

#### **UNIT – IV LOCALIZATION**

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, TeppeiTsujiata, "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.

**MV3501**

**MARINE PROPULSION**

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

#### **COOURSE 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",4<sup>th</sup> Edition,2009

**REFERENCES BOOKS:**

1. DJ Eyers and GJ Bruse, "Ship Construction", 7<sup>th</sup> Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1,5<sup>th</sup> Edition,2001.

**MAPPING OF COS AND POS:**

C O	PO												PSO			
	PO 1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
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
Av g	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

**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

**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

**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:**

<b>Mapping of COs with POs and PSOs</b>															
<b>COs/Pos&amp;P SOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
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. Završnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

**OGI352**

**GEOGRAPHIC INFORMATION SYSTEM**

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

**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

**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 AGRIBUSINESS 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 farming (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, 13<sup>th</sup> 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, 5<sup>th</sup> 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, 5<sup>th</sup> 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 Impression 2010.

	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**

**LT 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
<b>CO1</b>	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
<b>CO2</b>	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO3</b>	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO4</b>	3	3	3	3	1			1		1			1		1
<b>CO5</b>	3	3	3	3	1	1		1		1			1		1
<b>AVg.</b>	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

OFD354

**FUNDAMENTALS OF FOOD ENGINEERING****L T P C  
3 0 0 3****OBJECTIVES**

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

**UNIT I****9**

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II****9**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

**UNIT III****9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

**UNIT IV****9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

**UNIT V****9**

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

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

CO1 understand the importance of food polymers

CO2 understand the effect of various methods of processing on the structure and texture of food materials

CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

**TEXTBOOKS:**

1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

**OBJECTIVES:**

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

**UNIT I****10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II****8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III****9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV****9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V****9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

CO2 Awareness on regulatory and statutory bodies in India and the world

**REFERENCES:**

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

**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, carotenoids. 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 *In vitro* and *In vivo* 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	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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	-
<b>Overall CO</b>		-	-	-	-	-	-	-	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, 2<sup>nd</sup> 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

**OBJECTIVE:**

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

**UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING 9**

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

**UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES 9**

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

**UNIT III COMPONENTS AND TRIMS USED IN GARMENT 9**

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

**UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES 9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

**UNIT V GARMENT PRESSING, PACKING AND CARE LABELING 9**

Garment pressing – categories and equipment, packing; care labelling of apparels

**TOTAL: 45 PERIODS****OUTCOMES:**

Upon completion of the course, the students will be able to Understand

- CO1: Pattern making, marker planning, cutting  
 CO2: Types of seams, stitches and functions of needles  
 CO3: Components and trims used in garment  
 CO4: Garment inspection and dimensional changes  
 CO5: Garment pressing, packing and carelabelling

**TEXT BOOKS:**

1. Carr H., and Latham B., "The Technology of Clothing Manufacture", Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, "Introduction to Clothing Manufacture" Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.

**REFERENCES:**

1. Winifred Aldrich., "Metric Pattern Cutting", Blackwell Science Ltd., Oxford, 1994
2. Peggall H., "The Complete Dress Maker", Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., "Sewing Thread", NITRA, 1994
4. Ruth Glock, Grace I. Kunz, "Apparel Manufacturing", Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, "An Introduction to Quality Control for the Apparel Industry", J.S.N. Internationals, 1992.

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
<b>Avg</b>	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

**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, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A. Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> 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, 2<sup>nd</sup> 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, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

**OEC353****VLSI DESIGN****L T P C  
3 0 0 3****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 Eshraghian, "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

**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 JamilY.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

**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 inclinical 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", 3<sup>rd</sup> 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

- Create higher standard of knowledge on healthcare system and services
- 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



PROGRESS THROUGH KNOWLEDGE

## 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

**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 Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

**UNIT II FIXED INCOME SECURITIES 9**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.

**UNIT III APPROACHES TO EQUITY ANALYSIS 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 and activism

**TOTAL : 45 PERIODS****REFERENCES**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14<sup>TH</sup> Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5<sup>th</sup>, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. Zvi Bodie, Alex Kane, Alan J Marcus, Pitabhus Mohanty, Investments, McGraw Hill Education (India), 11 Edition (SIE), 2019

PROGRESS THROUGH KNOWLEDGE

**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 L T 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, 2<sup>nd</sup> 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****REFERENCES:**

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

**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.

**TOTAL: 45 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. Edi: 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 Technopreneurship: 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 00 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 businesses.
- 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 Development - 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 entrepreneurs.”

## 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, 5th ed, 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**



**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.

<b>CMG341</b>	<b>HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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 LT 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., 12<sup>TH</sup> 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.

PROGRESS THROUGH KNOWLEDGE  
**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

<b>CMG345</b>	<b>PUBLIC PERSONNEL ADMINISTRATION</b>	<b>L T P C</b> <b>3 0 0 3</b> (9)
<b>UNIT-I</b>		
1. Meaning, Scope and Importance of Personnel Administration		
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems		
<b>UNIT-II</b>		(9)
1. Generalist Vs Specialist		
2. Civil Servants' Relationship with Political Executive		
3. Integrity in Administration.		
<b>UNIT-III</b>		(9)
1. Recruitment: Direct Recruitment and Recruitment from Within		
2. Training: Kinds of Training		
3. Promotion		
<b>UNIT-IV</b>		(9)
1. All India Services		
2. Service Conditions		
3. State Public Service Commission		
<b>UNIT-V</b>		(9)
1. Employer Employee Relations		
2. Wage and Salary Administration		
3. Allowances and Benefits		
<b>REFERENCES:</b>		<b>TOTAL: 45 PERIODS</b>
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		
<b>CMG346</b>	<b>ADMINISTRATIVE THEORIES</b>	<b>L T P C</b> <b>3 0 0 3</b> (9)
<b>UNIT I</b>		
Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration		
<b>UNIT II</b>		(9)
Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory		
<b>UNIT III</b>		(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



## 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

Data mining, Text mining, Web mining, Data ware house.

9

### UNIT II DATA MINING PROCESS

Datamining process – KDD, CRISP-DM, SEMMA  
Prediction performance measures

9

### UNIT III PREDICTION TECHNIQUES

Data visualization, Time series – ARIMA, Winter Holts,

9

### UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES

Classification, Association, Clustering.

9

### UNIT V MACHINE LEARNING AND AI

Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

9

**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 Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. GalitShmueli, 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



**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:**

- Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
- Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
- Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
- Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management, I.K. International Publishing House Pvt. Ltd., 2016.
- Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

**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
<b>Avg.</b>	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	
<b>Avg.</b>	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-Polylactic 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<sub>2</sub>O<sub>3</sub>) -Zirconia (ZrO<sub>2</sub>)-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 SOURCES 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-O<sub>2</sub> battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodioted hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO<sub>2</sub>, LiFePO<sub>4</sub>, LiMn<sub>2</sub>O<sub>4</sub>) – 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)Se<sub>2</sub> 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 perylenetetracarboxylicbis - benzine – 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 solid 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

**CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT L T P C**  
**3 0 0 3**

**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 Ristirer 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

<b>UNIT I ENERGY AND ENVIRONMENT</b>	<b>9</b>
Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP	
<b>UNIT II ENERGY AUDITING</b>	<b>9</b>
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	
<b>UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES</b>	<b>9</b>
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	
<b>UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES</b>	<b>9</b>
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	
<b>UNIT V SUSTAINABLE DEVELOPMENT</b>	<b>9</b>
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,	
	<b>TOTAL: 45 PERIODS</b>

#### **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 (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>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.