



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

**B. E. ENVIRONMENTAL ENGINEERING**

**CHOICE BASED CREDIT SYSTEM**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :**

- I. To prepare students for successful careers in Environmental Engineering field that meets the needs of National and International organisations.
- II. To develop the confidence and ability among students to synthesize data and technical concepts and thereby apply it in real world problems.
- III. To develop students to use modern techniques, skill and mathematical engineering tools for solving problems in Environmental Engineering.
- IV. To provide students with a sound foundation in mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyse environmental problems and to prepare them for graduate studies.
- V. To promote students to work collaboratively on multi-disciplinary projects and make them engage in life-long learning process throughout their professional life.

**PROGRAM OUTCOMES (POs)**

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

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

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

12 **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.

## **PROGRAM SPECIFIC OUTCOMES (PSOs)**

Graduates of the programme B.E Environmental Engineering will be able to

**PSO1** Knowledge of Environmental Engineering discipline

Demonstrate in-depth knowledge Environmental Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge.

**PSO2** Critical analysis of Environmental Engineering problems and innovation

Critically analyze complex Environmental Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.

**PSO3** Conceptualization and evaluation of engineering solutions to Environmental Engineering Issues Conceptualize and solve Environmental Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of health, safety, and socio-cultural factors

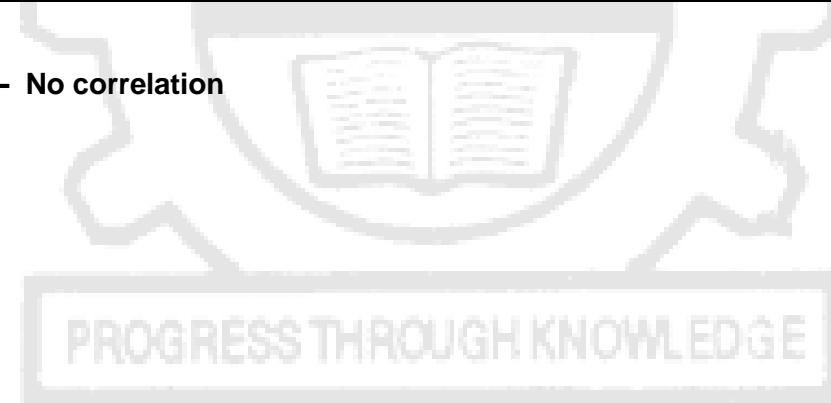
## **PEO / PO Mapping:**

## **Mapping of Course Outcomes and Programme Outcomes**

YEAR II	SEMESTER IV	Environmental Legislations	3	3	2	3	1	2	2	1	2	1	1	3	3	2	3
		Water Supply Engineering	3	3	3	3	2	3	1	3	2	3	1	3	3	3	3
		Environmental Management Systems	3	1	2	2	1	3	3	2	1	1	1	2	3	2	3
		Air and Noise Pollution Control Engineering	2	3	3	3	3	2	2	1	2	1	2	2	2	2	2
		Municipal Solid Waste Management	2	3	3	2	2	3	2	3	2	1	3	3	3	3	2
		Fate and Transport of Contaminants in the Environment	3	3	2	3	1	2	2	1	2	1	1	2	3	2	1
		NCC Credit Course Level 2#	3	3	2	3	1	2	2	1	3	1	1	2	3	2	2
		Environmental Chemistry and Microbiology Laboratory	1	2	3	3	1	1	1	1	3	1	1	3	2	3	3
			<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
YEAR III	SEMESTER V	Soil Mechanics and Foundation Engineering	3	3	3	3	1	3	1	1	3	2	1	2	3	3	3
		Life Cycle Assessment	3	3	3	3	1	3	1	1	3	2	1	1	3	3	3
		Wastewater Engineering	2	3	3	3	1	2	1	1	1	1	1	2	3	2	3
		Professional Elective I															
		Professional Elective II															
		Professional Elective III															
		Mandatory Course-I*	2	2	3	2	2	2	2	2	2	1	2	2	2	2	3
		Environmental Engineering Laboratory	2	2	3	2	2	2	2	3	2	3	2	3	2	3	3
		Environmental Engineering Design and Drawing	3	3	2	3	3	2	2	2	2	2	2	3	3	3	3
YEAR III	SEMESTER VI	Environmental Monitoring Instruments	2	2	3	2	2	2	2	2	2	1	2	2	2	2	3
		Industrial Wastewater Management	3	3	3	3	1	3	1	1	3	2	1	1	3	3	3
		Open Elective – I*	2	2	1	2	1	2	2	1	2	2	1	2	2	2	3
		Professional Elective IV															
		Professional Elective V															
		Professional Elective VI															
		Professional Elective VII															
		Mandatory Course-II&	2	2	1	2	1	2	2	1	2	2	1	2	2	2	3
		NCC Credit Course Level 3#	3	2		2	2	3		2	3	2		2	3	2	2
		Environmental Instrumentation Laboratory	2	2	1	2	1	2	2	1	2	2	1	2	2	2	3

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
YEAR IV	SEMESTER VII	Environmental Impact Assessment	3	2	3	2	2	2	2	3	3	2	1	1	2	2	2
		Environmental Health and Safety	2	2	2	2	2	3	2	1	3	2	3	2	3	3	2
		Human Values and Ethics	3	2	3	3	3	3	2	2	3	2	2	3	3	3	3
		Engineering Economics and Financial Accounting	2	2	2	2	2	3	2	1	3	2	3	2	3	3	2
		Open Elective – II**	3	2	3	3	3	3	2	2	3	2	2	3	3	3	3
		Open Elective – III***	2	2	2	2	2	3	2	1	3	2	3	2	3	3	2
		Open Elective – IV***	3	2	3	3	3	3	2	2	3	2	2	3	3	3	3
YEAR V	SEMESTER VIII	Project work/Internship	3	3	3	3	1	3	1	1	3	2	1	1	3	3	3

1 – Low; 2 – Medium; 3 – High; ‘-’ – No correlation



**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

S.No.	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1.	Groundwater and Well Engineering	2	2	2	2	2	2	2	3	1	2	2	2	2	2	2
2.	Functional Design of Rainwater Harvesting Systems	2	2	2	2	2	2	3		2	1	2	2	2	2	3
3.	Operation and maintenance of Water and Wastewater Treatment Plants	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2
4.	Sludge and Septage Management	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2
5.	Marine Pollution and Control	3	3	2	3	2	3	2	2	2	2	2	2	3	2	2
6.	Natural Wastewater Treatment Systems	2	2	3	2	2	2	2	2	2	1	2	1	3	2	3
7.	Design of Water and Wastewater Treatment Plants	3	3	3	1	2	2	2	2	2	2	2	2	2	2	2
8.	Indoor Air Quality Management	2	3	2	2	3	2	3	3	2	2	1	3	2	2	3
9.	Noise Pollution Control in Industries	2	2	3	2	3	3	2	2	3	3	2	2	3	2	2
10.	Climate Change and Adaptation	2	2	2	2	2	3	2	2	3	1	2	2	2	2	2
11.	Low Carbon Economy	3	3	3	2	2	3	2		2		1	1	2	2	2
12.	Climatology and Meteorology	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2
13.	Air Quality Modelling and Mapping	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2
14.	Climate Change Modelling	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2
15.	Biochemical and Thermochemical Conversion of Biomass	3	2	2	2	3	3	3		2	1	3	2	2	2	2
16.	Biomedical Waste Management	3	3	3	2	2	3	2		2		1	1	2	2	2
17.	Landfill engineering and Remediation Technology	3	3	3	2	2	3	2		2		1	1	2	2	2

18.	Plastic and E Waste Management	3	2	3	2	2	3	2	2	2		2	2	3	2	3
19.	Industrial Hazardous Waste Management	2	2	3	2	2	2	2	2	3	3		2	2	3	2
20.	Resource recovery from Waste	2	2	2	2	2	2	2	2	2	2	3	2	2	3	2
21.	Green Buildings	3	3	3	1	2	2	2	2	2	2	2	2	2	2	2
22.	Surface and Groundwater Quality Modelling	3	3	3	3	3	3	3	2	2	2	2	3	3	3	3
23.	Remote sensing and GIS Applications in Environmental Management	2	2	2	2	3	2	2	2	3	2	3	3	2	2	3
24.	Occupational Health, Safety and Risk Assessment	1	2	2	3	2	3	1	2	2		1	3	1	2	2
25.	Planning, Design and Management of Large Housing complexes	2	2	3	3	2	3	2		2			3	2	1	2
26.	Energy Management in Industries															
27.	Public Health Engineering Services in Buildings	2	2	3	3	2	3	2		2			3	2	1	2
28.	Environmental System Engineering	3	2	2	2	3	2	2	2	3	2	3	3	2	2	2
29.	Coastal Zone Management	2	3	3	2	3	2	3	1	3	2	3	2	2	3	2
30.	Irrigation Water Quality and Waste Water Management	2	2	2	2	3	2	2	3	2	2	2	3	3	3	3
31.	Solar and Wind Energy System	3		2									3	2	2	2
32.	Epidemiology and Control of Communicable Diseases	2	3	3	2	3	2	3	1	3	2	3	2	2	3	2
33.	Cleaner Production	2	2	2	3	2	2	2	2	2	1	2	2	3	2	3
34.	Organic Farming for Sustainable Agricultural Production	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3
35.	Project Formulation and Implementation	2	2	2	3	2	2	2	2	2	1	2	2	3	2	3

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**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**  
**B. E. ENVIRONMENTAL ENGINEERING**  
**CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII**

**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>								

<sup>\$</sup> 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.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
4.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
5.	BE3255	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	3
6.		NCC Credit Course Level 1 <sup>#</sup>	-	2	0	0	2	2 <sup>#</sup>
7.	GE3252	தமிழகும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
<b>PRACTICALS</b>								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language <sup>\$</sup>	EEC	0	0	4	4	2
				<b>TOTAL</b>	<b>14</b>	<b>1</b>	<b>16</b>	<b>31</b>
<b>23</b>								

<sup>#</sup> 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.

<sup>\$</sup> Skill Based Course

### SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3391	Probability and Statistics	BSC	3	1	0	4	4
2.	EN3301	Environmental Chemistry	PCC	3	0	0	3	3
3.	EN3302	Environmental Microbiology	PCC	3	0	0	3	3
4.	EN3303	Sustainable Development	PCC	3	0	0	3	3
5.	EN3304	Fluid Mechanics and Hydraulics	PCC	3	0	0	3	3
6.	CE3351	Surveying and Levelling	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	EN3311	Environmental Fluid Mechanics Laboratory	PCC	0	0	3	3	1.5
8.	CE3361	Surveying and Levelling Laboratory	PCC	0	0	3	3	1.5
9.	GE3361	Professional Development \$	EEC	0	0	2	2	1
				<b>TOTAL</b>	<b>18</b>	<b>1</b>	<b>8</b>	<b>27</b>
\$ Skill Based Course								

### SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EN3401	Environmental Legislations	PCC	3	0	0	3	3
2.	EN3402	Water Supply Engineering	PCC	3	0	0	3	3
3.	EN3403	Environmental Management Systems	PCC	3	0	0	3	3
4.	EN3404	Municipal Solid Waste Management	PCC	3	0	0	3	3
5.	EN3405	Fate and Transport of Contaminants in the Environment	PCC	3	0	0	3	3
6.	CCE331	Air and Noise Pollution Control Engineering	PCC	3	0	0	3	3
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	EN3411	Environmental Chemistry and Microbiology Laboratory	PCC	0	0	4	4	2
				<b>TOTAL</b>	<b>18</b>	<b>0</b>	<b>4</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

## SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EN3501	Soil Mechanics and Foundation Engineering	PCC	3	0	0	3	3
2.	EN3502	Life Cycle Assessment	PCC	3	0	0	3	3
3.	EN3503	Wastewater Engineering	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
7.		Mandatory Course-I <sup>&amp;</sup>	MC	3	0	0	3	0
<b>PRACTICALS</b>								
8.	EN3511	Environmental Engineering Laboratory	PCC	0	0	4	4	2
9.	EN3512	Environmental Engineering Design and Drawing	PCC	0	0	4	4	2
<b>TOTAL</b>				<b>21</b>	<b>0</b>	<b>8</b>	<b>29</b>	<b>22</b>

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

## SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	EN3601	Environmental Monitoring Instruments	PCC	3	0	0	3	3
2.	CCE334	Industrial Wastewater Management	PCC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Professional Elective VI	PEC	3	0	0	3	3
6.		Professional Elective VII	PEC	3	0	0	3	3
7.		Open Elective – I <sup>*</sup>	OEC	3	0	0	3	3
8.		Mandatory Course-II <sup>&amp;</sup>	MC	3	0	0	3	0
9.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
10.	EN3611	Environmental Instrumentation Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				<b>24</b>	<b>0</b>	<b>4</b>	<b>28</b>	<b>23</b>

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

<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.	CCE333	Environmental Impact Assessment	PCC	3	0	0	3	3
2.	CCE332	Environmental Health and Safety	PCC	3	0	0	3	3
3.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
4.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
<b>TOTAL</b>				<b>20</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>20</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)

### 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.	EN3811	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

**TOTAL CREDITS: 163**

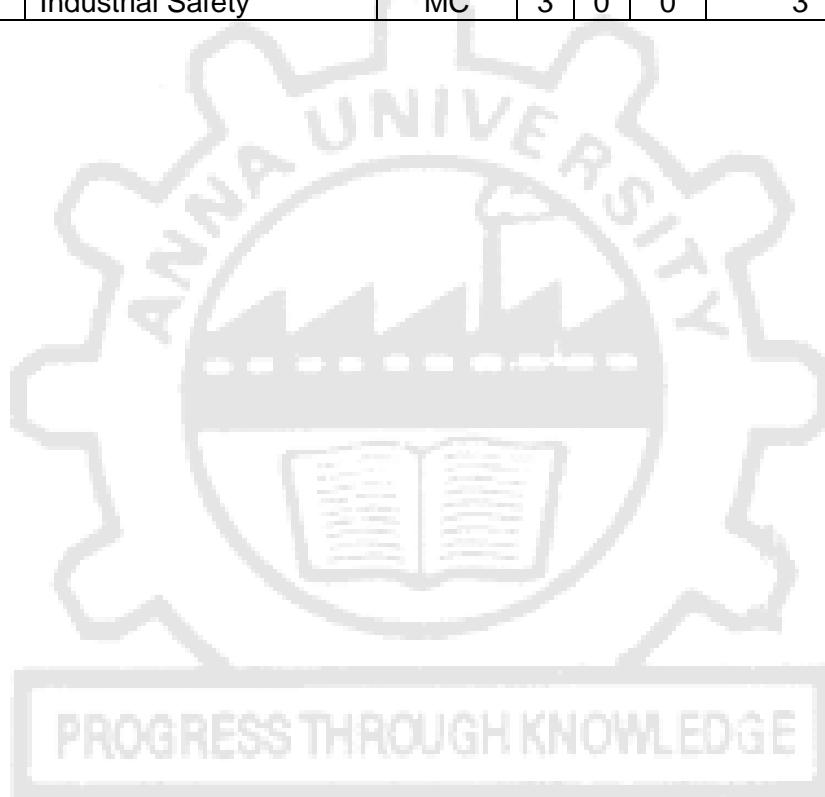
**PROGRESS THROUGH KNOWLEDGE**

### MANDATORY COURSES I

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

## MANDATORY COURSES II

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



### PROFESSIONAL ELECTIVE COURSES : VERTICALS

<b>VERTICAL I Water and Wastewater Engineering</b>	<b>VERTICAL II Air Pollution Engineering</b>	<b>VERTICAL III Solid Waste Management</b>	<b>VERTICAL IV Environmental Management</b>	<b>VERTICAL V Diversified Courses</b>
Groundwater and Well Engineering	Indoor Air Quality Management	Biochemical and Thermochemical Conversion of Biomass	Surface and Groundwater Quality Modelling	Coastal Zone Management
Functional design of Rainwater Harvesting Systems	Noise Pollution Control in Industries	Biomedical Waste Management	Remote Sensing and GIS Applications in Environmental Management	Irrigation Water Quality and Wastewater Management
Operation and Maintenance of Water and Wastewater Treatment Plants	Climate Change and Adaptation	Landfill Engineering and Remediation Technology	Occupational Health, Safety and Risk Assessment	Solar and Wind Energy System
Sludge and Septage Management	Low Carbon Economy	Plastic and E waste Management	Planning, Design and Management of Large Housing Complexes	Epidemiology and Control of Communicable Diseases
Marine Pollution and Control	Climatology and Meteorology	Industrial Hazardous waste Management	Energy Management in Industries	Cleaner Production
Natural Wastewater Treatment Systems	Air Quality Modelling and mapping	Resource recovery from waste	Public Health Engineering Services in Buildings	Organic Farming for Sustainable Agricultural Production
Design of Water and Wastewater Treatment Plants	Climate Change Modelling	Green buildings	Environmental system Engineering	Project Formulation and Implementation

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

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

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

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

### VERTICAL I: WATER AND WASTEWATER ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CAI333	Groundwater and Well Engineering	PEC	3	0	0	3	3
2.	EN3001	Functional Design of Rainwater Harvesting Systems	PEC	3	0	0	3	3
3.	EN3002	Operation and maintenance of Water and Wastewater Treatment Plants	PEC	3	0	0	3	3
4.	EN3003	Sludge and Septage Management	PEC	3	0	0	3	3
5.	EN3004	Marine Pollution and Control	PEC	3	0	0	3	3
6.	EN3005	Natural Wastewater Treatment Systems	PEC	3	0	0	3	3
7.	EN3006	Design of Water and Wastewater Treatment Plants	PEC	3	0	0	3	3

### VERTICAL II : AIR POLLUTION ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EN3007	Indoor Air Quality Management	PEC	3	0	0	3	3
2.	EN3008	Noise Pollution Control in Industries	PEC	3	0	0	3	3
3.	CAI332	Climate Change and Adaptation	PEC	3	0	0	3	3
4.	EN3009	Low Carbon Economy	PEC	3	0	0	3	3
5.	EN3010	Climatology and Meteorology	PEC	3	0	0	3	3
6.	EN3011	Air Quality Modelling and Mapping	PEC	3	0	0	3	3
7.	EN3012	Climate Change Modelling	PEC	3	0	0	3	3

### VERTICAL III: SOLID WASTE MANAGEMENT

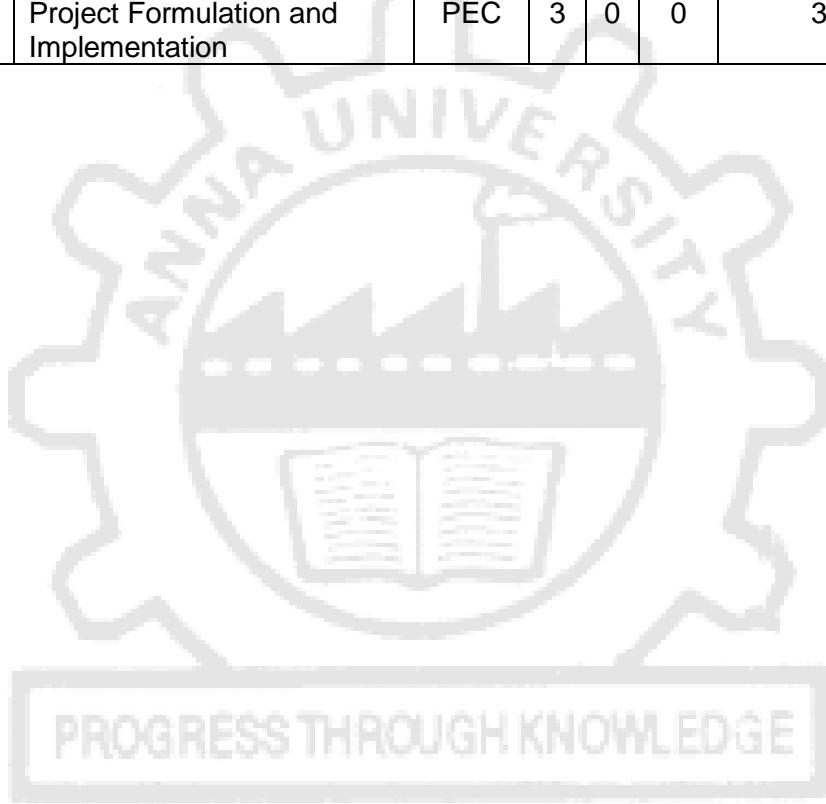
SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CAI331	Biochemical and Thermochemical Conversion of Biomass	PEC	3	0	0	3	3
2.	EN3013	Biomedical Waste Management	PEC	3	0	0	3	3
3.	EN3014	Landfill Engineering and Remediation Technology	PEC	3	0	0	3	3
4.	EN3015	Plastic and E waste Management	PEC	3	0	0	3	3
5.	EN3016	Industrial Hazardous Waste Management	PEC	3	0	0	3	3
6.	EN3017	Resource recovery from Waste	PEC	3	0	0	3	3
7.	EN3018	Green Buildings	PEC	3	0	0	3	3

### VERTICAL IV: ENVIRONMENTAL MANAGEMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EN3019	Surface and Groundwater Quality Modelling	PEC	3	0	0	3	3
2.	EN3020	Remote sensing and GIS Applications in Environmental Management	PEC	3	0	0	3	3
3.	EN3021	Occupational Health, Safety and Risk Assessment	PEC	3	0	0	3	3
4.	EN3022	Planning, Design and Management of Large Housing Complexes	PEC	3	0	0	3	3
5.	EN3023	Energy Management in Industries	PEC	3	0	0	3	3
6.	EN3024	Public Health Engineering Services in Buildings	PEC	3	0	0	3	3
7.	EN3025	Environmental System Engineering	PEC	3	0	0	3	3

**VERTICAL V: DIVERSIFIED COURSES**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EN3026	Coastal Zone Management	PEC	3	0	0	3	3
2.	CAI334	Irrigation Water Quality and Wastewater Management	PEC	3	0	0	3	3
3.	CAI335	Solar and Wind Energy System	PEC	3	0	0	3	3
4.	EN3027	Epidemiology and Control of Communicable Diseases	PEC	3	0	0	3	3
5.	EN3028	Cleaner Production	PEC	3	0	0	3	3
6.	EN3029	Organic Farming for Sustainable Agricultural Production	PEC	3	0	0	3	3
7.	EN3030	Project Formulation and Implementation	PEC	3	0	0	3	3



### **OPEN ELECTIVES**

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

#### **OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)**

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	CCS333	Augmented Reality /Virtual Reality	OEC	2	0	2	4	3

#### **OPEN ELECTIVES – III**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
4.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
5.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
6.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
7.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
8.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to Non-Destructive Testing	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.	OCE353	Lean Concepts, Tools and Practices	OEC	3	0	0	3	3

20.	OEE352	Electric Vehicle Technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
25.	OFD353	Introduction to Food Processing	OEC	3	0	0	3	3
26.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
27.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
28.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
29.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
30.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
31.	CPE334	Energy Conservation and Management	OEC	3	0	0	3	3
32.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
33.	OEC351	Signals and Systems	OEC	3	0	0	3	3
34.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
35.	CBM348	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
36.	CBM333	Assistive Technology	OEC	3	0	0	3	3
37.	OMA352	Operations Research	OEC	3	0	0	3	3
38.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
39.	OMA354	Linear Algebra	OEC	3	0	0	3	3
40.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
41.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
42.	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.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
3.	OMA356	Random Processes	OEC	3	0	0	3	3
4.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3

5.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
6.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
7.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
8.	CME343	New Product Development	OEC	3	0	0	3	3
9.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
10.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
11.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
12.	AU3002	Batteries and Management System	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.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
22.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
25.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
26.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
27.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	CRA332	Drone Technologies	OEC	3	0	0	3	3
29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
32.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
33.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
34.	OCH353	Energy Technology	OEC	3	0	0	3	3
35.	OCH354	Surface Science	OEC	3	0	0	3	3
36.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
37.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3

38.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
39.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
40.	FT3201	Fibre Science	OEC	3	0	0	3	3
41.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
42.	OPE353	Industrial Safety	OEC	3	0	0	3	3
43.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
44.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
45.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
46.	OEC353	VLSI Design	OEC	3	0	0	3	3
47.	CBM370	Wearable Devices	OEC	3	0	0	3	3
48.	CBM356	Medical Informatics	OEC	3	0	0	3	3
49.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
50.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
51.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

## SUMMARY

NAME OF THE PROGRAMME										
	Subject Area	Credits per Semester								Credits Total
		I	II	III	IV	V	VI	VII	VIII	
1.	HSMC	4	3					5		12
2.	BSC	12	4	4						20
3.	ESC	5	14							19
4.	PCC			18	20	13	8	6		65
5.	PEC					9	12			21
6.	OEC						3	9		12
7.	EEC	1	2	1	0				10	14
	Total	22	23	23	20	22	23	20	10	163
8.	Mandatory Course (Non credit)					✓	✓			

### **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) or 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 addition to all the verticals of other programmes)**

<b>VERTICAL I</b>	<b>VERTICAL II</b>	<b>VERTICAL III</b>	<b>VERTICAL IV</b>	<b>VERTICAL V</b>
<b>Fintech and Block Chain</b>	<b>Entrepreneurship</b>	<b>Public Administration</b>	<b>Business Data Analytics</b>	<b>Environment and Sustainability</b>
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and 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 Entrepreneurship	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	CATE GORY	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	CATE GORY	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 and Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity and 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 Entrepreneurship	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

### VERTICAL 3: PUBLIC ADMINISTRATION

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

### VERTICAL 4: BUSINESS DATA ANALYTICS

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

### VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

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

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

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

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

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

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

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

(i) Physical Activity

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

(ii) Creative Arts

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

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont'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**

**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To learn to use basic grammatical 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.

<b>UNIT I</b>	<b>INTRODUCTION TO EFFECTIVE COMMUNICATION</b>	<b>1</b>
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?		
<b>INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION</b>		<b>8</b>
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: Why/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).		
<b>UNIT II</b>	<b>NARRATION AND SUMMATION</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>DESCRIPTION OF A PROCESS / PRODUCT</b>	<b>9</b>
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).		
<b>UNIT IV</b>	<b>CLASSIFICATION AND RECOMMENDATIONS</b>	<b>9</b>
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.		
<b>UNIT V</b>	<b>EXPRESSION</b>	<b>9</b>
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

- CO1:** To use appropriate words in a professional context
- CO2:** To gain understanding of basic grammatical structures and use them in right context.
- CO3:** To read and infer the denotative and connotative meanings of technical texts
- CO4:** To read and interpret information presented in tables, charts and other graphic forms
- CO5:** 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.

## REFERENCES:

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, Kulbhushan 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's-PO's & PSO's MAPPING

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

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

MA3151

MATRICES AND CALCULUS

L T P C  
3 1 0 4

## COURSE OBJECTIVES :

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

## UNIT I MATRICES

9+3

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

**UNIT II DIFFERENTIAL CALCULUS** 9+3

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

**UNIT III FUNCTIONS OF SEVERAL VARIABLES** 9+3

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

**UNIT IV INTEGRAL CALCULUS** 9+3

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

**UNIT V MULTIPLE INTEGRALS** 9+3

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

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES :**

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

**CO1** Use the matrix algebra methods for solving practical problems.

**CO2** Apply differential calculus tools in solving various application problems.

**CO3** Able to use differential calculus ideas on several variable functions.

**CO4** Apply different methods of integration in solving practical problems.

**CO5** Apply multiple integral ideas in solving areas, volumes and other practical problems.

**TEXT BOOKS :**

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 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's-PO's & PSO's MAPPING**

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

**PH3151**
**ENGINEERING PHYSICS**
**L T P C**  
**3 0 0 3**
**COURSE OBJECTIVES:**

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

**UNIT I            MECHANICS**
**9**

Multiparticle 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.<sup>[1][2]</sup> 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

**CO1** Understand the importance of mechanics.

**CO2** Express their knowledge in electromagnetic waves.

**CO3** Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

**CO4** Understand the importance of quantum physics.

**CO5** Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXT BOOKS:**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
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	-	-	-	-	-	-	-	-	-
AVG	3	3	1.6	1.2	1.8	1	-	-	-	-	-	-	1	-	-

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

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

**CY3151****ENGINEERING CHEMISTRY**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.

- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

## **UNIT I WATER AND ITS TREATMENT**

**9**

**Water:** Sources and impurities, **Water quality parameters:** Definition and significance of colour, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride 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 demineralisation 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:

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

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

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

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

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

#### TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17<sup>th</sup> Edition, DhanpatRai 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. ShikhaAgarwal, "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's-PO's & PSO's MAPPING

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

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

GE3151

PROBLEM SOLVING AND PYTHON PROGRAMMING

L T P C  
3 0 0 3

#### COURSE 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**

**COURSE 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", 2<sup>nd</sup> 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**

**L T P C**  
**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 – ஜம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

#### **அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர வினையாட்டுகள்:**

**3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் வினையாட்டுகள்.

#### **அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்:**

**3**

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

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

**3**

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

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

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

**PROGRESS THROUGH KNOWLEDGE**

**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 Bharathidasan.

**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, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS** 3  
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE** 3  
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

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

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

**COURSE 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**

## **COURSE 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", 2<sup>nd</sup> 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	-	-
Avg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

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

**BS3171**

**PHYSICS AND CHEMISTRY LABORATORY**

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

#### **PHYSICS LABORATORY: (Any Seven Experiments)**

##### **COURSE OBJECTIVES:**

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

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle  
b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

**TOTAL: 30 PERIODS**

##### **COURSE OUTCOMES:**

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

**CO1** Understand the functioning of various physics laboratory equipment.

**CO2** Use graphical models to analyze laboratory data.

**CO3** Use mathematical models as a medium for quantitative reasoning and describing physical reality.

**CO4** Access, process and analyze scientific information.

**CO5** Solve problems individually and collaboratively.

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

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

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

#### CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

##### COURSE 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
1. Preparation of Na<sub>2</sub>CO<sub>3</sub> 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 (TiO<sub>2</sub>/ZnO/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

**TEXT BOOKS :**

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

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

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

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

GE3172

ENGLISH LABORATORY

L T P C  
0 0 2 1**COURSE 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

- CO1** To listen to and comprehend general as well as complex academic information
- CO2** To listen to and understand different points of view in a discussion
- CO3** To speak fluently and accurately in formal and informal communicative contexts
- CO4** To describe products and processes and explain their uses and purposes clearly and accurately
- CO5** 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's-PO's & PSO's 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**COURSE 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****COURSE OUTCOMES:**

At the end of the course, learners will be able

**CO1** To compare and contrast products and ideas in technical texts.

**CO2** To identify and report cause and effects in events, industrial processes through technical texts

**CO3** To analyse problems in order to arrive at feasible solutions and communicate them in the written format.

**CO4** To present their ideas and opinions in a planned and logical manner

**CO5** 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.

**REFERENCES:**

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, New Delhi.
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's-PO's & PSO's MAPPING

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

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

MA3251

STATISTICS AND NUMERICAL METHODS

L T P C  
3 1 0 4

#### COURSE 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****COURSE OUTCOMES:**

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

- CO1** Apply the concept of testing of hypothesis for small and large samples in real life problems.
- CO2** Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- CO3** Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- CO4** Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- CO5** 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:**

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7<sup>th</sup> Edition, 2007.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12<sup>th</sup> Edition, 2020.
5. 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.
6. 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's-PO's & PSO's 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	-	-	-

## **COURSE 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

**UNIT III ELECTRICAL MACHINES**  
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

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

## UNIT V      SENSORS AND TRANSDUCERS

9

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

TOTAL: 45 PERIODS

## COURSE OUTCOMES:

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

**CO1** acquire knowledge about heat transfer through different materials, thermal performance of building and thermal insulation.

**CO<sub>2</sub>** gain knowledge on the ventilation and air conditioning of buildings.

**CO3** understand the concepts of sound absorption, noise insulation and lighting designs.

**CO3** understand the concepts of sound absorption, noise insulation and lighting designs  
**CO4** now about the processing and applications of composites, metallic glasses, shape memory alloys and ceramics

**CO5** get an awareness on natural disasters such as earth quake, cyclone, fire and safety measures

**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					-	-	-

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**

**COURSE OUTCOMES:**

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

**CO1** Use BIS conventions and specifications for engineering drawing.

**CO2** Construct the conic curves, involutes and cycloid.

**CO3** Solve practical problems involving projection of lines.

**CO4** Draw the orthographic, isometric and perspective projections of simple solids.

**CO5** 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, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 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 layout 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's-PO's & PSO's 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)															

**BE3255****BASIC CIVIL AND MECHANICAL ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
- To help students acquire knowledge in the basics of surveying and the materials used for construction.
- To provide an insight to the essentials of components of a building and the infrastructure facilities.
- To explain the component of power plant units and detailed explanation to IC engines their working principles.
- To explain the Refrigeration & Air-conditioning system.

**UNIT I PART A: OVERVIEW OF CIVIL ENGINEERING****5**

Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings.

**UNIT I PART B: OVERVIEW OF MECHANICAL ENGINEERING****4**

Overview of Mechanical Engineering - Mechanical Engineering Contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering – Manufacturing, Automation, Automobile and Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.

**UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS****9**

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours.

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber - Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

### **UNIT III BUILDING COMPONENTS AND INFRASTRUCTURE 9**

Building plans – Setting out of a Building - Foundations: Types of foundations - Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering.

Types of Bridges and Dams – Water Supply Network - Rain Water Harvesting – Solid Waste Management - Introduction to Highways and Railways - Introduction to Green Buildings.

### **UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 9**

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices

### **UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9**

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Properties of air - water mixture, concepts of psychometric and its process.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

**CO1:** Understanding profession of Civil and Mechanical engineering.

**CO2:** Summarise the planning of building, infrastructure and working of Machineries.

**CO3:** Apply the knowledge gained in respective discipline

**CO4:** Illustrate the ideas of Civil and Mechanical Engineering applications.

**CO5:** Appraise the material, Structures, machines and energy.

#### **TEXT BOOKS:**

1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018

#### **REFERENCES:**

1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
2. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd, 2013.
3. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
4. Shantha Kumar SRJ., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.

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

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	-	-	1	-	-	1	2	1	2	-	1	-	-	-
2	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
3	2	-	-	-	-	-	1	2	2	2	-	2	-	-	-
4	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
5	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
Avg	2	-	-	0.2	-	-	1	2	1.2	2	-	1.8	-	-	-
Low (1) ; Medium (2) ; High (3)															

### NCC Credit Course Level 1\*

<b>NX3251</b>	<b>(ARMY WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		2	0	0	2
<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>
		2	0	0	2
<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

**TOTAL : 30 PERIODS**

#### **NCC Credit Course Level 1\***

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

**TOTAL : 30 PERIODS**

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

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

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

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

**அலகு III உற்பத்தித் தொழில் நுட்பம்:** 3

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாண்யங்கள் - நாண்யங்கள் 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 குழுழித் 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 நூல்களையின்பதிப்பு 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 பிரசரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (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 beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3**

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

**UNIT V 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 பிரசரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (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.

**GE3271**

**ENGINEERING PRACTICES LABORATORY**

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

#### **COURSE OBJECTIVES:**

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

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

#### **GROUP – A (CIVIL & ELECTRICAL)**

**PART I            CIVIL ENGINEERING PRACTICES**

**15**

#### **PLUMBING WORK:**

- 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 in household 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.

<b>PART II</b>	<b>ELECTRICAL ENGINEERING PRACTICES</b>	<b>15</b>
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- 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)**

<b>PART III</b>	<b>MECHANICAL ENGINEERING PRACTICES</b>	<b>15</b>
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**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.

<b>PART IV</b>	<b>ELECTRONIC ENGINEERING PRACTICES</b>	<b>15</b>
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**SOLDERING WORK:**

- a) Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

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

**ELECTRONIC EQUIPMENT STUDY:**

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

**TOTAL : 60 PERIODS**

## **COURSE OUTCOMES:**

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

- CO1** Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
  - CO2** Wire various electrical joints in common household electrical wire work.
  - CO3** Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
  - CO4** Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

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

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

## COURSE OUTCOMES:

After completing this course, the students will be able to

- CO1:** Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power
  - CO2:** Analyze experimentally the load characteristics of electrical machines
  - CO3:** Analyze the characteristics of basic electronic devices
  - CO4:** Use LVDT to measure displacement

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

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

GE3272

COMMUNICATION LABORATORY

L T P C  
0 0 4 2

### COURSE 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

**CO1** Speak effectively in group discussions held in a formal/semi formal contexts.

**CO2** Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions

**CO3** Write emails, letters and effective job applications.

**CO4** Write critical reports to convey data and information with clarity and precision

**CO5** 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's-PO's & PSO's MAPPING**

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

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

- **Note:** The average value of this course to be used for program articulation matrix.

**MA3391**

**PROBABILITY AND STATISTICS**

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

**COURSE OBJECTIVES**

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- 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 classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

**UNIT I PROBABILITY AND RANDOM VARIABLES** **9 + 3**

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

**UNIT II TWO- DIMENSIONAL RANDOM VARIABLES** **9 + 3**

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

**UNIT III ESTIMATION THEORY** **9 + 3**

Unbiased estimators - Efficiency - Consistency - Sufficiency - Robustness - Method of moments - Method of maximum Likelihood - Interval estimation of Means - Differences between means, variations and ratio of two variances

**UNIT IV NON- PARAMETRIC TESTS** **9 + 3**

Introduction - The Sign test - The Signed - Rank test - Rank - sum tests - The U test - The H test - Tests based on Runs - Test of randomness - The Kolmogorov Tests .

**UNIT V STATISTICAL QUALITY CONTROL****9 + 3**

Control charts for measurements ( $\bar{X}$  and R charts) – Control charts for attributes ( p, c and np charts) – Tolerance limits - Acceptance sampling.

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

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

- CO1** Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- CO2** Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- CO3** Apply the concept of testing of hypothesis for small and large samples in real life problems.
- CO4** Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- CO5** Have the notion of sampling distributions and statistical techniques used in engineering and management problems

**TEXT BOOKS**

1. Johnson. R.A., Miller. I.R and Freund. J.E, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata Mc Graw Hill, 4th Edition, 2007.
3. John E. Freund, "Mathematical Statistics", Prentice Hall, 5th Edition, 1992.

**REFERENCES:**

1. Gupta. S.C. and Kapoor. V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2014.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2010.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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	0	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>0.8</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>

**EN3301****ENVIRONMENTAL CHEMISTRY****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To educate the students in the area of water, air and soil chemistry
- To explain the theoretical basis and observational methods for study of contaminants and interactions in the environment

**UNIT I FUNDAMENTALS 9**

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product( $K_{sp}$ ), heavy metal precipitation, amphoteric hydroxides,  $CO_2$  solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order- 12 Principles of green chemistry.

**UNIT II AQUATIC CHEMISTRY 9**

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction , pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation .

**UNIT III ATMOSPHERIC CHEMISTRY 9**

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming,  $CO_2$  capture and sequestration – acid rain- origin and composition of particulates. black carbon, air quality parameters determination.

**UNIT IV SOIL CHEMISTRY 9**

Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

**UNIT V EMERGING POLLUTANTS 9**

Heavy metals-chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals- Pesticides, Dioxins & Furan, PCBs , PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites ,environmental applications.

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

On completion of the course, the student is expected to

**CO1:** Gain competency in solving environmental issues of chemicals based pollution

**CO2:** Determine chemicals mobility in aquatic systems

**CO3:** Identify contaminating chemicals in air and their fate

**CO4:** Understand the type of soil contaminants and provide remediation

**CO5:** Identify emerging environmental contaminants including speciation

**REFERENCES:**

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2017.
2. Colin Baird,, Environmental Chemistry, Freeman and company, New York, 5th Edition,2012.
3. Manahan, S.E., "Environmental Chemistry", Eleventh Edition, CRC press, 2022.
4. Ronald A. Hites , "Elements of Environmental Chemistry", Wiley, 2nd Edition,2020.

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

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

EN3302

ENVIRONMENTAL MICROBIOLOGY

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- The course provides a basic understanding on microbiology relevant to environmental engineering for candidates with little prior knowledge of the subject
- The morphology, behaviour and biochemistry of bacteria, fungi, protozoa, viruses, and algae are outlined.
- The microbiology of wastewater, sewage sludge and solid waste treatment processes is also provided. Aspects on nutrient removal and the transmission of disease causing organisms are also covered.
- An exposure to toxicology due to industrial products and by-products are also covered.

#### UNIT I FUNDAMENTALS OF MICROBIOLOGY 9

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, concentration and detection of virus. control of microorganisms preservation of microorganisms, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

#### UNIT II MICROBIAL DIVERSITY AND NUTRIENT TURNOVER 9

Distribution of microorganisms in different environments – diversity of microorganisms – fresh and marine, terrestrial – microbes in surface soil, air – outdoor and Indoor, aerosols, bio safety in laboratory – extreme environment – archae bacteria – occurrence in water supplies – problems and control. biogeochemical cycles-nitrogen, carbon, phosphorus, sulphur – Role of Microorganism in nutrient cycle.

#### UNIT III METABOLISM OF MICROORGANISMS 9

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics, disruption in metabolism and disease. biodegradation of organic pollutants

#### UNIT IV MICROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS 9

Microbiology of biological treatment processes – aerobic and anaerobic,  $\alpha$ -oxidation,  $\beta$ -oxidation, nitrification and denitrification, eutrophication. nutrients removal – BOD, nitrogen, phosphate. microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, E-coli, streptococcus, clostridium, Bioleaching

**UNIT V            TOXICOLOGY****9**

Ecotoxicology – toxicants and toxicity, factors influencing toxicity.effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring.

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

**On completion of the course, the student is expected to**

- CO1** Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights.
- CO2** Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.
- CO3** Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes.
- CO4** Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.
- CO5** Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

**REFERENCES:**

1. Bhatia S.C. , "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher, 2008
2. Gabriel Bitton, Wastewater Microbiology, 3<sup>rd</sup> Edition, 2005
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press,3<sup>rd</sup> Edition 2014
4. Volodymyr Ivanov,Environmental Microbiology for Engineers 2nd Edition, CRC Press, 2021, ISBN 9781498702126
5. Nduka Okafor, Environmental Microbiology of Aquatic and Waste systems. Springer Publishers, 2011, ISBN 978-94-007-1459-5
6. Stanley E. Manahan, "Environmental Science and Technology", Lewis Publishers, 2008.
7. Hurst, C.J. Manual of "Environmental Microbiology". 2nd Ed. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199 - X. 2007
8. Frank C. Lu and Sam Kacew, LU's Basic Toxicology, Taylor & Francis, London 5th Ed, 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						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

**EN3303****SUSTAINABLE DEVELOPMENT****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mind-set for Sustainable development.

**UNIT I            SUSTAINABILITY AND DEVELOPMENT CHALLENGES            9**

Definition of sustainability – environmental, economic and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation – climate change – desertification.

**UNIT II            PRINCIPLES AND FRAME WORK            9**

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20 – Rio Principles of sustainable development – Agenda 21 natural step peoples earth charter – business charter for sustainable development – UN Global Compact – Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

**UNIT III            SUSTAINABLE DEVELOPMENT AND WELLBEING            9**

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution – Combating Poverty - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

**UNIT IV            SUSTAINABLE SOCIO-ECONOMIC SYSTEMS            10**

Sustainable Development Goals and Linkage to Sustainable Consumption and Production Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings – Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change – Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

**UNIT V            ASSESSING PROGRESS AND WAY FORWARD            8**

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

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

On completion of the course, the student is expected to

**CO1** Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.

- CO2** Identify and critically analyze the social environmental and economic dimensions of sustainability in terms of UN Sustainable development goals.
- CO3** Develop a fair understanding of the social, economic and ecological linkage o Human wellbeing, production and consumption.
- CO4** Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
- CO5** Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

**REFERENCES:**

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2018
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris, 2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla, IIED and UNFPA, Earthscan, UK, 2008

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

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

1.low, 2-medium, 3-high, “-- no correlation

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

EN3304

FLUID MECHANICS AND HYDRAULICS

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

- To introduce the students about the properties of the fluids, behaviour of fluids under static, kinematic and dynamic conditions through the control volume approach and expose them to the applications of the conservation laws and to impart basic knowledge of the dimensional analysis and model studies along with flow through pipes.
- The students will be exposed to the basic concepts of open channel flows with significance to steady uniform flows along with flow measurements in open channels.
- To expose the students to the classification of pumps the basic principles of working and to design centrifugal pump.

**UNIT I FLUID PROPERTIES AND FLUID STATICS**

9

Definition and properties of fluid - Fluid statics – Fluid pressure and measurement – Mechanical gauges - Forces on plane and curved surfaces - Buoyancy - Stability of floating bodies.

**UNIT II FLUID KINEMATICS AND FLUID DYNAMICS** 9

Classification of fluid flows - Continuum hypothesis - System and Control volume approach - Streamline, streak-line and path-lines - Application of continuity, energy and momentum - Euler's equation of motion along a stream line - Bernoulli's equation - Linear momentum equation

**UNIT III FLOW THROUGH PIPES AND MODEL STUDIES** 9

Reynolds experiment - Laminar flow through circular pipe - Darcy-Weisbach equation - Moody diagram - Major and minor losses in pipe flow – Total energy line – Hydraulic grade line – Siphon - Pipes in series and parallel- Equivalent pipes- Fundamental dimensions - Dimensional homogeneity - Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

**UNIT IV OPEN CHANNEL FLOWS** 9

Types of flow – Characteristics of open channel - Chezy's equation - Manning equation – Hydraulically efficient channel sections - Critical depth – Specific energy application to channel transitions – Flow measurement in channels and natural streams – Current meter – Classification of hydraulic jumps- momentum equation- Energy loss.

**UNIT V PUMPS** 9

Types of pumps – Efficiencies -Selection of pump capacity - Centrifugal pump – Characteristics and working principle – Types of impellers - Priming – NPSH - Cavitation – Minimum speed to start the pump - Specific speed – Submersible pump - Jet pump – Air lift pump - Sludge pump - Reciprocating pump and its working principles.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Chandramouli P N, Applied Hydraulic Engineering, Yes Dee Publisher, 2017
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Subramanya K., Flow in Open Channels, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2019.
4. Modi P.N and Seth Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House, New Delhi, 2019.

**REFERENCES:**

1. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education (India) Pvt. Ltd., 2017.
2. Ven Te Chow, Open Channel Hydraulics, McGraw Hill, New York, 2009.
3. Subramanya K, Fluid Mechanics and Hydraulic Machines: Problems and Solutions, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2018.

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

- CO1** Demonstrate the properties of fluid and its behaviour in static conditions along with pressure measurements.
- CO2** Apply the conservation laws applicable to fluid flows and its application through fluid kinematics and dynamics.
- CO3** Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel and to understand the concept of application of dimensional analysis in model studies.
- CO4** Describe the basics characteristics of open channel flows and analysis of steady uniform flow with hydraulically efficient channel sections and to measure the flows in artificial/natural channels.
- CO5** Explain the classification, design and working principles of various pumps.

## 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	1	1	1	2	1	2	1	2	3	2	1
2	3	2	1	1	1	1	1	2	1	2	1	2	3	2	1
3	3	2	3	2	1	1	1	2	1	2	1	2	3	3	2
4	3	3	3	2	1	1	1	3	1	2	1	3	3	3	3
5	3	3	2	2	1	1	1	3	1	2	1	3	3	3	3
Avg.	3	2	3	2	1	1	1	2	1	2	1	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.

CE3351

SURVEYING AND LEVELLING

L T P C

3 0 0 3

### COURSE OBJECTIVES:

- To introduce the rudiments of plane surveying and geodetic principles to Environmental Engineers and to learn the various methods of plane and geodetic surveying to solve the real world problems. To introduce the concepts of Control Surveying. To introduce the basics of Astronomical Surveying

### UNIT I FUNDAMENTALS OF CONVENTIONAL SURVEYING 9

Definition – Classifications – Basic principles – Equipment and accessories for ranging and chaining – Methods of ranging – Well conditioned triangles – Chain traversing – Compass – Basic principles – Types – Bearing – System and conversions – Sources of errors and Local attraction – Magnetic declination – Dip – compass traversing – Plane table and its accessories – Merits and demerits – Radiation – Intersection – Resection – Plane table traversing.

### UNIT II LEVELLING 9

Level line – Horizontal line – Datum – Benchmarks – Levels and staves – Temporary and permanent adjustments – Methods of leveling – Fly leveling – Check leveling – Procedure in leveling – Booking – Reduction – Curvature and refraction – Reciprocal leveling – Precise leveling - Contouring.

### UNIT III THEODOLITE SURVEYING 9

Horizontal and vertical angle measurements – Temporary and permanent adjustments – Heights and distances – Tacheometric surveying – Stadia Tacheometry – Tangential Tacheometry – Trigonometric leveling – Single Plane method – Double Plane method.

### UNIT IV CONTROL SURVEYING AND ADJUSTMENT 9

Horizontal and vertical control – Methods – Triangulation – Traversing – Gale's table – Trilateration – Concepts of measurements and errors – Error propagation and Linearization – Adjustment methods - Least square methods – Angles, lengths and levelling network.

### UNIT V MODERN SURVEYING 9

Total Station: Digital Theodolite, EDM, Electronic field book – Advantages – Parts and accessories – Working principle – Observables – Errors - COGO functions – Field procedure and applications.GPS: Advantages – System components – Signal structure – Selective availability and antispoofing receiver components and antenna – Planning and data acquisition – Data processing – Errors inGPS – Field procedure and applications.

**TOTAL 45 PERIODS**

### COURSE OUTCOMES:

On completion of the course, the student is expected to

- CO1** Introduce the rudiments of various surveying and its principles.
- CO2** Imparts knowledge in computation of levels of terrain and ground features
- CO3** Imparts concepts of Theodolite Surveying for complex surveying operations
- CO4** Understand the procedure for establishing horizontal and vertical control
- CO5** Imparts the knowledge on modern surveying instruments

### TEXTBOOKS:

1. Dr. B. C. Punmia, Ashok K. Jain and Arun K Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, Sixteenth Edition, 2016.
2. T. P. Kanetkarand S. V. Kulkarni, Surveying and Levelling, Parts 1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 2008.

### REFERENCES:

1. R. Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.
2. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, Mc Graw Hill 2001.
3. Bannister and S. Raymond, Surveying, Seventh Edition, Longman 2004.
4. S. K. Roy, Fundamentals of Surveying, Second Edition, Prentice Hall of India2010.
5. K. R. Arora, Surveying Vol I & II, Standard Book house, Twelfth Edition 2013.
6. C. Venkatramaiah, Textbook of Surveying, Universities Press, Second Edition, 2011.

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

PO/PSO	Course Outcome					Overall Correlation of CO s to POs
	CO1	CO2	CO3	CO4	CO5	
<b>PROGRAM OUTCOMES(PO)</b>						
PO1	Knowledge of Engineering Sciences	2	3	3	3	3
PO2	Problem analysis	2	3	3	3	2
PO3	Design / development of solutions	3	2	3	3	3
PO4	Investigation	2	2	2	3	2
PO5	Modern Tool Usage	2	2	3	3	3
PO6	Engineer and Society	3	3	3	3	3
PO7	Environment and Sustainability			2	2	2
PO8	Ethics	2	2	2	2	2
PO9	Individual and Team work	2	2	2	3	2
PO10	Communication					
PO11	Project Management and Finance	2	2	2	2	2
PO12	Life Long Learning				2	2
<b>PROGRAM SPECIFIC OUTCOMES(PSO)</b>						
PSO1	Knowledge of Civil Engineering discipline	3	3	3	3	3
PSO2	Critical analysis of Civil Engineering problems and innovation	3	3	3	3	3
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering	3	3	3	3	3

EN3311

**ENVIRONMENTAL FLUID MECHANICS LABORATORY****L T P C  
0 0 3 1.5****COURSE OBJECTIVE:**

- To provide hands on experience in calibration of flow meters, performance characteristics of pumps and turbines.

**LIST OF EXPERIMENTS****A. FLOW MEASUREMENT**

1. Bernoulli's Experiment
2. Calibration of Rotameter
3. Flow through Orifice meter/Mouthpiece,
4. Flow through Venturi meter and Notches

**B. LOSSES IN PIPES**

5. Determination of friction factor in pipes.
6. Determination of minor losses

**C. PUMPS**

7. Characteristics of Centrifugal pumps
8. Characteristics of Gear pump
9. Characteristics of Submersible pump
10. Characteristics of Reciprocating pump

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

On completion of the course, the student is expected to be able to

**CO1** Understand and Apply the concept of Bernoulli equation in fluid flow

**CO2** Calibrate the flow measuring devices in a pipe line/channel

**CO3** Measure friction factor in pipes and compare with Moody diagram

**CO4** Determine the performance characteristics of rotodynamic pumps.

**CO5** Determine the performance characteristics of positive displacement pumps.

**REFERENCES:**

1. Hydraulic Laboratory Manual
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics. Standard Book House. New Delhi, 2017.
3. Subramanya K, Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill Edu. Pvt. Ltd. 2011

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

PO/PSO	Course Outcome					Overall Correlation of COs to POs
	CO1	CO2	CO3	CO4	CO5	
PO1 Knowledge of Engineering Sciences	2	3	3	3	3	3
PO2 Problem analysis	2	2	3	3	3	3
PO3 Design / development of solutions	1	1	2	2	2	2
PO4 Investigation	3	3	3	3	3	3
PO5 Modern Tool Usage	1	1	1	1	1	1
PO6 Engineer and Society	2	2	2	2	2	2
PO7 Environment and Sustainability	2	2	2	2	2	2
PO8 Ethics	1	1	1	1	1	1
PO9 Individual and Team work	2	2	3	3	3	2
PO10 Communication	1	1	1	1	1	1
PO11 Project Management and Finance	1	1	1	1	1	1
PO12 Life Long Learning	2	2	2	2	2	2

PSO1	Knowledge of Civil Engineering discipline	2	3	3	3	3	3
PSO2	Critical analysis of Civil Engineering problems and innovation	1	1	2	2	2	2
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering Issues	1	1	1	1	1	1

**CE3361**

## **SURVEYING AND LEVELLING LABORATORY**

**L T P C**  
**0 0 31.5**

### **COURSE OBJECTIVES:**

- At the end of the course the student will possess knowledge about survey field techniques

### **LIST OF EXPERIMENTS:**

#### **Chain Survey**

1. Study of chains and its accessories, Aligning, Ranging, Chaining and Marking Perpendicular offset
2. Setting out works – Foundation marking using tapes single Room and Double Room

#### **Compass Survey**

3. Compass Traversing – Measuring Bearings & arriving included angles

#### **Levelling - Study of levels and levelling staff**

4. Fly levelling using Dumpy level & Tilting level
5. Check levelling

#### **Theodolite - Study of Theodolite**

6. Measurements of horizontal angles by reiteration and repetition and vertical angles
7. Determination of elevation of an object using single plane method when base is Accessible/inaccessible.

#### **Tacheometry – Tangential system – Stadia system**

8. Determination of Tacheometric Constants
9. Heights and distances by stadia Tacheometry
10. Heights and distances by Tangential Tacheometry

#### **Total Station - Study of Total Station, Measuring Horizontal and vertical angles**

11. Traverse using Total station and Area of Traverse
12. Determination of distance and difference in elevation between two inaccessible points using Total station

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

On completion of the course, the student is expected to

- CO1** Impart knowledge on the usage of basic surveying instruments like chain/tape, compass and levelling instruments
- CO2** Able to use levelling instrument for surveying operations
- CO3** Able to use theodolite for various surveying operations
- CO4** Able to carry out necessary surveys for social infrastructures
- CO5** Able to prepare planimetric maps

## **REFERENCES:**

1. T. P. Kanetkar and S. V. Kulkarni, Surveying and Levelling, Parts 1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 24<sup>th</sup> Reprint, 2015.
2. Dr. B. C. Punmia, Ashok K. Jain and Arun K. Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, 17<sup>th</sup> Edition, 2016.
3. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, McGraw Hill 2001
4. Bannister and S. Raymond, Surveying, Seventh Edition, Longman 2004 a. David Clark, Plane and Geodetic Surveying for Engineers, Volume I, Constable and Company Ltd, London, CBS, 6<sup>th</sup> Edition, 2004.
5. David Clark and James Clendinning, Plane and Geodetic Surveying for Engineers, Volumell, Constable and Company Ltd, London, CBS, 6<sup>th</sup> Edition, 2004.
6. S. K. Roy, Fundamentals of Surveying, Second Edition, Prentice 'Hall of India 2004
7. K. R. Arora, Surveying Vol. I & II, Standard Book house, Eleventh Edition, 2013.

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

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	3	3	3	3	3
PO2	Problem analysis	2	2	1	3	3	2
PO3	Design / development of solutions	3	3	2	2	3	3
PO4	Investigation	3			3	2	3
PO5	Modern Tool Usage	2	3	3	2	2	3
PO6	Engineer and Society	3	3	2	3	3	3
PO7	Environment and Sustainability	2	3		3	3	3
PO8	Ethics	3	3		2	2	3
PO9	Individual and Team Work	3	3	3	3	3	3
PO10	Communication	3	3		3	3	3
PO11	Project Management and Finance	3	3		3	3	3
PO12	Life Long Learning	1	1	2	1	1	1
PSO1	Knowledge of Civil Engineering discipline	3	3	3	3	3	3
PSO2	Critical analysis of Civil Engineering problems and innovation	3	3	3	3	3	3
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering Issues	3	3	3	3	3	3

**GE3361**

**PROFESSIONAL DEVELOPMENT**

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

## **COURSE 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**

**COURSE OUTCOMES:**

On successful completion the students will be able to

**CO1** Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements

**CO2** Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding

**CO3** Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

**EN3401****ENVIRONMENTAL LEGISLATIONS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To explain the role of law, policy and institutions in the conservation and management of natural resources as well as pollution control
- To introduce the laws and policies both at the national and international level relating to environment
- To equip the students with the skills needed for interpreting laws, policies and judicial decisions

**UNIT I            INTRODUCTION TO ENVIRONMENTAL LEGISLATIONS AND INTERNATIONAL SCENARIO****9**

Significance of Environmental Law -International Environmental Law -Development of International Environmental Law -Source and General principals of International Environmental Law -General rights and obligations of States -General Issues of the international law related to environmental protection -Stockholm Declaration-Rio Declaration on Environment and Development-Basel Convention on the Control of Trans boundary Movement of Hazardous Wastes and their disposal- Convention of Biological Diversity-U.N Frame Work Convention on Climate Change-Montreal Protocol on Substances that deplete Ozone Layer-Kyoto Protocol.

**UNIT II            INDIAN CONSTITUTIONS AND ENVIRONMENTAL PROTECTION            9**

Indian Constitution and Environmental Protection -Constitutional provisions concerning Environment Articles 14,15,(2) (b) 19 (e),21,31,32,38,39,42,47, 48-A,49,51,51-A: Indian Environmental Policy 2006 Administrative machinery for pollution control Common Law & Criminal Law Nuisance, Negligence, Strict liability and Absolute liability, Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440) Section 133 of Cr.P.C.

**UNIT III            REMEDIES FOR ENVIRONMENTAL POLLUTION            9**

Common Law Remedies/Remedies under Law of Tort – Penal Remedies – Indian Penal Code and Code of Criminal Procedure – Remedies under Constitutional Law – Writs – Public Interest Litigation - Public Liability Insurance Act, 1991 – The National Green Tribunal Act 2010

**UNIT IV            MAJOR INDIAN LEGISLATIONS            9**

Water Act (1974) Air Act (1981) Environmental Protection Act (1986) Major Notifications, The Municipal solid Wastes (Management and Handling) Rules 2016-Bio Medical Wastes (Management and Handling) Rules 2016- Hazardous Wastes (Management and Handling Rules 2016- Environment Impact Assessment Notifications- Coastal Regulation Zone Notification- Public Hearing Notifications

**UNIT V            ENVIRONMENT AND DEVELOPMENT CASE LAWS            9**

Meaning and concept of development - Its impact on environment; conflict between environment and development, Concept of Sustainable Development., Polluter Pay Principle, Precautionary Principle, Public Trust Doctrine. Landmark Judgments - Oleum gas leakage case, Rural Litigation and Entitlement Kendra, Dehradun, (1985) Supp SCC 487) Vellore Citizen Welfare Forum vs. Union of India, (1996) 5SCC 647) Ganga Pollution case (1988) I SCC) S. Jagannath vs. UOI (1997) SCC867) Vellore Citizens welfare forum case M.C. Mehta Vs. Kamalnath (1997) I SCC 388)

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

On completion of the course, the student is expected to

**CO1** Understand origins and sources of environmental laws, and understand how and by whom environmental laws are made and interpreted

- CO2** Understand the key principles of, and actors within, environmental laws  
**CO3** Understand the National Environmental Policy and Various Legislations enacted in line with Policy  
**CO4** Critically analyze environmental laws within various contexts and to evaluate laws against procedural and substantive criteria.  
**CO5** Understand and the Legal system operating in India and will be in a position to prepare compliance reports for getting environmental clearance.

#### REFERENCES:

1. Leelakrishnan P., Environmental Law in India, Butterworths Wadhwa, 3<sup>rd</sup> Edition 2010
2. Leelakrishnan P., Environmental Case Book, Lexis Nexis, 2010
3. Shanthakumar S., Environmental Law – An Introduction, Butterworths, 2008
4. Shyam Diwan and Armin Rosencranz, Environmental Law and Policy in India, Oxford, 2002

#### 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	1			3		
2	1					1	2		2	1			3		
3	2		2	3		2	3	3		2		2	3		
4	2		2			2	3	3		1		2			
5		3	2	3	3	2	3	3		2	1	2	3	2	2
Avg.	2	3	2	3	3	2	3	3		1	1	2	3	2	2

1.low, 2-medium, 3-high, “-- no correlation

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

EN3402

WATER SUPPLY ENGINEERING

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- The course objective is to identify the sources and quantity of surface and ground water bodies and their demand for the public and also to study the quality of water and their treatment techniques.

#### UNIT I PUBLIC WATER SUPPLY SCHEMES AND QUANTITY OF WATER 8

Necessary and objectives of public water supply schemes – planning and financing – Quantity of water – water requirements – continuous and intermittent supply – water demand – variations in rate of demand- its effect on design – design period – population growth and forecast – estimating the quantity of water required.

#### UNIT II HYDROLOGICAL CONCEPTS AND SOURCES OF WATER 9

Hydrological concepts – hydrological cycle – Sources of water – Intakes – types of intakes – infiltration galleries – infiltration well – storage reservoirs – storage capacity by analytical method and mass curve method – types of wells – sanitary protection of wells – tests for yield of a well.

#### UNIT III QUALITY OF WATER AND TRANSPORTATION OF WATER 8

Quality of water – portable water and mineral water – contamination of water – sampling techniques– analysis of water – Bacteriological analysis- water borne diseases – water quality standards. Transportation of water – Hydraulics of pipe flow – pipes & its types – design of pipes – Joints – pipe appurtenances – pumps – types of pumps – selection of pumps.

**UNIT IV PURIFICATION OF WATER 12**

Treatment of water- working principles of all the unit process of water treatment, Purpose and its design – screening – plain sedimentation – coagulation sedimentation – filtration – disinfection – water softening and Desalination– Operation & Maintenance aspects of all the unit process.

**UNIT V OTHER TREATMENTS AND DISTRIBUTION OF WATER 9**

Removal of Iron and Manganese – Fluoridation and Defluoridation– distribution of water – Planning – Methods of distribution – Service Reservoirs – purpose – types – locations and height – Design aspects – requirements of good distribution system – layout of distribution system- Net work analysis – preventive methods to reduce wastage of water – pipe appurtenances – house service connection.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

**CO1** Understand the various components of water supply scheme

**CO2** Design of intake structure and conveyance system for water transmission

**CO3** Understand the process of conventional treatment of water and design of water treatment system.

**CO4** Understand and design the various advanced treatment system and knowledge about the recent advances in water treatment process

**CO5** Design and evaluate water distribution system and water supply in buildings

**TEXTBOOKS :**

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, "Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

**REFERENCES :**

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.
5. Mark J. Hammer & Mark J. Hammer Jr., "Water and Waste Water Technology", Prentice Hall of India Pvt. Ltd., New Delhi, 2008.

**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	3	2				3	2	3
<b>2</b>	3	2	2		2	2				3			3	2	
<b>3</b>	3	2	3			2				3			3	2	
<b>4</b>		2			3					3		2	3	2	
<b>5</b>	3	2	3	2				3			2		3	3	
<b>Avg.</b>	3	3	3	2	3	2	1	3	2	3	2	2	3	2	3

**EN3403****ENVIRONMENTAL MANAGEMENT SYSTEMS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To impart an understanding of systems approach to Environmental Management as per ISO 14001 and skills for environmental performance assessment in terms of legal compliance, pollution prevention and continual improvement.

**UNIT I            ENVIRONMENTAL MANAGEMENTSTANDARDS            9**

Unique Characteristics of Environmental Problems - Classification of Environmental Impact Reduction Efforts - Systems approach to Corporate environmental management - Business Charter for Sustainable Production and Consumption – Tools and Barriers - Evolution of Environmental Stewardship –National policies on abatement of pollution and conservation of resources - Charter on Corporate responsibility for Environmental protection - Environmental quality objectives – Rationale of Environmental standards: Concentration and Mass standards, Effluent and stream standards, Emission and ambient standards, Minimum national standards, environmental performance evaluation: Indicators, benchmarking

**UNIT II            PREVENTIVE ENVIRONMENTAL MANAGEMENT            9**

Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification –Material balance – Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries – Preventive Environmental Management over Product cycle.

**UNIT III            ENVIRONMENTAL MANAGEMENT SYSTEM            10**

ISO 14000 family- EMS as per ISO 14001– benefits and barriers of EMS – Understanding the organisation and its context- Understanding the needs and expectations of interested parties- Determining the scope of the environmental management system- Leadership and commitment- Environmental policy- Organizational roles, responsibilities and authorities- Actions to address risks and opportunities- Environmental objectives and planning – Resources- Competence-Awareness- Communication-Documented Information –Operational Planning and Control- Emergency preparedness and response- Monitoring, measurement, analysis and evaluation - Management review

**UNIT IV            ENVIRONMENTAL AUDIT            8**

Environmental management system audits as per ISO 19011-Internal Audits and Certification Audits – Principles of auditing- Roles and qualifications of auditors - Determining auditor competence- Managing an audit programme – Establishing and Implementing audit programme- Selecting audit team members and Assigning responsibility - Conducting an audit- opening meeting, Audit evidence gathering - Collecting and verifying information - Managing and maintaining audit programme records- closing meeting and reporting - Non conformance – Corrective and preventive actions - Continual improvement - compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit

**UNIT V            CASE STUDIES            9**

Case studies on applications of EMS, Waste Audits and Pollution Prevention in Textile industry , Tanning industry, Electroplating, Pulp & Paper, Dairy, Chemical industries and service organizations.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

- On completion of the course, the student is expected to
- CO1** Explain the various elements of Corporate Environmental Management systems and audits complying to international environmental management system standards
- CO2** Apply the knowledge of science and engineering fundamentals to pollution prevention assessment and environmental performance evaluation
- CO3** Develop environmental management systems for organisations
- CO4** Conduct environmental management system audits taking into account the sustainability context
- CO5** Conduct research pertinent to pollution prevention and communicate effectively to different stakeholders as well as engage in independent life-long learning

### REFERENCES:

- ISO 14001/14004:2016 Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2015
- ISO 19011: 2018, "Guidelines for auditing Management Systems, International Organisation for Standardisation, 2018
- ISO 14031:2021, Environmental management -- Environmental performance evaluation Guidelines, International Organisation for Standardisation, 2015
- Marek Bugdol and Piotr Jedynak, Integrated Management Systems, Springer International, 2015.
- Ryan Dupont, Kumar Ganesan, Louis Theodore, Pollution Prevention: Sustainability, Industrial Ecology, and Green Engineering, Second Edition, CRC Press, 2016
- Paul L Bishop †Pollution Prevention: Fundamentals and Practice€, McGraw- Hill International, Boston,2004.
- Lennart Nilsson, Per Olof Persson, Lars Rydén, Siarhei Darozhka and Audrone Zaliauskiene,Cleaner Production Technologies and Tools for Resource Efficient Production, The Baltic University Environmental Management book series, Uppsala 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			3	3	3
2	3	2		2		2				2			3	2	3
3		2	3			2				2			3	2	3
4		2							2	2	2		3	2	3
5		2		2			1					1		2	3
Avg.	3	2	3	2		2	1	2	2	2		1	3	3	3

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

EN3404

MUNICIPAL SOLID WASTE MANAGEMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

### UNIT I SOURCES AND TYPES

8

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects – Municipal solid waste (M&H) rules – integrated management-Public awareness; Role of NGO's.

<b>UNIT II</b>	<b>ON-SITE STORAGE AND PROCESSING</b>	<b>8</b>
On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – Reduction, Reuse and Recycling.		
<b>UNIT III</b>	<b>COLLECTION AND TRANSFER</b>	<b>8</b>
Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation & maintenance; options under Indian conditions – Field problems- solving.		
<b>UNIT IV</b>	<b>OFF-SITE PROCESSING</b>	<b>12</b>
Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio-methanation; Thermal processing options – case studies under Indian conditions.		
<b>UNIT V</b>	<b>DISPOSAL</b>	<b>9</b>
Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor– Dumpsite Rehabilitation		
		<b>TOTAL: 45 PERIODS</b>
<b>COURSE OUTCOMES:</b>		
The students completing the course will have		
<b>CO1</b>	understand the nature and characteristics of municipal solid wastes and the regulatory requirements regarding municipal solid waste management	
<b>CO2</b>	explains the segregation of solid waste and the onsite storage methods	
<b>CO3</b>	explains the various transfer methods and to know the site condition for the transfer station	
<b>CO4</b>	select appropriate methods for processing and disposal of solid and hazardous wastes, taking into account the impact of the solutions in a sustainability context	
<b>CO5</b>	knowledge about selection of appropriate disposal methods and its handling in an efficient manner	

## **TEXTBOOKS:**

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. Solid Wastes: Engineering Principles and Management Issues. New York: McGraw Hill, 1977.
  2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981
  3. Paul T Williams, "Waste Treatment and Disposal". John Wiley and Sons, 2005

## REFERENCES

- REFERENCES:**

  1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2016.
  2. Bhide A.D. and Sundaresan, B.B. Solid Waste Management Collection, Processing and Disposal, 2001
  3. Manser A.G.R. and Keeling A.A, "Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996
  4. George Tchobanoglous and FrankKreith, Handbook of "Solid waste Management", McGraw Hill, New York, 2002

## 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	3	2	2			2
2	2			1		2	3	2		3			3		
3		3									3		2	3	
4			3		2						2	2			
5	2		2	2		3				3					3
Avg.	2	2	2	2	2	3	3	2	2	3	2	2	3	2	3

1.low, 2-medium, 3-high, “--“ no correlation

## EN3405 FATE AND TRANSPORT OF CONTAMINANTS IN THE ENVIRONMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVE:

- To educate the students on the mechanism of transport and fate of contaminants in the geosphere of the environment.

### UNIT I EQUILIBRIUM AND TRANSPORT MECHANISMS 10

Concentration and Phase density – air-water equilibrium, Soil-water equilibrium, Earthen solid-air equilibrium. Liquid-chemical equilibrium – thermal equilibrium at environmental interfaces. Diffusion and mass transfer – molecular diffusion- Fick,s Law – eddy diffusion – mass transfer theories -fundamentals of heat transfer –heat and mass transfer.

### UNIT II EXCHANGE RATES BETWEEN AIR AND WATER 8

Desorption of gases and liquids from aerated basins and rivers – completely mixed basin – plug flow basin – gas exchange rates between the atmosphere and the surface of rivers – exchange of chemical across the air – water interface of lakes and oceans.

### UNIT III EXCHANGE RATES BETWEEN WATER AND THE EARTHEN MATERIAL 9

Dissolution of chemicals -natural convection dissolution – water interface – mass transfer coefficients at the sediment – water interface. Flux of chemicals between sediment and the overlying seawater – movement of chemicals through the benthic boundary layer.

### UNIT IV EXCHANGE RATES BETWEEN AIR AND SOIL 9

Turbulence above the air – soil interface – the Richardson number – chemical flux rates through the lower layer of the atmosphere –evaporation of liquid chemicals spilled on land – chemical flux rates through the upper layer of earthen material.

### UNIT V CONTAMINANT TRANSPORT ANALYSIS 9

Potential theory- Potential Functions- Stream Function – Travel time along with Stream Functions- Residential Time Distribution Theory- Analysis of Chemical Spills and Contaminant plumes – Fourier analysis of Initial value – point spill analysis- vertically mix spill analysis- Horizontal Plane Source analysis

**TOTAL: 45 PERIODS**

### COURSE OUTCOME

On completion of the course, the student is expected to

**CO1** Understand the equilibrium and transport mechanisms

**CO2** Have a knowledge of gas exchange rates between air and water

**CO3** Have a knowledge of gas exchange rates between water and soil

**CO4** Have a knowledge of gas exchange rates between air and soil.

## **CO5 Understand contaminant transport analysis**

## **TEXT BOOKS:**

1. Thibodeaux, L.J, "Environmental Chemo dynamics: Movement Of Chemicals In Air, Water and Soil", 2<sup>nd</sup> edition ., Wiley - Intercedence, New York, 1996.
  2. Schnoor, J.L., Environmental Modelling Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons Inc., New York, 1996.
  3. Walton, J.C., Fate and Transport of Contaminants in the Environment, College Publishing 2008.
  4. Charbeneau, R.J., Groundwater Hydraulics and Pollutant Transport, Waveland Press, 2006

## REFERENCES:

1. Zheng, C., and Bennett, G.D., Applied Contaminants Transport Modelling, Wiley-Blackwell, 2002.
  2. Samiullah, Y., Prediction of the Environmental Fate of Contaminants, Springer 2011.
  3. David Chin., Water Quality Engineering in Natural Systems: Fate and Transport Process in the Environment, Wiley-Blackwell, 2013.
  4. Hemond, H.F., and Fechner, E.J., Chemicals Fate and Transport in the Environment, Academic Press, 2014.
  5. Cussler, E.L, Diffusion: Mass Transfer In Fluid Systems, Cambridge University press, 1994

**CCE331 AIR AND NOISE POLLUTION CONTROL ENGINEERING L T P C**  
**3 0 0 3**

## **COURSE OBJECTIVES:**

- To impart knowledge on the sources, effects and control techniques of air pollutants and noise pollution.

## **UNIT I**                   **GENERAL**

9

Atmosphere as a place of disposal of pollutants – Air Pollution – Definition - Air Pollution and Global Climate - Units of measurements of pollutants - Air quality criteria - emission standards - National ambient air quality standards - Air pollution indices - Air quality management in India.

UNIT II SOURCES: CLASSIFICATION AND EFFECTS

Sources and classification of air pollutants - Man made - Natural sources - Type of air pollutants - Pollution due to automobiles - Analysis of air pollutants - Chemical, Instrumental and biological methods. Air pollution and its effects on human beings, plants and animals - Economic effects of air pollution - Effect of air pollution on meteorological conditions - Changes on the Meso scale, Micro scale and Macro scale.

**UNIT III SAMPLING, METEOROLOGY AND AIR QUALITY MODELLING**

Sampling and measurement of particulate and gaseous pollutants - Ambient air sampling - Stack sampling. Environmental factors - Meteorology - temperature lapse rate and stability – Adiabatic lapse rate - Windrose - Inversion – Wind velocity and turbulence - Plume behavior - Dispersion of air pollutants- Air Quality Modeling.

**UNIT IV AIR POLLUTION CONTROL MEASURES**

Control - Source correction methods - Control equipments - Particulate control methods – Bag house filter - Settling chamber - cyclone separators - inertial devices - Electrostatic precipitator - scrubbers - Control of gaseous emissions - Absorption - Absorption equipment - adsorption and combustion devices (Theory and working of equipment only).

**UNIT V NOISE POLLUTION AND ITS CONTROL**

9

Sources of noise – Units and Measurements of Noise - Characterization of Noise from Construction, Mining, Transportation and Industrial Activities, Airport Noise – General Control Measures – Effects of noise pollution – auditory effects, non-auditory effects. Noise Menace– Prevention and Control of Noise Pollution – Control of noise at source, control of transmission, protection of exposed person - Control of other types of Noise Sound Absorbent

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

On completion of the course, the student is expected to

- CO1** Understand various types and sources of air pollution and its effects
- CO2** Know the dispersion of air pollutants and their modeling
- CO3** Know about the principles and design of control of particulate pollutants
- CO4** Understand the principles and design of control of gaseous pollutant
- CO5** Know the sources, effects and control of vehicular, indoor air and noise pollution

**TEXTBOOKS:**

1. C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2006.
2. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 2017
3. Dr. Y. Anjaneyulu, "Air Pollution and Control Technologies", Allied publishers Pvt. Ltd., 2019.

**REFERENCES:**

1. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition, McGraw Hill Inc, New Delhi, 2000.
2. Air Pollution act, India, 1987
3. Peterson and E.Gross Jr., "Hand Book of Noise Measurement", 7<sup>th</sup> Edition, 1974
4. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986
5. Antony Milne, "Noise Pollution: Impact and Counter Measures", David & Charles PLC, 1979.
6. Kenneth wark, Cecil F.Warner, "Air Pollution its Origin and Control", Harper and Row Publishers, New York, 1998.

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>1</b>	3				3			2	1	2			2		
<b>2</b>	2			3		2							2	1	2
<b>3</b>	2		3		3		1				2		2	2	2
<b>4</b>	2		3		3		1				2		2	2	2
<b>5</b>	3	3	2	3	2					2			2		
<b>Avg.</b>	2	3	3	3	3			2	1	2	2	2	2	2	2

1.low, 2-medium, 3-high, “-“- no correlation

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

**EN3411 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY LABORATORY L T P C  
0 0 4 2**

**COURSE OBJECTIVES:**

- To train in the analysis of physico-chemical parameters with hands on experience
- To train the students in the analysis of various microbiological techniques, microbiological analysis, enzyme assay, pollutant analysis and operation of bioreactors.

**A: Environmental Chemistry**

1. Estimation of hardness in Water sample by volumetric titration
2. Estimation of Chloride in Water sample by volumetric titration
3. Determination of sulphate
4. Determination of phosphate
5. Determination of Total Solids, Total suspended solids, Total dissolved solids
6. Determination of COD in the wastewater sample
7. Determination of BOD in the wastewater sample

**B: Environmental Microbiology**

1. Preparation of culture media
2. Isolation and Culturing of Microorganisms
3. Gram Staining of bacteria
4. Bacteriological analysis of wastewater (Coliforms & Streptococcus) – MPN Technique
5. Bacteriological analysis of wastewater (Coliforms & Streptococcus MF technique

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES**

- CO1** Analyze the water quality parameters such as hardness chloride and sulphate  
**CO2** Characterize the wastewater parameters like phosphate, solids COD and BOD  
**CO3** Prepare culture media necessary for microbial growth  
**CO4** Isolate and culture the bacteria - identify the bacteria -able to handle microscope  
**CO5** Analyze the coliform count in the wastewater.

**REFERENCES**

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 23rd Ed. Washington, 2017
2. "Laboratory Manual for the Examination of water, wastewater soil, Rump, H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. Charles P. Gerba, "Environmental Microbiology: A laboratory manual", Elsevier Publications, 3rd, 2014

**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		3	1	3		3		2	2	1	
2	3	2		3	2	3	1	3		3		2	1		2
3	2	2	1	3	2	3	1	3		3		2			
4	2	2		3	2	3	1	3	2	3	1	2			1
5	3	2		3	2	3	1	3		3		2		1	
Avg.	3	2	1	3	2	3	1	3	2	3	1	2	1	1	2

1.low, 2-medium, 3-high, “-“- no correlation

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

**EN3501**

**SOIL MECHANICS AND FOUNDATION ENGINEERING**

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

**COURSE OBJECTIVES:**

- To understand the basic properties and strength nature of various soils and their settlement behavior in foundations.

**UNIT I SOIL PROPERTIES AND COMPACTION OF SOIL 9**

Nature of Soil-Problems with soil-phase relation-particle size distribution-Atterberg limits-classification for engineering purposes-BIS Classification system-Soil compaction-factors affecting compaction- laboratory and field compaction methods and monitoring-Clay Mineralogy.

**UNIT II SOIL MOISTURE- PERMEABILITY, STRESSE'S IN SOILS 9**

Soil water-Various forms-Capillary rise-Suction-Effective stress concepts in soil-Total, neutral and effective stress distribution in soil -Permeability -Darcy's Law-Permeability measurement in the laboratory-quick sand condition-Stress distribution in soil media -Boussinesq's formula-stress due to line load ,Circular and rectangular loaded area-approximate methods- Use of influence charts-Westergaard equation for point load.

**UNIT III SHEARSTRENGTH ANDSLOPE STABILITY 9**

Shear strength of cohesive and cohesion less soil-Mohr, Coulomb failure theory-Measurement of shearstrength-directshear,Triaxialcompression,UCCandVaneshartests-Types of shear tests based on drainage and their applicability, Drained and undrained behavior of clay and sand. Slope failure mechanisms-Modes-Infinite slopes-Finite slopes-Total and effective stress analysis-Stability analysis for purely cohesive soils-Method of slices-Modified Bishop's method-Friction circle method-stability number.

**UNIT IV SOILEXPLORATION 9**

Scope and objectives-Methods of exploration-averaging and boring-Wash boring and rotarydrilling-Depthofboring-Spacings of borehole-Sampling-Representative and undisturbed sampling-sampling techniques- Split spoon sampler, Thin tube sampler, Stationary piston sampler-Bore log report-Penetration tests (SPT and SCPT)-Data interpretation(Strength parameters and Liquefaction potential).

**UNIT V FOUNDATION- BEARINGCAPACITYANDSETTLEMENT 9**

Introduction-Location and depth of foundation-Selection of foundation based on soil condition codal provisions-bearing capacity of shallow foundation on homogeneous deposits-Terzaghi's formula and BIS formula-factors affecting bearing capacity-problems-Bearing Capacity from in-situ tests(SPT,SCPT and plate load)-Allowable bearing pressure, Settlement-Components of settlement-Determination of settlement of foundations on granular and clay deposits-Allowable settlements-Codal provision-Methods of minimizing settlement, differential settlement.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

On completion of the course, the student is expected to be able to

- CO1** Graduates will demonstrate an ability to identify various types of soils and its properties, formulate and solve engineering Problems
- CO2** Graduate will show the basic understanding of flow through soil medium and its impact of engineering solution
- CO3** Graduate to understand about the basic concept of stress distribution in loaded soil medium and soil settlement due to consolidation
- CO4** Graduate will show the understanding of shear strength of soils and its impact of engineering solutions to the loaded soil medium and also will be aware of contemporary issues on shear strength of soils.
- CO5.** Graduate will demonstrate an ability to plan and execute a detailed site investigation to select geotechnical design parameters and type of foundation

**TEXTBOOKS:**

1. Punmia.B.C, Soil Mechanics and Foundations, Laxmi Publications Pvt .Ltd, NewDelhi, 1995.
2. Murthy,V.N.S, "Soil Mechanics and Foundation Engineering", UBS Publishers Distribution Ltd, NewDelhi, 1999.
3. PurushothamaRaj.P., "SoilMechanicsandFoundationEngineering",2<sup>nd</sup> Edition, Pearson Education, 2013

**REFERENCES:**

1. Coduto,D.P, Geotechnical Engineering Principles and Practices ,Prentice Hall of India Private Limited, NewDelhi,2002.
2. McCarthy D.F, Essentials of Soil Mechanics and Foundations Basic Geo techniques, SixthEdition, Prentice-Hall , NewJersey,2002.
3. Bowles J.E, "Foundation analysis and design",McGraw-Hill,1996.

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

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

**EN3502**
**LIFE CYCLE ASSESSMENT**
**L T P C  
3 0 0 3**
**COURSE OBJECTIVES:**

- To impart knowledge and skills on the concept and methodology of Life Cycle Assessment as per international standards and its potential applications to develop sustainable products and promote sustainable consumption.

**UNIT I            LIFE CYCLE THINKING AND LIFE CYCLE MANAGEMENT            9**

Introduction to Life Cycle Thinking – Industrial ecology – Life cycle management (LCM) and Stakeholder Expectations - LCM drivers and issues - materials flow analysis - Life cycle of Products and services- International organizations and networks - History and definition of LCA - analytical tools for product and service systems —Value creation along the life cycle—technical characteristics – applications – limitations

**UNIT II            LCA GOAL, SCOPE AND INVENTORY            9**

ISO 14040 framework for LCA - Life cycle goal and scope definition - function, functional unit and reference flow System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Inventory Analysis: Raw Material Extraction and Processing , Manufacturing and Production , Product Use and Consumption , End-of-life Management, Transportation and Distribution - Dealing with Allocation Issues - Solutions to the multi functionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI – LCA software and database - Data quality - Data collection and relating data to unit processes – Data validation - Cut-off and data estimation .

<b>UNIT III</b>	<b>LIFE CYCLE IMPACT ANALYSIS AND INTERPRETATION</b>	<b>9</b>
Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification -Characterization - Optional elements - normalization , grouping, weighting ,data quality analysis - Characterization models – Impact assessment Case studies -Simplified/streamlined Life Cycle Assessments – procedural approaches, numerical approaches - Examples of numerical approaches - contribution analysis, perturbation analysis, uncertainty - analysis, comparative analysis, key issue analysis – Treatment of uncertainties - Elements in uncertainty handling - Sensitivity of LCA results – Sustainability analysis - Extending LCA - economic dimension, social dimension - Life cycle costing – Ecoefficiency - Combining LCA and LCC – Case studies		
<b>UNIT IV</b>	<b>DESIGN FOR ENVIRONMENT AND ECOLABELLING</b>	<b>9</b>
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, re materialization, trans materialization – 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		
<b>UNIT V</b>	<b>LCA SOFTWARES AND CASE STUDIES</b>	<b>9</b>
LCA Softwares - LCA Software Demo: SimaPro, GREET, BEES, CMU EIO,GABI - Advances in LCA: Hybrid LCA, Thermodynamic LCA - LCA case studies on Product Design, Product Improvement, Product Comparison and Policy development.		

## COURSE OUTCOMES

On completion of the course, the student is expected to be able to

- On completion of the course, the student is expected to be able to

  - CO1** Explain the various functional elements of Life Cycle Analysis and Design for Environment
  - CO2** Apply the knowledge of science and engineering fundamentals to characterize the environmental interactions of products and services
  - CO3** Design of engineering systems taking into account the material flow and pollutant interactions between engineering decisions and the environment
  - CO4** Select appropriate LCA tools to support product/process design and decision making, taking into account the impact of the solutions in a sustainability context
  - CO5** Conduct research pertinent to Life Cycle Management and communicate effectively to different stakeholders in terms of eco labels as well as engage in independent life-long learning

## REFERENCES:

- REFERENCES:**

  1. ISO 14040-2016-Environmental management - Life cycle assessment - Principles and framework, International Organization for Standardization, 2016
  2. Ralph Horne, Tim Grant, Karli Verghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing, 2009
  3. ISO/TR 14047:2003, Environmental management - Life cycle impact assessment - Examples of application of ISO 14042, International Organization for Standardization, 2007.
  4. International Organization for Standardization: ISO TR 14062 Environmental management- Integrating environmental aspects into product design and development, 2002.
  5. 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
  6. Catherine Benoit, UQAM/CIRAI, and Bernard Mazijn, Guidelines for Social Life Cycle Assessment of Products. United Nations Environment Programme.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			2					3		2		2	3	3
2	2					2					3		2	3	3
3	3	2	2			3				2	3	3	3	3	3
4						3		3	2		2	3	3	3	3
5	2			3	2	2	2	3	2	2	3		3	3	3
Avg.	2	2	2	3	2	2	2	3	3	2	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.

**EN3503**

**WASTEWATER ENGINEERING**

**L T P C**

**3 0 0 3**

#### COURSE OBJECTIVE:

- The objectives of this course is to help students develop the ability to apply basic understanding of physical, chemical, and biological phenomena for successful design, operation and maintenance of sewage treatment plants.

#### **UNIT I PLANNING AND DESIGN OF SEWERAGE SYSTEM 9**

Characteristics and composition of sewage-- population equivalent -Sanitary sewage flow estimation – Sewer materials – Hydraulics of flow in sanitary sewers – Sewer design - Storm runoff estimation – sewer appurtenances – sewage pumping-drainage in buildings-plumbing systems for drainage- Discharge standards for Effluents.

#### **UNIT II PRIMARY TREATMENT OF SEWAGE 9**

Objectives – Unit Operations and Processes – Selection of treatment processes — Onsite sanitation - Septic tank- Primary treatment – Principles, functions and design of sewage treatment units - screens - grit chamber-primary sedimentation tanks –Operation and Maintenance aspects.

#### **UNIT III SECONDARY TREATMENT OF SEWAGE 10**

Objectives – Selection of Treatment Methods – Principles, Functions, - Activated Sludge Process and Extended aeration systems –Rotating biological contactors-Trickling filters Waste Stabilization Ponds – Operation and Maintenance

#### **UNIT IV ADVANCES IN SEWAGE TREATMENT 8**

Sequencing Batch Reactor – Moving bed biofilm reactor-Membrane Bioreactor - UASB - Biogas recovery- Reclamation and Reuse of sewage – Constructed Wetland –Nutrient removal systems.

#### **UNIT V SEWAGE DISPOSAL AND SLUDGE MANAGEMENT 10**

Dilution – Self purification of surface water bodies Oxygen sag curve – deoxygenation and reaeration - Land disposal – Sewage farming – sodium hazards - Soil dispersion system. Objectives - Sludge characterization – Sludge Thickening – Dewatering – Drying - ultimate residue disposal – Septage Management.

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

**CO1** Understand on the characteristics and composition of sewage ,ability to estimate sewage generation and design sewer system including sewage pumping stations

- CO2** Select type of treatment system and able to perform basic design of the unit operations that are used in sewage treatment. knowledge of septic tank design  
**CO3** Gain knowledge of selection of treatment process and biological treatment process  
**CO4** Acquire knowledge of advance treatment technology and reuse of sewage  
**CO5** Understand the, self-purification of streams and sludge and septage disposal methods.

**TEXTBOOKS:**

1. Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers, New Delhi, 2015.
2. Duggal K.N., "Elements of Environmental Engineering" S.Chand and Co. Ltd., New Delhi, 2014.
3. Punmia, B.C., Jain, A.K., and Jain.A.K., Environmental Engineering, Vol.II, Laxmi Publications, 2010.

**REFERENCES:**

1. Manual on Sewerage and Sewage Treatment Systems Part A,B and C, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. Metcalf and Eddy- Wastewater Engineering—Treatment and Reuse, Tata Mc.Graw-Hill Company, New Delhi, 2010.
3. Syed R. Qasim "Wastewater Treatment Plants", CRC Press, Washington D.C.,2010
4. Gray N.F, "Water Technology", Elsevier India Pvt. Ltd., 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	3			1	3					2	2	2
2	3		3	2	2					3			3	3	2
3	2		3	2		2							2	3	2
4	2		3	2	3	2		3			3		2	3	2
5	2	2	3	2	2			3	3				3	2	2
Avg.	2	2	3	2	2	2	1	3	3	3	3	3	2	2	2

1.low, 2-medium, 3-high, “-- no correlation

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

EN3511

ENVIRONMENTAL ENGINEERING LABORATORY

L T P C  
0 0 4 2

**COURSE OBJECTIVES:**

- This subject includes the list of experiments to be conducted for characterization of water and municipal sewage. At the end of the course, the student is expected to be aware of the procedure for quantifying quality parameters for water and sewage.

**LIST OF EXPERIMENTS: ANALYSIS OF WATER SAMPLE**

1. Sampling and preservation methods for water and wastewater (Demonstration only)
2. Measurement of Electrical conductivity and turbidity
3. Determination of fluoride in water by spectrophotometric method /ISE
4. Determination of iron in water (Demo)
5. Determination of Sulphate in water
6. Determination of Optimum Coagulant Dosage by Jar test apparatus
7. Determination of available Chlorine in Bleaching powder and residual chlorine in water

## **ANALYSIS OF WASTEWATER SAMPLE**

8. Estimation of suspended, volatile and fixed solids
9. Determination of Sludge Volume Index in waste water
10. Determination of Dissolved Oxygen
11. Estimation of B.O.D.
12. Estimation of C.O.D.
13. Determination of Ammonia Nitrogen in wastewater
14. Determination of coliform (Demonstration only)

**TOTAL: 60 PERIODS**

## **COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

- CO1** calibrate and standardize the equipment  
**CO2** collect proper sample for analysis  
**CO3** know the sample preservation methods  
**CO4** perform field oriented testing of water, wastewater  
**CO5** perform coliform analysis

## **REFERENCES:**

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 22nd Ed. Washington, 2012.
2. "Laboratory Manual for the Examination of water, wastewater soil Rump", H.H. and Krist H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. "Methods of air sampling & analysis", James P.Lodge Jr(Editor) 3rd Edition, Lewis publishers, Inc, USA, 1989.

## **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	2		2					2		2		2	3	2
<b>2</b>	2			2				3					3	3	3
<b>3</b>	3	2	3		3						2	3	2	3	3
<b>4</b>		3	3						3			2	2	2	3
<b>5</b>	2		3		2	2	2	3	2	3	3		3	3	3
<b>Avg.</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>

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

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

**EN3512                    ENVIRONMENTAL ENGINEERING DESIGN AND DRAWING                    LT P C**  
**0 0 4 2**

## **COURSE OBJECTIVES:**

- To train the students on preparing layout to for water and wastewater treatment plants as well as general arrangement diagrams for units in water and wastewater treatment.

## **LIST OF DRAWINGS:**

- i. Layout of Water treatment plant
- ii. Infiltration gallery and pumping station.
- iii. Flash mixer
- iv. Clariflocculator
- v. Slow and rapid sand filters
- vi. Layout for Sewage Treatment Plants
- vii. Primary and secondary settling tanks
- viii. Activated sludge process

- ix. Sequencing Batch Reactor
  - x. Sludge digestion tank
  - xi. Septic tank with dispersion trench
  - xii. Flow Chart of ETP for selected Industries.
  - xiii. Flow Chart for CETP

TOTAL: 60 PERIODS

## OUTCOMES

**CO1 Ability to prepare flow charts and layouts of water and waste water treatment plants**

**CO1** Ability to prepare flow charts and layouts of water and  
**CO2** Ability to draw the filtration units required for treatment

**CO3** Ability to design and detail structures and reactors required for water and wastewater treatment

**CO4** Ability to design the pumping station and infiltration gallery

## **CO5 Ability to prepare flow charts for ETP and CETP**

## REFERENCES

1. Birde.G.SandBirde.J.S, "Water supply and sanitary Engineering", DhanpatRai Publications Pvt.Ltd New Delhi,2001.
  2. Rangwala.S.C, "Fundamentals of water supply and sewerage Engineering", Charotar Publishing,2000.
  3. Mannualon wastewater and treatment CPHEECO, Ministry of Urban Affairs and Employment, Govt.ofIndia,NewDelhi,1990.
  4. Shah.C.S., "Water supply and Sanitation", Galgotia publishing company, NewDelhi,1994.
  5. Metcalf and Eddy,"WasteWaterEngineering-Treatment and reuse", TataMcGraw Hill,New Delhi,20

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

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

1.low, 2-medium, 3-high, “--“- no correlation

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

EN3601

## ENVIRONMENTAL MONITORING INSTRUMENTS

L T P C  
3 0 0 3

## COURSE OBJECTIVES

- To educate the students on the sample collection and various instrumental methods of monitoring the quality of air, water and solid waste.

UNIT I MONITORING AND CHARACTERIZATION OF ENVIRONMENT 9

General approach to environmental analysis, Choice of Lab. Vs. Field analysis, Environmental monitoring-current and future status, Lab. Standards, Data quality objectives, statistics in environmental monitoring, Accuracy and precision, detection limit, types of errors, Automated Data acquisition and processing-sensors and transducers , Monitoring Network and real time monitoring

<b>UNIT II</b>	<b>ENVIRONMENTAL SAMPLING</b>	<b>9</b>
Location, planning, sampling equipment's for water, solids and air, sample storage for physical and chemical contaminants, types of sampling, representative samples, sample preparation techniques-Solvent Extraction, SPE, Head space, Purge and trap and SPME		
<b>UNIT III</b>	<b>WATER ANALYSIS</b>	<b>9</b>
Techniques for analysis of major ions-UV-visible Spectrophotometer, Flame photometer, AAS, ICP (AES and MS), Trace organic pollutants (PCB, dioxins, pesticides) GC and HPLC (Columns Detectors and Application)		
<b>UNIT IV</b>	<b>ATMOSPHEREIC ANALYSIS</b>	<b>9</b>
Ambient air and flue gas, Gaseous pollutants-Determination of time weighted average concentration (Absorption trains, solid adsorbents and differential tubes), Direct reading instruments(fluorescence ,chemiluminescent, IR and Electrochemical sensors, GC-MS for trace organics, Particulate sampling methods- High volume sampler, personal sampler, PM 10 and 2.5, Metals Direct (XRF) and dissolution methods (AAS/AES)		
<b>UNIT V</b>	<b>ANALYSIS OF SOIL AND WASTE</b>	<b>9</b>
Problem in analysis of soil and Waste -sampling, pretreatment -extraction and clean up, New extraction techniques, Automated soxhlet and solvent extraction, microwave digestion and sonication, SCF(CO <sub>2</sub> ), Analysis for trace pollutants, Analysis of leachate.		

**TOTAL:45 PERIODS**

#### **COURSE OUTCOMES:**

- CO1:** Able to select appropriate instrumental method for chemical analysis
- CO2:** Understand spectroscopic methods of analysis of pollutants
- CO3:** Select correct method for toxic organics estimation using chromatography methods
- CO4:** Understand electro and nondestructive methods of analysis
- CO5:** Familiar with online analyzers

#### **REFERENCES:**

1. Reeve, R.N., "Introduction to Environmental Analysis", Analytical Techniques in the Sciences, John Wiley & Sons, Chichester, UK, 2002.
2. Barcelo, D.(editor), "Environmental analysis. Techniques, Applications and Quality Assurance", Elsevier, The Netherlands, 1996
3. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, and Applications, Marcel Dekker; 2nd Edition , 2005,
4. Janick Artiola, Ian Pepper and Mark Brusseau, environmental monitoring and Characterization Academic Press,2004.

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

<b>CO's</b>	<b>PO's</b>												<b>PSO's</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>
<b>1</b>	3	2			3								1	2	2
<b>2</b>	3	2		2	2	2					2		2		
<b>3</b>	3	3		2	3								2		
<b>4</b>	2	1	2	1	3				3						
<b>5</b>	3	2	2	2	3	2	2		3	2	2	2	2	2	2
<b>Avg.</b>	3	2	2	2	3	2	2		3	2	2	2	2	2	2

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

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

**CCE334****INDUSTRIAL WASTEWATER MANAGEMENT****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To impart knowledge on the concept and application of Industrial pollution prevention, cleaner technologies, industrial wastewater treatment and residue management.
- Understand principles of various processes applicable to industrial wastewater treatment
- Identify the best applicable technologies for wastewater treatment from the perspective of yield production.

**UNIT I INTRODUCTION****8**

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling – generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.

**UNIT II INDUSTRIAL POLLUTION PREVENTION &WASTE MINIMISATION****8**

Prevention vis a vis Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimisation Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing & Promoting Pollution Prevention Programs in Industries.

**UNIT III INDUSTRIAL WASTEWATER TREATMENT****10**

Flow and Load Equalisation – Solids Separation – Removal of Fats, Oil & Grease-Neutralisation-Removal of Inorganic Constituents – Precipitation, Heavy metal removal, Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Electro dialysis & Evaporation –Removal of Organic Constituents – Biological treatment Processes, Chemical Oxidation Processes, Advanced Oxidation processes – Treatability Studies.

**UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT****9**

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

**UNIT V CASE STUDIES****10**

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing –Sugar and Distilleries

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

After completion of this course, the students is expected to be able to,

- CO1** Explain the source and types of industrial wastewater and their environmental impacts and choose the regulatory laws pertaining to environmental protection
- CO2** Identify industrial wastewater pollution and implement pollution prevention, waste minimization in industries
- CO3** Apply knowledge and skills to design industrial wastewater treatment schemes
- CO4** Audit and analyze environmental performance of industries to internal, external client, regulatory bodies and design water reuse management techniques
- CO5** Conduct research to develop effective management systems for industrial wastewater that are technically sound, economically feasible and socially acceptable

## **REFERENCES:**

1. "Industrial wastewater management, Treatment & disposal, Water Environment" Federation Alexandria Virginia, Third Edition, 2008.
2. Lawrence K. Wang, Yung Tse Hung, Howard H. Lo and Constantine Yapijakis "Handbook of Industrial and Hazardous Waste Treatment", Second Edition, 2004.
3. Metcalf & Eddy, Inc., George Tchobanoglou, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017
4. Nelson Leonard Nemerow, "industrial waste Treatment", Elsevier, 2007.
5. Wesley Eckenfelder W., " Industrial Water Pollution Control", Second Edition, Mc Graw Hill, 2000.
6. Paul L. Bishop, Pollution Prevention: - Fundamentals and Practice, Mc-Graw Hill International, Boston, 2000.
7. Waste water Treatment for pollution control and reuse by Soli. J. Arceivala, Shyam. R. Asolekar, Tata McGraw Hill, 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
<b>1</b>	3										3	1	2		3
<b>2</b>		3	2	2				3	3	2					2
<b>3</b>	2	3	3						3	2	2	3		2	3
<b>4</b>	2		3		2		2	3	3						
<b>5</b>	2	3	2	3		1	2			2	3		3		3
<b>Avg.</b>	2	3	3	2	2	1	2	3	3	2	3	2	2	2	3

1.low, 2-medium, 3-high, “-“ no correlation

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

**EN3611**

**ENVIRONMENTAL INSTRUMENTATION LABORATORY**

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

## **COURSE OBJECTIVES:**

- To train the students on the use of different instruments used for performance monitoring and testing of equipment in wastewater treatment, air pollution control, effluent analysis and emission monitoring.

## **LIST OF EXPERIMENTS:**

- A. Sample Collection, Handling and Preservation**
  - Sampling Protocol: Planning a Sampling Strategy
  - The Representative Sample: Random vs. Judgmental Sampling
  - Sampling Equipment: Devices and Containers for soil, air and water.
  - Sampling Techniques: soil and water
  - Sampling Techniques: gases and vapors
  - Sample Documentation and Preservation, Chain of Custody (COC)
- B. Methods of Analysis**
  - Sample Preparation: Interferences and Detection Limits
  - Quality Control
  - Field Quality Control: Duplicate Samples
  - Quality Control in the Laboratory: Equipment Calibration, Matrix spike and Blank samples.
  - Calibration
- C. Electrode (potentiometric) Methods:**
  - Use of bench top and field model pH meters
  - Use of Dissolved Oxygen Meters.
  - Use of TDS Meters.

- D. Spectrophotometry**
  - Estimation of Phosphate.
  - Estimation of Hydrocarbon.
  - Estimation of Nitrogen.
  - Estimation of Heavy Metals.
- E. Chromatography**
  - Liquid/Gas Chromatography.
  - Gas Chromatograph.
  - HPLC
- F. High Volume Sampler**
  - PM and Gas Pollutant analysis

**TOTAL: 60 PERIODS**

#### **COURSE OUTCOMES:**

The students completing the course will have

- CO1** To conduct treatability studies on water and wastewater treatment
- CO2** To determine the removal / degradation of pollutants from water and wastewater and arrive at kinetics
- CO3** To design scaled up reactors for treatment of water and wastewater treatment based on laboratory studies
- CO4** To determine ambient air quality of given study area in terms of Particulate and Gaseous Pollutants

#### **REFERENCES:**

1. Douglas A. Skoog and Donald M. West, Analytical chemistry: An introduction, CBS publishing Japan Ltd. New York, 2017.
2. Sawyer. C.N., and McCarty P. L. Chemistry for environmental engineering, McGraw-Hill Publications, 4<sup>th</sup> edition, 2017.
3. Standards Methods for the Examination of Water and Waste Water, 17<sup>th</sup> Edition, WPCF, APHA and AWWA, USA, 1989.

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

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

**CCE333**

**ENVIRONMENTAL IMPACT ASSESSMENT**

**L T P C**

**3 0 0 3**

#### **COURSE OBJECTIVES:**

- To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.
- To provide knowledge related to the broad field of environmental risk assessment, important processes that control contaminant transport and tools that can be used in predicting and managing human health risks.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.		
<b>UNIT II</b>	<b>IMPACT IDENTIFICATION AND PREDICTION</b>	<b>10</b>
Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modelling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment		
<b>UNIT III</b>	<b>SOCIO-ECONOMIC IMPACT ASSESSMENT</b>	<b>8</b>
Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation		
<b>UNIT IV</b>	<b>EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN</b>	<b>9</b>
Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment		
<b>UNIT V</b>	<b>CASE STUDIES</b>	<b>9</b>
Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects		

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

- CO1** Apply the principle of limit state design for concrete pipe design
- CO2** Do structural design of Water tanks
- CO3** Design the water treatment plant Structures.
- CO4** Design the components of wastewater treatment plant structures.
- CO5** Apply the knowledge of structural design to various environmental engineering structures.

#### **REFERENCES:**

1. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York. 1996
2. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley-Interscience, New Jersey. 2003
3. World Bank –Source book on EIA
4. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York,1996.
6. K. V. Raghavan and A A. Khan, "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 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						2	3	3					2		
2	3	2	3	2	2			3	2			1		2	2
3		2	3	2	2			3	2			1		2	
4			3		3	2	2	2	2	1	1			2	2
5	3			2				2							
Avg.	3	2	3	2	2	2	2	3	2	1	1	1	2	2	2

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

CCE332

ENVIRONMENTAL HEALTH AND SAFETY

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To educate overview of EHS in industries and related Indian regulations, types of Health hazards, effect, assessment and control methods and EHS Management System

### UNIT I INTRODUCTION

9

Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of trade union safety representatives - Ergonomics.

### UNIT II OCCUPATIONAL HEALTH AND HYGIENE

10

Definition of occupational health and hygiene - Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits - Hierarchy of control measures - Role of personal protective equipment and the selection criteria

### UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS

11

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control, Noise, Chemical and Radiation Safety – Electrical Safety – Fire Safety – Safety at Construction sites, ETP – Machine guarding – Process Safety, Working at different levels

### UNIT IV HAZARDS AND RISK MANAGEMENT

8

Safety appraisal – Job Safety Analysis-Control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques –Onsite and Offsite emergency Plans. Employee Participation- Education and Training- Case Studies

### UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT

7

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

After completion of this course, the students are expected to be able to understand:

- CO1** Need for EHS in industries and related Indian regulations
- CO2** Various types of Health hazards, effect, assessment and control methods
- CO3** Various safety systems in working environments
- CO4** The methodology for preparation of Emergency Plans and Accident investigation
- CO5** EHS Management System and its elements

## REFERENCES

- Industrial Health and Safety Acts and Amendments, by Ministry of Labour and Employment, Government of India
- Fundamentals of Industrial Safety and Health by Dr.K.U. Mistry, Siddharth Prakashan, 2012
- The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
- Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services, 2005.
- Environmental and Health and Safety Management by Nicholas P.Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995

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

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

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

## 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

**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	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

EN3811

PROJECT WORK/INTERNSHIP

L T P C  
0 0 20 10

**COURSE OBJECTIVE:**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

**STRATEGY:**

The student works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction. The student will be evaluated based on the report and the viva voce examination by a team of examiners including one external examiner.

**TOTAL: 300 PERIODS**

**COURSE OUTCOMES:**

- On Completion of the project works students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

**CO1** Identify Environmental engineering problems reviewing available literature.

**CO2** Identify appropriate techniques to analyze complex Environmental engineering problems.

**CO3** Apply engineering and management principles through efficient handling of Project have a clear idea of his/her area of work and they are in a position to carry out the work in a systematic way.

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

PO/PSO	Course Outcome			Overall Correlation of Cos to POs
	CO1	CO2	CO3	
<b>PO1</b> Knowledge of Engineering Sciences	3	3	2	3
<b>PO2</b> Problem analysis	1	3	2	2
<b>PO3</b> Design/development of solutions	1	1	2	1
<b>PO4</b> Investigation	3	3		3
<b>PO5</b> Modern Tool Usage				
<b>PO6</b> Individual and Teamwork	3	3	2	3
<b>PO7</b> Communication	2		2	2
<b>PO8</b> Engineer and Society	2		2	2
<b>PO9</b> Ethics	2		2	2
<b>PO10</b> Environment and Sustainability	1	1	1	1
<b>PO11</b> Project Management and Finance	1	1	1	1
<b>PO12</b> Life Long Learning	3	3	3	3
<b>PSO1</b> Knowledge of Environmental Engineering discipline	3	3	1	3
<b>PSO2</b> Critical analysis of Environmental Engineering problems and innovation	3	3	1	3
<b>PSO3</b> Conceptualization and evaluation of engineering solutions to Environmental Engineering Issues	3	3	1	3

## **PROFESSIONAL ELECTIVE COURSES: VERTICALS**

### **VERTICAL I: WATER AND WASTEWATER ENGINEERING**

**CAI333**

**GROUNDWATER AND WELL ENGINEERING**

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

#### **COURSE OBJECTIVES**

- To acquaint and equip the students with the techniques of groundwater development and management

#### **UNIT I                  GROUND WATER OCCURRENCE                  9**

Occurrence of groundwater, temporal and spatial variability of groundwater, methods for groundwater exploration, determination of aquifer parameters, pumping tests, assessment of groundwater potential

#### **UNIT II                  WELL CONSTRUCTION                  9**

Groundwater structures, groundwater development and utilization, types of water wells, design and construction of water wells, drilling methods, well development, well maintenance and rehabilitation, groundwater monitoring, monitoring wells, design and construction of monitoring wells

#### **UNIT III                  GROUNDWATER POLLUTION                  9**

Groundwater development and quality considerations, groundwater contamination, sources and causes of groundwater pollution, contaminated systems and their rehabilitation, groundwater bioremediation, management of salt water ingress in inland and coastal aquifers.

#### **UNIT IV                  GROUNDWATER MANAGEMENT                  9**

Management of declining and rising water table, Natural and artificial groundwater recharge, Groundwater recharge basins and injection wells. Groundwater management in irrigation command, conjunctive water use, water lifting, different types of pumps, selection of pumps, pump characteristics curve, cost of groundwater pumping, comparative economics of surface and groundwater use for irrigation

#### **UNIT V                  GROUNDWATER DEVELOPMENT POLICIES                  9**

Major issues related to groundwater development and management in India, Legal aspects of groundwater exploitation, Diagnostic survey of sick wells/tube wells and their rehabilitation.

**TOTAL:45 PERIODS**

#### **COURSE OUTCOMES**

- CO1** The students will be able to describe the concepts of aquifer parameters  
**CO2** The students will be able to describe the components involved in Groundwater structures  
**CO3** The students will be able to describe the Groundwater development and quality considerations  
**CO4** The students will be able to describe the Management of declining and rising water table  
**CO5** The students will be able to prioritize and execute the Groundwater development programme

#### **TEXT BOOKS :**

- 1 Walton, W.C. 1976. Groundwater Resource Evaluation. Mc Graw Hill. New York.
- 2 Karanth, K.R. 1987. Groundwater Assessment, Development and Management. Tata-mcgraw Hill. New Delhi.
- 3 Michael, A.M. and Khepar, S.D. 1989. Water Well and Pump Engineering. Tata-mcgraw Hill Publ. Co. New Delhi.

## REFERENCES

- 1 Giordano, M. and Villholth, K.G. 2007. The Agricultural Groundwater Revolution Volume 3.
  - 2 CABI Head Office, Nosworthy Way, Wallingford, Oxfordshire, OX10 8DE, UK Ghosh, N.C. and Sharma, K.D. 2006. Groundwater Modelling and Management.
  - 3 Madan Kumar Jha and Stefan Peiffer Applications of Remote Sensing and GIS Technologies in Groundwater Hydrology: Past, Present and Future.

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

PO/PSO		Course Outcome					Overall correlation of CO s to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	2	3	2	2	2	2
PO2	Problem Analysis	2	2	2	3	1	2
PO3	Design/ Development of Solutions	2	2	2	2	1	2
PO4	Investigations	2	2	2	1	2	2
PO5	Modern Tool Usage	2	3	2	2	3	2
PO6	Individual and Team work	1	1	1	2	3	2
PO7	Communication	2	3	2	1	2	2
PO8	The Engineer and Society	3	3	2	3	3	3
PO9	Ethics	1	1	2	1	2	1
PO10	Environment and Sustainability	2	3	2	1	1	2
PO11	Project Management and Finance	2	3	2	2	1	2
PO12	Life Long Learning	2	2	3	2	2	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	2	2	2	2	1	2
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	2	2	2	1	2
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	2	2	2	2	1	2

## **COURSE OBJECTIVES:**

- To meet the increasing demand of water.
  - To avoid the flooding of roads.
  - Supplement domestic water needs.
  - To raise the underground water table.

<b>UNIT I</b>	<b>GENERAL</b>	<b>8</b>
Objectives of rainwater harvesting - principles, importance and issues. Water harvesting techniques – classification based on source, storage and use. Runoff harvesting – short-term and long - tem techniques. Short - term harvesting techniques		
<b>UNIT II</b>	<b>GROUNDWATER</b>	<b>9</b>
Over-exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dug wells and bore wells; direct and reverse rotary drilling; cable tool and DTH hammer drilling; gravel packing and well development procedures.		
<b>UNIT III</b>	<b>ARTIFICIAL RECHARGE STRUCTURES</b>	<b>10</b>
Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge borewells. Rainwater harvesting in urban areas : RWH structures - design - construction.		
<b>UNIT IV</b>	<b>MAINTENANCE AND MONITORING OF RWH</b>	<b>9</b>
Estimation of probable runoff from an area including from roof tops - maintenance and monitoring of RWH structures. Study of benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water for recharge in urban areas.		
<b>UNIT V</b>	<b>CONSTRUCTION AND ESTABLISHING RWH</b>	<b>9</b>
Precautions for source, construction and establishing RWH structures. Exploration techniques and selection of artificial recharge zones - electrical resistivity investigations using horizontal profiling and vertical sounding techniques: interpretation of resistivity data in terms of subsurface geology.		

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES**

At the completion of the course,

- CO1** The student will be able to understand the importance rainwater harvesting Systems
- CO2** The students shall be aware of the issues related to over exploitation of groundwater
- CO3** Apply knowledge and skills to design various rainwater recharging structures
- CO4** Understand the issues pertaining to monitoring and maintenance of rainwater harvesting structures.
- CO5** Gain an overarching understanding of construction and establishment of rainwater harvesting structures.

#### **REFERENCES**

1. M. L. Munjal, 2014, Noise and Vibration Control, World Scientific Press: Singapore
2. E. G. Williams, 1999, Fourier Acoustics: Sound Radiation and Near Field Acoustic Holography, Academic Press: New York

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

<b>CO's</b>	<b>PO's</b>												<b>PSO's</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>
<b>1</b>			2						2		2				
<b>2</b>	3	2				2	3		2		2		2		
<b>3</b>	2		2	2		2							2		
<b>4</b>	2				2	2			2		2		2	2	
<b>5</b>	2	3	3	2	2	2	3		2	1		2		3	3
<b>Avg.</b>	2	2	2	2	2	2	3		2	1	2	2	2	2	3

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

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

## **COURSE OBJECTIVE:**

- To educate the student on the various operation & maintenance aspects of water treatment systems, sewer systems, sewage treatment plants and effluent treatment plants.

UNIT I ELEMENTS OF OPERATION AND MAINTENANCE 9

Strategy for good operation and maintenance- preventive and corrective maintenance scheduling - operation and maintenance Plan - proper and adequate tools, spare units and parts - training requirements- laboratory control- records and reports- housekeeping – sampling procedureanalytical techniques- code of practice for analytical laboratories- measurement of flows, pressures and Levels -safety in O&M operations - management information system - measures for conservation of energy

UNIT II OPERATION AND MAINTENANCE OF WATER SUPPLY SYSTEMS 9

Operational problems, O&M practices and records of operation of reservoir and intakes - causes of failure of wells- rehabilitation of tube wells & bore wells- prevention of incrustation and corrosion - problems in transmission mains- maintenance of pipelines and leakage control- repair method for different types of pipes- preventive and corrective maintenance of water pumps - problems in the water distribution system and remedies- water quality monitoring and surveillance

UNIT III OPERATION AND MAINTENANCE OF SEWERAGE SYSTEMS

Components and functions of sewerage system – maintenance of collection system – operational problems- clogging of pipes – hazards – precautions against gas hazards – precautions against infections – devices for cleaning the conduits – preventive and corrective maintenance of sewage pumps –operation and maintenance of sewage pumping stations- maintenance hazards and operator protection –SOP-case studies

## **UNIT IV      OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENT UNITS**

Operation and maintenance in screen chamber, grit chamber and clarifiers- operation issues, trouble shooting guidelines and record keeping requirements for clarifier, equalization basins, neutralization unit - chemical storage and mixing equipment - chemical metering equipment - flash mixer –filters, thickeners and centrifuges- filter press - start-up and maintenance inspection - motors and pumps - hazards in chemical handling – jar test - chlorination equipment - membrane process systems- SDI and LSI determination- process chemistry and chemical dosage calculations- SOP-case studies

## **UNIT V            OPERATION AND MAINTENANCE OF BIOLOGICAL TREATMENT UNITS**

Construction, operation and maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- startup and shutdown procedures-DO, MLSS and SVI monitoring- trouble shooting guidelines –planning, organizing and controlling of plant operations – capacity building, case studies of retrofitting- SOP-case studies

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

**CO1** Understand the O&M issues pertaining to STP and WTP

#### **CO2 Understand operation and maintenance of water intakes and supply systems**

**CO3** Recognize the O&M issues relevant to sewerage system

#### **CO4 Understand operation and maintenance of physico-chemical treatment units**

## **C05 Understand operation and maintenance of biological treatment units**

## **REFERENCES:**

1. CPHEEO, Manual on operation and maintenance of water supply systems, Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, Government of India 2013
2. Ministry of Drinking Water and Sanitation, operation and maintenance manual for rural water supplies, Government of India, 2013
3. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017
4. Ananth S Kodavasal, The STP Guide-Design, Operation and maintenance, Karnataka State Pollution Control Board, Bangalore, 2011
5. Frik Schutte, handbook for the operation of water Treatment Works, The Water Research Commission, The Water Institute of Southern Africa, TT265/06, 2006.
6. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.2 liquid process, 2007.
7. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.1 Management and support systems, sixth edition, 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	3	2	2	3	2		2		2	2		2			
2	2		3	3				2		2	2			2	
3	2	3	3	3		2	2		2			2			2
4	2		3	2	2			2		2			2	2	
5	3	2	3	2	1	2			1			2		2	
Avg.	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2

1.low, 2-medium, 3-high, “--“ no correlation

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

**EN3003**

**SLUDGE AND SEPTAGE MANAGEMENT**

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

### **COURSE OBJECTIVES**

- To gain knowledge and skills on sources, characteristics and treatment of sludge
- To understand the importance of septage management.

### **UNIT I            SOURCES AND CHARACTERISTICS OF SLUDGE            9**

Objectives of sludge treatment – sources of sludge- Sludge from WTP, STP and CETP- Sludge- Quantification-generation from various treatment plants – Characteristics in each stage of treatment —Physico-chemical and biological-- Mass balance in sludge treatment

### **UNIT II            SLUDGE THICKENING AND DEWATERING            9**

Sludge thickening- Gravity thickening - Drum thickener - Air floatation – Centrifugation-conditioning -Sludge Dewatering- Centrifuge- Vacuum Filtration-Sludge drying bed- performance of thickener and dewatering systems-operation and maintenance

### **UNIT III            SLUDGE STABILIZATION            9**

Objectives-Aerobic and Anaerobic Sludge digestion processes – Types of anaerobic digesters – design of Low rate and High rate digesters – Two stage digester-Aerobic digestion- Pure oxygen and thermophilic aerobic digestion - Chemical and Thermal stabilization process

### **UNIT IV            REUSE AND LAND APPLICATION OF SEWAGE SLUDGE            9**

Introduction- beneficial use-requirements and associated risks-handling and management- storage - operation aspects of transport and application of biosolids application land-

Lagooning- Landfilling- land farming-Composting-windrow composting -Vermicomposting - Laws and regulations on sludge management

#### **UNIT V            SEPTAGE MANAGEMENT**

**9**

Sources of Septage – characteristics- Public health and environmental hazards- Elements of septage management- Pumping and Desludging Septic Tanks-Transportation- Treatment- Dewatered septage sludge reuse- Operation and maintenance - Planning and implementation of septage management schemes-Case studies

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

**CO1** Understand sources and characteristics of various sources of sludge.

**CO2** Design sludge thickening and dewatering units

**CO3** Design of sludge stabilization units

**CO4** Know about the requirements and associated risk while reusing sewage sludge

**CO5** Plan and implement septage management scheme

#### **REFERENCES**

1. Septage management in urban India, National Urban Sanitation policy, Ministry of Urban Development Government of India,2013
2. National Policy on Faecal Sludge and Septage Management (FSSM) Ministry of Urban Development Government of India,2017
3. A.F. Ismail, Takeshi Matsuura, Membrane Technology for Water and Wastewater Treatment, Energy and Environment, CRC Press, 2016
4. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.2 liquid process.
5. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.1Management and support systems, sixth edition.
6. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse fourth Edition, McGraw-Hill, 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	2	2	3	3	1	3					2		2		2
2	2	3	3	3		2	2		2					2	
3	2		2		2		2	2	3	2	2		3		3
4	2	3	3	2	2					2		2		3	
5	2	3	3		1	3		2			2	2	2		2
Avg.	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2

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

**EN3004**

**MARINE POLLUTION AND CONTROL**

**L T P C**

**3 0 0 3**

#### **COURSE OBJECTIVES:**

- To educate the Coastal and Marine environment.
- To educate the ocean dynamics
- To sources of marine pollution and methods for monitoring, modeling and control.

**UNIT I MARINE AND COASTAL ENVIRONMENT** 9

Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology, coastal features – beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes—the oceans and climate, coastal zone regulation in India- national and international treaties.

**UNIT II OCEAN HYDRODYNAMICS** 9

Wave theory, waves in shallow waters – refraction, diffraction and shoaling, approximations for deep and shallow water conditions – tidal classification - general circulation of ocean waters - ocean currents - coastal sediment transport - onshore offshore sediment transport - beach formation and coastal processes - Tsunamis, storm surge, El Nino effect.

**UNIT III MARINE POLLUTION** 9

Sources of marine pollution – point and non-point sources, pollution caused by effluent discharge, oil exploration, dredging, offshore mining, port and harbour activities, power plants, agriculture runoff, plastic waste, marine debris and marine litter - effects of marine pollution on marine water quality and coastal ecosystems.

**UNIT IV MARINE POLLUTION MONITORING** 9

Basic measurements - sounding boat, echo sounders – current meters - tide gauge - use of GPS – measurement of coastal water characteristics – sea bed sampling – modelling of pollutant transport and dispersion - oil spill models - ocean monitoring satellites – applications of remote sensing and GIS in monitoring marine pollution – online marine pollution monitoring,

**UNIT V MARINE POLLUTION CONTROL MEASURES** 9

Marine discharges and effluent standards, pollution control strategies – marine outfall design selection of optimal marine outfall locations - Total Maximum Daily Load (TMDL) applications – protocols in marine pollution control– Integrated Coastal Zone Management (ICZM) and sustainable development.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Ability to know about marine environment.

**CO2** Understand the physical concepts lying behind the oceanic currents and natural processes of various activities happening over the marine environment.

**CO3** Acquired knowledge on the marine pollution and the effect of the same on the ecology.

**CO4** Should have gained knowledge on remote sensing and various other techniques for measuring and monitoring oceanic environment parameters.

**CO5** Should have acquired knowledge on control of marine pollution and sustainable development.

**REFERENCES:**

1. "Marine Pollution (5th Edition) R.B. Clark, C. Frid and M Attrill Oxford Science Publications, 2001
2. Marine pollution Dr.P.C.Sinha , Anmol Publications Pvt. Ltd, 1998.
3. "Problems of Marine Pollution" : India and Canada, Raghavan, Sudha , Eastern Book Corporation, Delhi, India, 2005
4. Laws, E.A., "Aquatic pollution", an introductory text. John Wiley and Sons, Inc., New York, 2018.

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

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

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

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

EN3005

NATURAL WASTEWATER TREATMENT SYSTEMS

L T P C  
3 0 0 3

#### COURSE OBJECTIVE

- To gain knowledge and understanding of wetlands on types of wetlands, constructed wetland - application, design, method of treatment of both domestic and industrial wastewaters and case studies.
- To gain knowledge on design, construction and operation of waste stabilization pond and sludge disposal.

#### UNIT I INTRODUCTION TO WETLAND TREATMENT SYSTEM 9

Definition and concept of wetland - types of wetland. Wetland - ecology, flora and fauna, ecological aspects, human health and wetland, onsite applications. introduction to constructed wetland-types- free water surface, subsurface wetland-horizontal and vertical flow-wastewaters and their application in wetland - constructed wetland plants-media – in constructed wetland.

#### UNIT II CONSTRUCTED WETLAND AND REMOVAL MECHANISMS 9

Site identification- construction and design of constructed wetland, startup, operation and maintenance of wetland system-wetland hydrology- hydraulics. Treatment of domestic wastewater and its performance, mechanisms of pollutant removal- suspended solids, organic matter, nitrogen, phosphorus, pathogen and other contaminants. Reuse of treated wastewater and its applications- limitation of constructed wetland system.

#### UNITIII CASE STUDIES ON CONSTRUCTED WETLAND SYSTEM 8

Constructed wetland- treatment of domestic wastewater- greywater - landfill leachate – treatment of industrial wastewaters- textile wastewater – dairy wastewater and its performance. Removal of specific pollutants such as heavy metals, aromatics and emerging contaminants etc. Use of amendments in wetland construction, and its performance. Capital and maintenance costs.

#### UNITIV DESIGN OF WASTEWATER POND SYSTEMS 10

Introduction- facultative -partial -mix aerated- ponds -complete -mix aerated pond systems - anaerobic ponds -nitrogen removal in lagoons. Modified high -performance aerated pond systems for nitrification and denitrification - nitrogen removal in ponds coupled with wetlands and gravel bed nitrification filters -Control of algae and design of settling basins. Hydraulic control of ponds - removal of phosphorous -removal of pharmaceuticals and personal care products and antibiotic resistant genes.

**UNIT V SLUDGE MANAGEMENT AND TREATMENT**

9

Sludge quantity and characteristics - stabilization and dewatering -sludge freezing -reed beds - Vermi stabilization -comparison of bed type operations -composting land application and surface disposal of bio solids onsite wastewater systems -effluent disposal and reuse. Sludge quantity and characteristics-stabilization and dewatering-sludge freezing reed beds-Vermi stabilization- Comparison of bed-type operations-composting land application and surface disposal of biosolids- on-site wastewater systems- effluent disposal and reuse.

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

On completion of the course, the student is expected to be able to

- CO1** Explain the various aspects of wetland system, its function and its application in the treatment of wastewaters
- CO2** Apply the knowledge of science and engineering fundamentals to know the types of wetlands, construction and operation of wetlands, wetland hydraulics and design of wetland and its performance Understand the process of treatment of domestic waste in the removal of solids, organic matter, phosphate, nitrogen, pathogens and its reuse
- CO3** Understand the process of treatment of industrial wastewater in the removal of solids, organic matter, phosphate, nitrogen, heavy metals, phenolics and feasibility for reuse
- CO4** Understand the various pond system available for wastewater treatment. design of pond system -removal mechanism
- CO5** Manage and dispose the sludge naturally and economically.

**REFERENCES:**

1. EPA- Design Manual on constructed wetland and aquatic plant system for municipal wastewater treatment system
2. Treatment wetlands by Robert. H. Kadlec, Scott Wallace, CRC press published July 22, 2008
3. Natural Wastewater Treatment Systems, Ronald W. Crites, E. Joe Middlebrooks, Robert K. Bastia, 2nd Edition, CRC Press Published March 14, 2014
4. Waste water treatment in constructed wetlands with horizontal sub- surface flow by Jan Vyamazal and Lenka Kropfelova, Springer 2010.
5. Constructed wetlands for industrial wastewater treatment system by Alexandros I. Stefanakis (editor), Wiley black well.2018

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

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

**EN3006 DESIGN OF WATER AND WASTEWATER TREATMENT PLANTS L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- To educate the students on the principles and process designs of various treatment systems for water and wastewater.
- Develop an understanding of the characteristics of water and wastewater that must be considered during design of a treatment plant.

- Students will gain competency in the iterative process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process equipment items.

**UNIT I PRINCIPLES OF TREATMENT 9**

Pollutants in water and wastewater – characteristics - treatment processes – Selection criteria-types of reactors - kinetics – Unit operations and unit processes- - screening, skimming, floatation – mixing, equalization, sedimentation, filtration – gas transfer – adsorption – Isotherms –membrane separation, neutralization - coagulation flocculation – precipitation – stabilization – disinfection, Ion exchange – advanced oxidation processes.

**UNIT II DESIGN OF WATER TREATMENT PLANTS 9**

Design of treatment plant units – selection of process - upgrading existing plants – aerators – chemical feeding – Flash mixer- Clariflocculator – lamella and plate settlers- – filters – rapid sand filters, pressure filter, dual media filters-Multimedia filters – disinfectors- design of softeners – demineralization plant –reverse osmosis plants.

**UNIT III DESIGN OF CONVENTIONAL WASTEWATER TREATMENT PLANTS 9**

Design of aerobic treatment systems - activated sludge process and variations, trickling filters- bio tower-RBC- aerated lagoons – natural treatment systems- waste stabilization ponds, constructed wetland – Disinfection – Nutrient removal systems

**UNIT IV DESIGN OF ADVANCED WASTEWATER TREATMENT PLANTS 9**

Design of sequencing batch reactors- moving bed biofilm reactors- membrane bioreactor- reclamation and reuse of wastewater - application of membrane separation technologies in reuse of sewage -nutrient removal systems- UASB – post treatment systems for UASB reactor- anaerobic filters -recent trends.

**UNIT V RESIDUAL MANAGEMENT OPERATION AND MAINTENANCE ASPECTS 9**

Characteristics of sludge from WTP and STP-Design of sludge management facilities for WTP and STP-sludge thickening-sludge digestion- design of anaerobic digester-biogas generation- sludge dewatering –filter press - centrifugation-- sludge drying beds - construction, operation and Maintenance aspects of WTP and STP – trouble shooting – capacity building, case studies of Retrofitting.

**TOTAL 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

- CO1** Understand the principle of water and wastewater treatment
- CO2** Design and sizing the different components of water treatment plant.
- CO3** Design of conventional wastewater treatment units
- CO4** understand in detail about the design of advanced wastewater treatment units
- CO5** design the different elements of sludge treatment systems and understand the importance O&M issues pertaining to WTP and STP

**REFERENCES:**

1. Arceivala S.J., and Asolekar S.R "Wastewater Treatment for Pollution Control and reuse "McGraw Hill, third Edition, New Delhi, 2007.
2. Manual on "Sewerage and Sewage Treatment Systems Part A, Part B &Part C" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
3. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.
4. Qasim, S. R. and Guang Zhu "Wastewater Treatment and Reuse. Theory and Design Examples", CRC Press, New York, 2018.
5. F.R. Spellman, "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York 2009.
6. David Hendricks, "Fundamentals of Water Treatment Process", CRC Press, New York 2011.

## 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								2		
2		3	3	2		2			3						
3		3		1				2		2	2		2	2	2
4			2	2		2	2				2		2		2
5				1	2	2	3		2					3	
Avg.	3	3	3	1	2	2	2	2	2	2	2	2	2	2	2

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

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

## VERTICAL II : AIR POLLUTION ENGINEERING

EN3007

INDOOR AIR QUALITY MANAGEMENT

L T P C  
3 0 0 3

### OBJECTIVES

- The main objective of this course is to provide an indoor setting that is healthy for the occupants, and enhances well-being, performance and productivity.

### UNIT I INTRODUCTION

9

Introduction-sources and type of indoor pollutants-types-effects-Building related illness-Sick building syndrome— fundamental calculations -contaminant exposure level-Indoor air quality standards.

### UNIT II TYPE OF INDOOR ENVIRONMENT

9

Components and classification – industrial ventilation system -Special indoor environment-Hospitals --transportation-recreation building-commercial buildings-pollutants-human responses to indoor environment-lighting-acoustic environment-odour-thermal comfort.

### UNIT III MONITORING AND MEASUREMENT TECHNIQUES

9

Instrument and methods-Instrument selection process- Sampling and analysis -sensors-Estimation of pollution emission rate- emission factors-puss diffusion-evaporation and diffusion-drop evaporation-leaks-problems.

### UNIT IV PREVENTION AND CONTROL OF INDOOR POLLUTION

9

Air cleaning – Removal of gases and vapours-Adsorption-Chemisorption- other process-Particle removal by Filters, air cleaners, cyclones and scrubbers HVAC systems –Principle, function and type, air purifiers, bio filters –Current trends

### UNIT V INDOOR AIR QUALITY MANAGEMENT AND MODELING

9

Factor for designing healthy building- ventilation strategy- ventilation requirement-Indoor air quality model-well mixed model-statistical model- mass balance model- computational fluid dynamics model- modelling of air flows with gaseous contaminants-recent trends.

**TOTAL :45 PERIODS**

### COURSE OUTCOME:

Upon completion of this course, students should be able to:

**CO1 :** Identify the Common indoor air pollutants and their sources

**CO2:** Understand human responses to indoor environment

**CO3:** Estimate pollutant emission rates using emission factors and fundamental mass balance techniques.

**CO4:** Understand prevention and control of indoor pollution

**CO5:** Develop mathematical models for indoor air quality.

**TEXT BOOKS:**

1. John D Spengler, Jonathan M.Samet,John F. McCarthy "Indoor Air quality Handbook : by published by McGraw Hill Edn.2001.
2. Robert Jennings Heinsohn and John M Cimbala "Indoor Air Quality Engineering: Environmental Health and Control of indoor pollutants" Published by Marcel Dekker, New York, 2003.

**REFERENCES:**

- 1.Marco Maroni, B. Seifert and T. Lindvall "Indoor Air Quality: A Comprehensive Reference Book' Elsevier Science & Technology, 1995

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

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

**EN3008**

**NOISE POLLUTION CONTROL IN INDUSTRIES**

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

**COURSE OBJECTIVES:**

- To regulate and control noise producing and generating sources.
- To maintain the ambient air quality standards in respect of noise.

**UNIT I SOURCES OF NOISE POLLUTION**

**9**

Noise pollution – global implications of noise pollution-Sources-classification of noise pollutants-units of noise-effects of noise pollution on human animals and property and plants

**UNIT II PROPAGATION OF NOISE**

**9**

Noise pollution chemistry-basics of acoustics-specification of sound-power intensity-sound pressure levels-point and line sources-multiple sources-outdoor and indoor noise propagation-psycho acoustics-noise criteria.

**UNIT III EFFECTS OF NOISE POLLUTION**

**9**

Noise criteria-effects of noise on health-annoyance rating schemes-special noise environments-infra sound-ultra sound-impulsive sound-and sonic boom-noise standards-and limit values-noise instrumentation-monitoring procedure-noise indices.

**UNIT IV CONTROL OF NOISE POLLUTION**

**9**

Control – source correction methods-control equipment -prevention of noise pollution-suppression of noise at source-acoustic zoning-methods of prevention.

**UNIT V STANDARD FOR NOISE POLLUTION**

**9**

Sources – weighting networks-measurement of noise indices-noise pollution standards-active and passive methods-vibrations and their measurements-case study-of impact on human health.

**TOTAL : 45 PERIODS**

**COURSE OUTCOME:**

The students completing the course will have

- CO1** an understanding of the nature and characteristics of, noise pollution and basic concepts of air quality management
- CO2** ability to identify, formulate and solve air and noise pollution problems
- CO3** ability to design stacks and particulate air pollution control devices to meet applicable laws.
- CO5** Explain the source and types of industrial air pollution and their environmental impacts and choose the regulatory laws pertaining to environmental protection
- CO6** Conduct research to develop effective management systems for industrial air pollution that are technically sound, economically feasible and socially acceptable

**REFERENCES**

- Environmental Engineering – Arcadio P. Sincero and Gregoria A. Sincero, Prentice Hall of India, 1999.
- Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.
- Environmental Noise Pollution – PE Cunniff, McGraw Hill, New York, 1987.
- Handbook of Noise Measurement – APG Peterson & EE Gross PH, Englewood cliffs New Jersey, latest edition.
- Air Pollution Control Equipment – H. Brauer and Y. B. G. Verma, Berlin Heidelberg, New York, latest edition.

**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									3		
2	2	3	3	2										2	2
3	2	2	3			3		2						2	2
4					3		2		3		2			2	2
5					3		3		3	3	2	2		2	2
Avg.	2	2	3	2	3	3	2	2	3	3	2	2	3	2	2

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

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

**CAI332**
**CLIMATE CHANGE AND ADAPTATION**
**L T P C  
3 0 0 3**
**COURSE OBJECTIVES:**

- To know the basics, importance of global warming
- To know the concept of mitigation measures against global warming
- To learn about the global warming and climate change

**UNIT I EARTHS CLIMATE SYSTEM**
**9**

Role of ozone in environment ozone layer ozone depleting gases Green House Effect, Radiative effects of Greenhouses Gases Hydrological Cycle Green House Gases and Global Warming Carbon Cycle

**UNIT II ATMOSPHERE AND ITS COMPONENTS**
**9**

Importance of Atmosphere - Physical Chemical Characteristics of Atmosphere - Vertical structure of the atmosphere- Composition of the atmosphere Atmospheric stability- Temperature profile of the atmosphere - Lapse rates - Temperature inversion - effects of inversion on pollution dispersion.

**UNIT III IMPACTS OF CLIMATE CHANGE****9**

Causes of Climate change : Change of Temperature in the environment Melting of ice Pole-sea level rise-Impacts of Climate Change on various sectors Agriculture, Forestry and Ecosystem Water Resources Human Health Industry, Settlement and Society Methods and Scenarios Projected Impacts for Different Regions Uncertainties in the Projected Impacts of Climate Change Risk of Irreversible Changes.

**UNIT IV CLIMATE CHANGES AND ITS CAUSES****9**

Climate change and Carbon credits - CDM - Initiatives in India-Kyoto Protocol Intergovernmental Panel on Climate change - Climate Sensitivity and Feedbacks - The Montreal Protocol - UNFCCCIPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India.

**UNIT V CLIMATE CHANGE AND MITIGATION MEASURES****9**

Clean Development Mechanism -Carbon Trading -examples of future Clean Technology - Biodiesel - Natural Compost - Eco-Friendly Plastic - Alternate Energy -Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power -Mitigation Efforts in India and Adaptation funding Key Mitigation Technologies and Practices-Energy Supply - Transport - Buildings- Industry-Agriculture - Forestry - Carbon sequestration- Carbon capture and storage (CCS) - Municipal solid Waste (MSW) & Bio waste, Biomedical, Industrial waste International and Regional cooperation.

**FOR FURTHER READINGS**

Sequestration of carbon through renewable energy technologies

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

- CO1** Demonstrate an understanding of how the threats and opportunities of predicted climate changes will influence specific sectors at global and regional scale
- CO2** Identify the relationship between atmosphere and its components
- CO3** Analyze the impacts of climate change on environment parameters
- CO4** Evaluate the scientific insights underlying the assessment reports of the IPCC, with a focus on impacts, adaptation and mitigation
- CO5** Critically evaluate the relative opportunities and needs for mitigation and adaptation (including vulnerability assessments) in a variety of sectoral contexts

**TEXTBOOKS**

1. Sangam Shrestha, Mukand S. Babel and Vishnu Prasad Pandey,2014, Climate Change and Water Resources, CRC Press an imprint of the Taylor & Francis Group.
2. Intergovernmental Panel on Climate Change: <https://www.ipcc.ch/>

**REFERENCES**

1. Adaptation and mitigation of climate Scientific Technical Analysis, Cambridge University Press, Cambridge, 2006
2. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006
3. Jan C. van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes?, Cambridge University Press, 2003

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

PO/PSO	Course Outcome					Overall correlation of CO s to POs
	CO1	CO2	CO3	CO4	CO5	
PO1   Knowledge of Engineering Sciences	2	3	2	3	2	2
PO2   Problem Analysis	2	2	1	3	1	2
PO3   Design/ Development of Solutions	2	2	1	2	1	2

PO4	Investigations	2	3	2	1	2	2
PO5	Modern Tool Usage	2	3	3	2	3	3
PO6	Individual and Team work	1	1	2	2	3	2
PO7	Communication	2	2	3	1	2	2
PO8	The Engineer and Society	3	3	2	3	3	3
PO9	Ethics	1	1	2	1	2	1
PO10	Environment and Sustainability	2	3	2	1	1	2
PO11	Project Management and Finance	2	3	2	2	1	2
PO12	Life Long Learning	2	2	3	2	2	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	1	2	2	3	2
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	2	3	2
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	1	2	2	3	2

**EN3009**

## **LOW CARBON ECONOMY**

**LT P C  
3 0 0 3**

### **COURSE OBJECTIVES:**

- To impart knowledge on different sources of carbon emission, carbon reduction opportunities, low carbon technologies and Indian Missions on Climate Change

### **UNIT I            CARBON EMISSION**

**9**

Sources – Primary sectors – Agriculture, Livestock, Forestry – Mining, Secondary sectors – metal processing – non metallic product processing, wood processing – paper and pulp making – food processing, Tertiary sectors – Transportation services, health services

### **UNIT II            CARBON REDUCTION OPPORTUNITIES**

**9**

Energy efficiency – Energy conservation – Fuel switching – Energy policy - Energy storage- Smart grid- Methane cycle- Nuclear power and Carbon Capture and Storage- green house gas balances and mitigation costs.

### **UNIT III            LOW CARBON TECHNOLOGIES**

**9**

Green home – sustainable energy sources – bio energy, solar, hydro, geothermal – Fuel cells and hydrogen – Electric vehicles

### **UNIT IV            ENERGY EFFICIENT PROGRAMMES**

**9**

Good housekeeping practices – Regulation and/standards – Industrial cogeneration – Fiscal policies – Agreement/targets – Energy audits – Research and Development

### **UNIT V            INTEGRATED ENERGY POLICY**

**9**

Policy for renewable and non-conventional energy sources – Household energy security – Energy environment linkages – Energy supply-side and demand-side environment concern – Environmental impacts of renewable energy – India's approach to climate change

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

The students completing the course will have the ability to

**CO1:** Identify sources of carbon emissions and outline the carbon reduction opportunities, low carbon technologies

**CO2:** Explore the carbon reduction opportunities

**CO3:** Develop low carbon technologies

**CO4:** Develop energy efficient programmes and integrated energy policy in line with national and global approach to climate change mitigation.

**CO5** Develop policy for renewable and non-conventional energy sources

### **TEXTBOOKS:**

1. Tom Tietenberg, "Environmental and Natural Resource Economics", 5th Edition, Harper Collins College Publishers, 2000.
2. Perman R, Y. Ma, J. McGilvray and M. Common, Natural Resource and Environmental Economics, 3<sup>rd</sup> edition, Pearson Education, Harlow, 2003.

### **REFERENCES:**

1. Bertrand Metz et al., "IPCC Special Report on Carbon dioxide capture and storage, Cambridge University Press, 2005.
2. "Integrated Energy Policy" – Report of the Expert Committee, Government of India, Planning Commission, 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	3											1	3		
2			3				2		2				2		3
3		3		2		3	2				1	1	2	2	2
4	3		2		2	3	2		1				1	2	2
5	3	3	3		2	2	1		2		1	1	2	2	2
Avg.	3	3	3	2	2	3	2		2		1	1	2	2	2

**EN3010**

**CLIMATOLOGY AND METEOROLOGY**

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

### **COURSE OBJECTIVES:**

- To expose the students the various aspects of Climatology and Meteorology.

#### **UNIT I EARTH'S CLIMATE SYSTEM**

**9**

Introduction- Climate in the spotlight- The Earth's Climate Machine- Climate Classification- Global Wind Systems- Trade Winds and the Hadley Cell- The Westerlies- Cloud Formation and Monsoon Rains- Storms and Hurricanes- The Hydrological Cycle- Global Ocean Circulation- El Nino and its Effect- Solar Radiation- The Earth's Natural Green House Effect- Green House Gases and Global Warming- Carbon Cycle.

#### **UNIT II OBSERVED CHANGES AND ITS CAUSES**

**9**

Observation of Climate Change- Changes in patterns of temperature- Precipitation and sea level rise- Observed effects of Climate Changes- Patterns of Large scale Variability- Drivers of Climate change- Climate Sensitivity and Feedbacks- The Montreal Protocol- UNFCCC- IPCC- Evidences of changes in Climate and Environment- On a Global Scale and in Indian.

**UNIT III IMPACTS OF CLIMATE CHANGE** 9

Impacts of Climate Change on Various sectors- Agriculture, Forestry and Ecosystem-Water Resources- Human Health- Industry, Settlement and Society- Methods and Scenarios- Projected Impacts for Different Regions- Uncertainties in the Projected Impacts of Climate change- Risk of Irreversible Changes.

**UNIT IV METEOROLOGY** 9

Importance of the atmosphere- composition of atmosphere Regions and Stratification of atmosphere- Energy transfer in the atmosphere- Atmosphere mass transfer- Meteorology and weather meteorological parameters- Inversion and air pollution- Microclimate- Global aspect of Weather and Climate.

**UNIT V PLUME BEHAVIOR AND POLLUTANT DISPERSION** 9

Temperature Lapse rate- Atmospheric stability- Maximum Mixing Depth- Ventilation Coefficient- Meteorology influence on Plume Behavior- Effect of topography on Pollutant dispersion- Effect of air pollutants on meteorology- Effective stack height- Gaussian plume model.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students completing the course will have ability to

**CO1** Understand earth's climate system

**CO2** describe the pattern of changes in climate

**CO3** Understand the impacts of climate change

**CO4** Understand meteorology and weather meteorological parameters

**CO5** predict plume behavior and pollutant dispersion

**TEXTBOOKS:**

1. Stanley E.Manahan, "Environmental Science and Technology", Lewis Publisher, 1997
2. KVSA , Muralikrishna , "Air Pollution and central", published by Kanshal and co – Kakinada, 1997

**REFERENCES:**

1. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press 2003
2. Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge University Press Indian Pvt.Ltd, 2007
3. Anjaneyulu.Y „Air pollution and Control Technology" Allied Publishers (P) Ltd, India 2002.
4. IPCC, Fourth Assessment Report- the AR4 synthesis report.

**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	2	3	3	1	3					2		2		2
<b>2</b>	2	3	3	3		2	2		2						2
<b>3</b>	2		2		2		2	2	3	2	2		3		3
<b>4</b>	2	3	3	2	2					2		2		3	
<b>5</b>	2	3	3		1	3		2			2	2	2		2
<b>Avg.</b>	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2

**EN3011****AIR QUALITY MODELING AND MAPPING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To introduce the fundamentals of air pollution with a background on historical perspective on air pollution.
- To introduce the theory of dispersion of air pollution in the atmosphere.
- To discuss the major approaches for air pollution modeling
- To demonstrate the features and the use of most widely used commercial and freely available air quality models

**UNIT I MODELING CONCEPT****9**

Overview of different types of models-deterministic and stochastic approach- Steps in model development- numerical and simulations models- calibration and validation of models- Limitations- Transport phenomena- Mass balance analysis-Model development and decision making.

**UNIT II AIR POLLUTION MODELING****10**

Chemistry of air Pollutants - Atmospheric reactions, sinks for air pollution –Transport of air Pollutants - Meteorological settling for dispersal of air pollutants – Vertical structure of temperature and stability, atmospheric motions, Wind and shear, self-cleaning of atmosphere; transport and diffusion of stack emissions – atmospheric characteristics significant to transport and diffusion of stack emission – stack

**UNIT III AIR QUALITY MODELS****11**

Types modeling technique, modeling for nonreactive pollutants, single source, short term impact, multiple sources and area sources, Fixed box models- diffusion models – Gaussian plume derivation- modifications of Gaussian plume equation- long term average-multiple cell model- receptor oriented and source oriented air pollution models- model performance, accuracy and utilization-air Quality Index -air quality mapping

**UNIT IV INDOOR AIR QUALITY MODELS****9**

Indoor Air Pollutants - Volatile Organic Compounds , Inorganic Gaseous Pollutants Respirable Particulates ,Bioaerosols, Radon and its decay products-Infectious disease transmission- A/C units in indoor- Odours and sick building syndrome-Indoor Air quality Models.

**UNIT V SOFTWARE PACKAGE APPLICATIONS****6**

Commercial air quality models -ADMS, Airviro and USEPA models

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

The students completing the course will have ability to

- CO1** understand modelling concept
- CO2** Comprehend the fate and transport of air pollutants
- CO3** understand air quality modelling techniques
- CO4** develop indoor air quality models
- CO5** Apply soft computing techniques in air quality modelling

**REFERENCES:**

1. Zannetti, P. 1990. Air Pollution Modeling Theories, Computational Methods and Available Software. Van Nostrand Reinhold, New York.
2. R.W.Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994
3. J.L.Schnoor, Environmental Modeling Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons Inc., New York, 1996.
4. Arthur C.Stern Air Pollution (Third Ed.) Volume I – Air Pol utants, their transformation and Transport, (Ed.), Academic Press, 2006.
5. Deaton and Wine Brake, "Dynamic Modeling of Environmental Systems", Wiley & Sons, 2002.

## 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	3	3	1	3					2		2		2
2	2	3	3	3		2	2		2					2	
3	2		2		2		2	2	3	2	2		3		3
4	2	3	3	2	2					2		2		3	
5	2	3	3		1	3		2			2	2	2		2
Avg.	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2

EN3012

## CLIMATE CHANGE AND MODELLING

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

- To introduce the emerging concepts of climate modelling and projecting future climate change, understand data analysis and application.

### UNIT I CLIMATE CHANGE AND CLIMATE VARIABILITY 9

Introduction- atmosphere - weather and climate - climate parameters (Temperature, Rainfall, Humidity, Wind etc.,) Equations governing the atmosphere - numerical weather prediction models - introduction to GCMs - applications in climate change projections

### UNIT II IPCC CLIMATE SCENARIOS 9

Intergovernmental PANEL on Climate Change (IPCC) - an overview - key assumptions – Representative Concentration Pathways (RCP 2.6, 4.5, 6.0, 8.5)

### UNIT III GLOBAL CLIMATE MODEL AND REGIONAL CLIMATE MODEL 9

Climate model – types of model- General Circulation Models (GCM) - Issues with GCMs - Introduction to RCMs and LAMs - RCMs modellers -advantages and disadvantages of GCMs and RCMs

### UNIT IV DOWNSCALING GLOBAL CLIMATE MODEL - AN OVERVIEW 9

Need for downscaling - selection of GCMs for regional climate change studies - ensemble theory selection of ensembles, model domain (Spatial domain and temporal domain), Resolution and climate variables - lateral boundary conditions - methods of downscaling (Statistical and Dynamical) - examples from each and their limitations.

### UNIT V ANALYSIS AND POST PROCESSING 9

Model validation and calibration- evaluating model performance- post processing - introduction to analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS - climate change impact - vulnerability assessment-case studies-Adaptation strategies

**TOTAL: 45 PERIODS**

### OUTCOMES

- On completion of the course, the student is expected to be able to
- CO1:** Understand the basics of climate change and variability
- CO2:** Comprehend the latest IPCC climate scenarios
- CO3:** Gain in-depth knowledge on climate models
- CO4:** Downscale of climate scenarios through different modelling techniques, and validate climate models
- CO5:** Post process the model outputs for climate impact assessment, know about adaptation strategies

**REFERENCES:**

1. IPCC Fifth Assessment Report, Cambridge University Press, Cambridge, UK, 2013
2. Neelin David J, "Climate Change and Climate Modelling", Cambridge University Press 2011
3. Kendal McGuffie, Ann Henderson, "A Climate Modelling" Primer 3<sup>rd</sup> Edition, John Wiley & Sons, Ltd, Chichester, UK 2005
4. Thomas Stocker, "Introduction to Climate Modelling", Advances in Geophysical and Environmental Mechanics and Mathematics. Springer Publication, 2011
5. David Archer, 'Global warming-Understanding the forecast', Blackwell publishing, 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	3	3	1	3					2		2		2
2	2	3	3	3		2	2		2					2	
3	2		2		2		2	2	3	2	2		3		3
4	2	3	3	2	2					2		2		3	
5	2	3	3		1	3		2			2	2	2		2
Avg.	2	3	3	3	2	3	2	2	3	2	2	2	2	2	2

**VERTICAL III: SOLID WASTE MANAGEMENT****CAI331 BIOCHEMICAL AND THERMOCHEMICAL CONVERSION OF BIOMASS**

L T P C  
3 0 0 3

**COURSE OBJECTIVE:**

- To expose the students with different bio and thermal conversion of biomass.

**UNIT I BIOMASS CHARACTERIZATION****9**

Biomass – types – fuels from biomass. Terms and units used in biomass production. Biomass fuel characterization – physical, chemical and thermal – energy release. Supply chain – harvesting / collection – transportation and processing. Briquetting – types – pelletizing.

**UNIT II BIOCHEMICAL CONVERSION****9**

Biochemical degradation – factors affecting biogas production - types of biogas plants – construction details – operation and maintenance – utilization of biogas - slurry handling, utilization and enrichment – high rate biomethanation process – landfills – bioethanol – feedstock – process – utilization - composting - methods – machinery.

**UNIT III THERMO CHEMICAL CONVERSION BY COMBUSTION****9**

Thermochemical degradation. stoichiometric air requirement - Combustion process – chemistry of combustion - combustion zones - emissions. Cofiring of biomass. Incinerators - layout. Combustion of wastes and MSW. Wood burning stoves - types- operation.

**UNIT IV THERMOCHEMICAL CONVERSION BY GASIFICATION AND PYROLYSIS****9**

Biomass gasification – chemistry of gasification – types of gasifier – Gas cleaning & conditioning - utilization of producer gas - emissions – commercial gasifiers plants. Pyrolysis – product recovery – types - biochar – bio oil – operation – recovery.

**UNIT V COGENERATION AND WASTE HEAT RECOVERY**

9

Cogeneration technologies – cycles – topping – bottoming – problems – applications – selection. Waste heat recovery - plate heat exchangers - waste heat boilers - heat pumps - thermic fluid heaters - selection of waste heat recovery.

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. Chawla, O.P.1986. "Advances in Biogas Technology". ICAR Publication, New Delhi.
2. Rao. S and B.B. Parulekar. 2000. Energy Technology – Non conventional, Renewable and Conventional. Khanna Publishers, New Delhi.
3. Horlock JH, 1987. Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford Press.

**REFERENCES**

1. Khandelwal K.C. and Mahdi, S.S. 1986. Biogas Technology. Tata Mc Graw Hill Pub. Co. Ltd., New Delhi.
2. Srivastava, P.K., Shukla, B.D. and Ojha, T.P. 1993. Technology and application of biogas. Jain Brothers, New Delhi.
3. Mathur,A.N.and Rathore,N.S.1993.,Biogas production Management and Utilisation. Himanshu Publication. New Delhi.
4. Chakraverty, A. 1993. Biotechnology and other alternate technologies for utilisation of biomass. Oxford and IBH Publishing Co., New Delhi.

**COURSE OUTCOMES:****CO1** Biomass identification and classes**CO2** Biomass characters and biochemical conversion.**CO3** Thermo chemical conversion techniques and cogeneration from waste**CO4** To know about application of biomass conversion**CO5** Analyse the energy generated from waste**CO's-PO's & PSO's MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis	1	1	1	2	3	2
PO3	Design/ Development of Solutions	2	2	3	2	3	2
PO4	Conduct Investigations of Complex Problems	2	2	2	3	3	2
PO5	Modern Tool Usage	1	3	3	3	3	3
PO6	The Engineer and Society	3	3	3	3	3	3
PO7	Environment and Sustainability	3	2	3	3	3	3
PO8	Ethics						
PO9	Individual and team work	2	2	2	2	2	2
PO10	Communication	1	1	1	1	1	1
PO11	Project management and finance	3	3	3	3	3	3
PO12	Life-long learning:	2	2	2	2	2	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	2	2	2	2	2	2

PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	2	2	2	2	2
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	2	2	2	2	2	2

**EN3013**

## **BIOMEDICAL WASTE MANAGEMENT**

**LT P C  
3 0 0 3**

### **COURSE OBJECTIVES**

- To collect & receive the biomedical waste from health care facilities.
- To analyze and decide the treatment and disposal scheme of wastes as per the guidelines

### **UNIT I            SOURCES OF BIOMEDICAL WASTE            9**

Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, – Sharps – Pathological Waste -Pharmaceutical Waste – Genotoxic Waste – Radioactive Waste – Chemical Waste – All other non-hazardous waste.

### **UNIT II            BIOMEDICAL WASTE MANAGEMENT            9**

Need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling and disposal.

### **UNIT III            HAZARDOUS MATERIALS            9**

Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Respiratory Protection.

### **UNIT IV            FACILITY SAFETY            9**

Introduction, Facility Guidelines: Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Tool Safety, Electrical Safety, Control of Hazardous Energy, Landscape and Ground Maintenance, Fleet and Vehicle Safety.

### **UNIT V            INFECTION CONTROL, PREVENTION AND PATIENT SAFETY            9**

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilant, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Healthcare-Associated Infections, Medication Safety.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

**On completion of the course, the student is expected to be able to**

**CO1** Have an overview biomedical waste and its categorization.

**CO2** Understand the need for disposal of biomedical waste, segregation and labeling

**CO3** Have an in-depth understanding of the hazardous materials, its regulation

**CO4** Have an overview on the facility guidelines

**CO5** Understand the infection control, prevention and patient safety.

## REFERENCE

1. Environmental Engineering by Arcadio Sincero and Gregoria Sincero, Second Edition, Prentice -Hall India
  2. Integrated Solid Waste Management: Engineering Principles and Management Issues by George Tchobanoglous, McGraw-Hill Publication
  3. Hazardous Waste Management by M LaGrega and others, McGraw-Hill Publication

## **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												1	3	
2	3		3				2		2				2		3
3	3	3		2		3	2				1		2	2	2
4	3		3		2	3	2		2				2	2	2
5	3	3	3		2	3	2		2		1		3	2	2
Avg.	3	3	3	2	2	3	2		2		1	1	2	2	2

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

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

**EN3014 LANDFILL ENGINEERING AND REMEDIATION TECHNOLOGY**

L T P C  
3 003

## **COURSE OBJECTIVE:**

- To understand the important characteristics and design principles of the waste containment and remediation industry as well as know the relevant regulations and engineering design requirements of landfills and contaminated site remediation

## UNIT I LANDFILL BASICS

8

Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuration - Legal frame work for landfilling – Landfill Site investigation- Regional Landfills- Environmental control using site design -- Landfill Design Tasks

## **UNIT II            LANDFILL LINERS AND COVER SYSTEMS**

10

Landfill barrier system components – Design of Compacted clay liners: Factors affecting hydraulic conductivity , Water content-density criteria, Thickness, Desiccation - Geo synthetic Clay Liners and Geomembranes; types, manufacturing, handling, seaming and testing - Asphalt Barriers and Capillary barrier - Composite Liner system design- liner construction and quality control- Leakage through Liners- vapor transmission and chemical compatibility - Installation of Geo membranes - Liner Leakage Mechanism – Diffusion - Controls on advection through liners - Single phase flow advection-diffusion- Landfill cover systems- Design of Cover Systems – Daily Cover – Intermediate Cover – Final Cover - Flow through Landfill Covers- Design and Analysis of Slope Stability- Anchor Trenches- Access ramps - Erosion control

## **UNIT III LEACHATE AND LANDFILL GAS MANAGEMENT**

9

Waste decomposition in landfills - Factors affecting leachate and landfill gas generation – Factors affecting Leachate Quantity in active and post closure conditions- Hydrologic Evaluation of *Landfill* Performance (HELP) model – Leachate Drainage Layer – Geotextile and Geonet design – leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems- Gas condensate issues & knockouts - Leachate treatment methods (biological and physico-chemical)- Leachate re-circulation & bioreactor landfills monitoring and control of leachate and Landfill gas- Landfill Settlement

## **UNIT IV      LANDFILL OPERATION AND CLOSURE**

8

Landfill Construction and Operational Controls – Fill Sequencing Plans – Cell Construction-Dozer and Compactor operations-Selection of Landfill Equipment- Landfill Administration-Record Keeping - Topographic mapping-Environmental Controls – Odour, Vector and Litter Control – Landfill Safety - Fire Control – Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills – Landfill Economics- landfill construction and operational cost estimation – establishing tipping fees

## **UNIT V            CONTAMINATED SITE REMEDIATION**

10

Contaminated sites - Fate and behavior of toxics and persistent substances in the environment – Engineering Issues in Site Remediation - Site Characterization - Framework for risk assessment at landfill sites - Remediation Principles: Source Control and Management of Migration Covers, Cutoff Walls, Solidification / Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment – Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining

TOTAL: 45 PERIODS

## **COURSE OUTCOMES:**

**On completion of the course, the student is expected to be able to**

- CO1** Have an overview of the Indian and international landfill regulations and guidelines for the design, construction, operation and management of landfills
  - CO2** Understand the design and construction of landfills, processes in landfills, methods for management and treatment of landfill gas and leachate
  - CO3** Have an in-depth understanding of the key pollutants in leachate and gas, their potential environmental impacts and the
  - CO4** Make engineering design and study performance of control systems used to manage and treat pollutant and waste emissions from sites.
  - CO5** Be able to apply a risk based assessment of contaminated sites and implement site remediation technologies

## REFERENCES:

- REFERENCES**

  1. Robert M. Koerner and Donald H Gray (2002), "Geotechnical aspects of Landfill Design and Construction", Prentice Hall, New Jersey.
  2. Neal Bolton P.E (1995), "The Handbook of Landfill Operations", Blue Ridge Services Inc., Atascadero, CA – ISBN 0-9646956-0-x
  3. David E Daniel and Robert M. Koerner (2007), "Waste Containment Facilities –Guidance for construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, American Society of Civil Engineers, ASCE Press.
  4. Donald L Wise and Debra J Trantolo (2018), "Remediation of Hazardous Waste Contaminated Soils, Marcel Dekker Inc., New York
  5. George Tchobanoglou, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
  6. Hari D Sharma and Krishna R. Reddy (2004), Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Techonolgies, John Wiely, New Jersy
  7. Oweis, I.S. and Khera, R.P (1998) *Geotechnology of Waste Management*, 2nd Edition, PWS Publishing Co., Boston, MA

### 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												1	3	
2	3		3				2		2				2		3
3	3	3		2		3	2				1		2	2	2
4	3		3		2	3	2		2				2	2	2
5	3	3	3		2	3	2		2		1		3	2	2
Avg.	3	3	3	2	2	3	2		2		1	1	2	2	2

1.low, 2-medium, 3-high, “-“ no correlation

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

**EN3015**

**PLASTICS AND E WASTE MANAGEMENT**

**L T P C**

**3 0 0 3**

#### COURSE OBJECTIVES:

- To know various sources of plastics waste generation and the segregation methods for recycling the plastics and recycling codes of commodity and engineering plastics
- To learn about primary recycling techniques with examples/case studies.
- To understand the recycling of various commodity and engineering plastics.

#### UNIT I SOURCES AND CHARACTERIZATION 9

Plastic and environment value additions, global policy, regulations, waste energy management. Waste treatment of various plastic plants, estimations of power requirement & efficiency of size reduction operation of plastics, environment pollution aspects. Need for recycling – Sorting and segregation of waste – Plastics identification- Plastics Production and composition – Plastics waste – Composition, quantities and disposal alternatives.

#### UNIT II PRIMARY RECYCLING OF PLASTIC WASTES 9

Primary recycling – Equipment's for primary recycling. Specific recycling techniques – PE films, PP battery case – Crushing and separation – PET films.

#### UNIT III SECONDARY RECYCLING OF PLASTIC WASTES 9

Recycling of plastics from urban waste – rheology, density, mechanical behavior. Secondary recycling Plastics wastes containing paper – hydrolytic treatment – processing methods – processing of mixed plastics waste – household waste – industrial sector – TPO based materials.

#### UNIT IV TERTIARY RECYCLING OF PLASTIC WASTES 9

Use of recyclable plastics in motor vehicles – recoverable materials – disposal of residuals – recyclable plastic components – virgin and recycled HDPE – Fluorinated and unfluorinated HDPE – fuel tanks. Tertiary recycling – Reactors used – Advantages – Dry method wet method - use of recyclable plastics in automobiles.

#### UNIT V E WASTE MANAGEMENT 9

E-waste; composition and generation. Global context in e-waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E-waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management, Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-

mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completing this course, the students would understand the impact of plastic waste on environment and learn the technologies available for recycling and reusing of both commercial and engineering plastics. They also become familiarize with various

**CO1** Sources of plastics waste generation and the segregation methods for recycling the plastics

**CO2** Learn about various equipment for recycling of plastics

**CO3** Understand the process involved in secondary recycling of plastics

**CO4** Comprehend the tertiary recycling of plastics

**CO5** Understand the process involved in E waste management

**TEXT BOOKS:**

1. Polymer recycling, Science, Technology and Applications, John Scheirs, John Wiley and Sons, England 1988
2. Recycling of Plastic Materials (Ed), Francesco Paolo La Mantia, Chem Tec Publishing, 1993
3. Plastics Waste Management (Ed), Nabil Mustafa, Marcel Dekker, New York, 1995.

**REFERENCES:**

1. Degradable polymers, Recycling and Plastic Waste Management (Eds) Ann Christine Albertson and Samuel J. Huang, Marcel Dekker, New York.
2. John Schiles, Polymer Recycling.
3. Recycling and Plastics Waste Management, Edited by Dr.J.S.Anand, CIPET, 1 997.

**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	3		3			3			3		2	2	2		
3	3	2	3	2	3	2	3	2					3	2	
4	2	2		2	2	2	3		2				3	2	3
5	3	2	2		2		2		2				2	2	2
Avg.	3	2	3	2	2	3	2	2	2		2	2	3	2	3

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

**EN3016**

**INDUSTRIAL HAZARDOUS WASTE MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To impart knowledge on the identification, characterization, source reduction, storage, transport, processing and safe disposal of hazardous wastes.

**UNIT I            WASTE IDENTIFICATION**

**9**

Hazardous waste definition – Physical and Health hazards wastes – Hazardous Waste Management and Handling Rules

**UNIT II            CHARACTERISATION**

**9**

Characterization of hazardous wastes – Analytical– Analytical methods –Hazardous waste inventory-Source reduction of hazardous wastes

<b>UNIT III</b>	<b>STORAGE AND TRANSPORT PROCESSING OF HAZARDOUS WASTES</b>	<b>9</b>
Handling and storage of Hazardous wastes –Waste Compatibility Chart – Hazardous Waste Transport- Manifest system – Transboundary movement of wastes – Basal Convention		
<b>UNIT IV</b>	<b>TREATMENT OF HAZARDOUS WASTES</b>	<b>9</b>
Hazardous waste treatment technologies – Physical, chemical and thermal treatment of hazardous waste – Solidification – Chemical fixation – Encapsulation – Incineration		
<b>UNIT V</b>	<b>SECURE LANDFILLS</b>	<b>9</b>
Hazardous waste landfills – Site selections – landfill design and operation – Regulatory aspects – Liner System- Cover system- Leachate Collection and Management – Environmental Monitoring System- Landfill Closure and post closure care.		

## COURSE OUTCOMES:

**COURSE OUTCOMES:** The students completing the course will have

- The students completing the course will have

  - CO1** Ability to understand the legal framework of hazardous wastes management
  - CO2** An insight into the characterization of hazardous wastes and the role of different stakeholders under the national legal framework
  - CO3** Ability to design facilities for the storage and transport of hazardous wastes
  - CO4** Understand the processing of hazardous wastes
  - CO5** Know the disposal methods of hazardous wastes

## **TEXTBOOKS:**

1. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hill International.
  2. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition- 2009.
  3. Harry M. Freeman, Standard handbook of Hazardous waste treatment and disposal McGraw Hill 1997.

## REFERENCES

1. Hazardous Waste (Management and Transboundary Movement) Rules, Ministry of Environment and Forests, Government of India, New Delhi, 1989
  2. Biomedical Waste (Management and Handling) Rules, Ministry of Environment and Forests, Government of India, New Delhi, 1998
  3. Electronic Waste Management and Handling Rules, Ministry of Environment and Forests, Government of India, New Delhi, 2011

## 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	2	3	3					
2	2	3		2	3	2	3					2	2	3	
3	2	2	3	2	2	2							2		2
4	3	2	2			2			2			2	2		
5	2	2				2			2			2		2	2
Avg.	2	2	3	2	2	2	2	2	3	3		2	2	3	2

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

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

**EN3017**

**RESOURCE RECOVERY FROM WASTE**

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

**COURSE OBJECTIVE:**

- To understand the principles and design of recovering materials and energy from wastes through mechanical, biological and thermal methods and manage the undesirable by-products.

**UNIT I            MECHANICAL PROCESSING FOR MATERIAL RECYCLING            10**

Resource recovery for a sustainable development- Material and energy flow management and analysis - Systems and processes for reduction, reuse and recycling -Objectives of Waste Processing-Source Segregation and Hand Sorting-Waste Storage and Conveyance – Shredding – Pulping - Size Separation by Screens- Density Separation by Air Classification – magnetic and electromechanical separation processes- Design Criteria and Equipment selection

**UNIT II            BIOLOGICAL PROCESSING FOR RESOURCE RECOVERY            10**

Mechanisms of Biological Processing – Aerobic Processing of Organic fraction - Composting methods and processes- factors affecting- Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control- Vermiculture: definition, scope and importance - common species for culture - Environmental requirements - culture methods- Applications of vermiculture- Potentials and constraints for composting in India-Largescale and decentralized plants.

**UNIT III            BIO-CHEMICAL CONVERSION OF WASTE TO ENERGY            9**

Principles and Design of Anaerobic Digesters – Process characterization and control- The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment - Methane generation by Anaerobic Digestion- Anaerobic reactor technologies - Commercial anaerobic Technologies- Single stage and multistage digesters- Digester design and performance-Gas collection systems-Methane Generation and Recovery in Landfills – Biofuels from Biomass

**UNIT IV            THERMO-CHEMICAL CONVERSION OF WASTE TO ENERGY            8**

Principles and Design of Energy Recovery Facilities -Types and principles of energy conversion processes - Incinerator design - Mass Burn and RDF Systems- Composition and calorific value of fuels and waste, Determination of the stoichiometric air consumption, Calculation of the flue gas composition - grate firing designs, boiler design, removal of bottom ash, heat recovery- Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans - Alternative thermal processes: co-incineration, pyrolysis, gasification, plasma arc - Process characterization and control- waste heat recovery- Bottom ash: Quantity, quality, treatment, utilization, disposal- Facility design- decentralized mobile plants- Planning and construction of incineration plants

**UNIT V            CASE STUDIES ON WASTE RECYCLING            8**

Recycling technologies for paper, glass, metal, plastic – Used Lead Acid Battery Recycling – End of Life Vehicle Recycling – Electronic Waste Recycling – Waste Oil Recycling – Solvent Recovery - Drivers and barriers for material recycling: social, legal and economic factors - Environmental impacts of waste recycling - Design for the environment: the life cycle approach.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On Completion of the Course, the Candidate should:

- CO1** Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of materials and energy from waste
- CO2** Appreciate the increasing importance of waste and resource management in achieving environmental sustainability

**CO3** Be able to analyze and describe the potential of solid waste as a secondary raw material, and the associated problems and possibilities in a sustainable society.

**CO4** Understand thermo-chemical conversion of waste to energy

**CO5** Conceptualize recycling options for waste to energy

#### REFERENCES:

- 1 Aarne Veslind and Alan E Rimer (1981), "Unit operations in Resource Recovery Engineering ", Prentice Hall Inc., London
- 2 Manser A G R, Keeling A A (1996). Practical handbook of processing and recycling on municipal waste. Pub CRC Lewis London, ISBN 1-56670-164
- 3 Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein, *Modern Composting Technologies* JG Press October 2005
- 4 Charles R Rhyner (1995), Waste Management and Resource Recovery, Lewis Publishers
- 5 Gary C. Young (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons

#### 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		1	3		3		3		2		
2	2		2		2	2	2			2		2	2		2
3	3	3	3	2	2	2	2	2	2		3		2	3	
4	2	2	2	3	3	2			2			2	2	2	
4	2	2	1		1		2	2			2		2		2
Avg.	2	2	2	2	2	2	2	2	2	2	3	2	2	3	2

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

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

EN3018

GREEN BUILDINGS

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- This course aims to train the student in understanding and familiarization of different heat flow calculations and building simulation software. Several case studies will be presented to demonstrate how the various passive, low energy and energy saving concepts have been applied to real life buildings. The concepts of green buildings will be introduced and different rating systems for green buildings will be explained.

#### UNIT I INTRODUCTION TO GREEN BUILDINGS

9

Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

#### UNIT II SITE SELECTION AND PLANNING

9

Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc. Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, wastewater treatment, recycle and reuse systems.

**UNIT III ENERGY EFFICIENCY**

9

Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

**UNIT IV BUILDING MATERIALS**

9

Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

**UNIT V INDOOR ENVIRONMENTAL QUALITY**

9

Day lighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

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

After completion of this course, the students are expected to be able to

- CO1** Understand the rating of green building
- CO2** Recognise the criteria for site section for green buildings
- CO3** Reduce adverse environmental impact
- CO4** Reduce embodied energy in building materials
- CO5** Understand the environmental quality pertaining to green building

**REFERENCES**

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. Alternative building materials and technologies by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. Non-Conventional Energy Resources by G. D. Rai, Khanna Publishers.
5. Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi 2004
- .6. Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010.
7. Charles J. Kibert, Sustainable Construction – Green Building Design and Delivery, John Wiley Sons, New York, 2016.
8. Regina Leffers, Sustainable Construction and Design, Pearson / Prentice Hall, USA, 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	3		3		2								2		
2		3	3	2		2			3						
3		3		1				2		2	2		2	2	2
4			2	2		2	2				2		2		2
5				1	2	2	3		2					3	
Avg.	3	3	3	1	2	2	2	2	2	2	2	2	2	2	2

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

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

## VERTICAL IV: ENVIRONMENTAL MANAGEMENT

<b>EN3019</b>	<b>SURFACE AND GROUNDWATER QUALITY MODELLING</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

### **COURSE OBJECTIVES:**

- To introduce the fundamentals of mathematical models for water quality and the importance of model building.
- To educate about the water parameters modeling and various ground water quality modelling.
- To demonstrate the features and the use of most widely used computerized models for water quality

<b>UNIT I</b>	<b>MODELING PERCEPTIONS</b>	<b>9</b>
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Engineers and Mathematical Models-Water quality models – Historical development - Different types of models-- Steps in model development - Importance of model building. - Calibration and verification of models- conservation of mass and momentum - Chemical reaction kinetics – Law of mass action, Rate constants, reaction order, types of reactions, equilibrium principles.

<b>UNIT II</b>	<b>POLLUTANT TRANSPORT AND REACTOR MODELING</b>	<b>10</b>
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Transport phenomena – Advection, diffusion, dispersion- simple transport models – Plug flow models- Application of PFR and MFR model - Steady state and time variable solutions- completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feedback reactor systems

<b>UNIT III</b>	<b>SURFACE WATER QUALITY MODELING</b>	<b>10</b>
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Water quality modelling of Streams, Lakes and impoundments and Estuaries – Water quality– model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelps model for point and distributed sources - Modified Streeter Phelps equations -Toxicant modelling in flowing water.

<b>UNIT IV</b>	<b>GROUNDWATER QUALITY MODELING</b>	<b>8</b>
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Groundwater flow and mass transport of solutes, Degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modelling

<b>UNIT V</b>	<b>WATER QUALITY MODELING SOFTWARE</b>	<b>8</b>
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Exposure to surface water and groundwater quality modelling software – MIKE 21, QUAL2E and MODFLOW Models and their application, Case studies.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOME:**

- CO1** Know about the principles of water quality modelling.
- CO2** Understand the pollutant transport phenomena in surface and groundwater.
- CO3** Apply the knowledge of surface water quality modelling to predict the water quality of rivers, lakes and estuary.
- CO4** Predict the groundwater contamination transport.
- CO5** Predict water quality of surface and sub surface water using numerical solution.

### **REFERENCES:**

1. Steven C. Chapra, "Surface Water Quality Modeling", Tata McGraw-Hill Companies, Inc., New Delhi, 2008.
2. "Water Quality Modelling for Rivers and Streams" Authors: Benedini, Marcello, Tsakiris, George, Springer Netherlands 2013.
3. "Hydrodynamics and Water Quality: Modelling Rivers, Lakes, and Estuaries", Zhen-Gang Ji, John Wiley & Sons, 2008.

4. "Modelling Groundwater Flow and Contaminant Transport By Jacob Bear, A. H.-D. Cheng, Springer Science & Business Media, 2010.
  5. "Mathematical Modelling of Groundwater Pollution" Ne-Zheng Sun, Alexander Sun, Springer New York, 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	3			3									2		2
3			2		2			2			2				3
4		2	3	3	3	3	3	2		2	2			3	
5		3	2		2	3	3		2		2	3	3	2	
Avg.	3	3	3	3	3	3	3	2	2	2	2	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.**

**EN3020      REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL MANAGEMENT**

L T P C  
3 003

## **COURSE OBJECTIVES:**

- To educate the students on aspects of Remote Sensing
  - Develop the different remote sensing technique
  - To educate the students on aspects of GIS and data management.
  - Develop the GIS Applications for monitoring and management of environment

UNIT I ELEMENTS OF REMOTE SENSING

9

**UNIT - ELEMENTS OF REMOTE SENSING**  
Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Electromagnetic spectrum, Energy interaction, Spectral response pattern of earth surface features. Energy recording technology

UNIT II                    REMOTE SENSING TECHNOLOGY

9

Classification of Remote Sensing Systems, Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR

UNIT III      SATELLITE REMOTE SENSING

9

Satellites and their sensors, satellite orbits, Indian space programme - Research and development - ISRO satellites, LANDSAT, ERS, SPOT, TERRA and NOOA satellite series, Characteristics of Remote Sensing data. Satellite data Products

UNIT IV      REMOTE SENSING APPLICATIONS AND CASE STUDIES

9

Visual image interpretation, Digital image processing – Image rectification, Enhancement, transformation, Classification, Data merging – Remote sensing applications in Monitoring and management of environment - Conservation of resources, Disaster management, Sustainable urban land use, Agriculture, EIA, Marine and Coastal zone management – Case studies

UNIT V      GEOGRAPHICAL INFORMATION SYSTEM CASE STUDIES

9

**GIS - Concepts and components, Spatial and non-spatial data, Vector and raster data structures, Data analysis, Database management – RS – GIS Integration, Image processing software, GIS software GIS applications in Monitoring and management of environment - Case studies.**

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

On completion of the course, the students are able to

- On completion of the course, the students are able to

  - CO1** Know the remote sensing principle and the different stages of remote sensing
  - CO2** Understand the various type remote sensing technology.
  - CO3** Apply the knowledge of satellite sensing system for different environmental issues.
  - CO4** Apply the knowledge of GIS and image analysis for environmental applications.
  - CO5** Develop the GIS data base. And work with multi-disciplinary team.

## REFERENCES:

1. Lillesand, T.M. and Kiefer, R.W, "Remote sensing and image interpretation", John Wiley and sons, New York, 2018.
  2. Golfried Konechy, Geoinformation: "Remote sensing, Photogrammetry and Geographical Information Systems", CRC press, 1st Edition, 2017.
  3. Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information systems" Oxford University Press, New York, 2017.
  4. "Pmapler and Applications of Imaging RADAR", Manual of Remote Sensing, Vol.2, ASPR, 2011

## 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			
2		2						2	2						
3		2		3			2	3			3				3
4	2		3	2	3	2	2			2	3		3	2	3
5			2	2			3		3	2	3	2	2	2	2
Avg.	2	2	2	2	3	2	2	2	3	2	3	3	2	2	3

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

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

## **EN3021 OCCUPATIONAL HEALTH, SAFETY AND RISK ASSESSMENT L T P C**

## **COURSE OBJECTIVES:**

- To educate overview of EHS in industries and related Indian regulations, types of Health hazards, effect, assessment and control methods and EHS Management System

UNIT I INTRODUCTION

9

Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of trade union safety representatives - Ergonomics.

UNIT II OCCUPATIONAL HEALTH AND HYGIENE 10

## **UNIT II OCCUPATIONAL HEALTH AND HYGIENE**

Definition of occupational health and hygiene - Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits - Hierarchy of control measures - Role of personal protective equipment and the selection criteria

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 11

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control, Noise, Chemical and Radiation Safety – Electrical Safety – Fire Safety – Safety at Construction sites, ETP – Machine guarding – Process Safety, Working at different levels

**UNIT IV HAZARDS AND RISK MANAGEMENT 8**

Safety appraisal – Job Safety Analysis-Control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques –Onsite and Offsite emergency Plans. Employee Participation- Education and Training- Case Studies

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 7**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students are expected to be able to understand:

- CO1** Need for EHS in industries and related Indian regulations
- CO2** Various types of Health hazards, effect, assessment and control methods
- CO3** Various safety systems in working environments
- CO4** The methodology for preparation of Emergency Plans and Accident investigation
- CO5** EHS Management System and its elements

**REFERENCES:**

1. ISO 45001:2018 Occupational health and safety management systems - Requirements with guidance for use, International Organisation for Standardisation, 2018
2. Industrial Health and Safety Acts and Amendments, by Ministry of Labour and Employment, Government of India
3. Fundamentals of Industrial Safety and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012
4. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
5. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services, 2005.
6. Environmental and Health and Safety Management by Nicholas P.Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995

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

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

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

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

**EN3022 PLANNING, DESIGN AND MANAGEMENT OF LARGE HOUSING COMPLEXES L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Expose students about origin growth and development of human settlements.
- Understand the character of rural and urban housing.
- Outline the issues concerning housing in the Indian context.
- Understand the housing policies and agencies responsible for housing development.

<b>UNIT I</b>	<b>EVOLUTION OF HUMAN SETTLEMENTS</b>	<b>9</b>
Early settlement pattern – Physical form and growth of settlements – Population growth, Urban and rural settlements – Impact of urbanization on housing.		
<b>UNIT II</b>	<b>RURAL AND URBAN HOUSING</b>	<b>9</b>
Rural housing in India - Typology of housing and housing character in Indian context – Early urban centers / cities, Mughal period, Before independence and After independence – Industrial townships - Satellite towns / New towns – Residential neighborhoods.		
<b>UNIT III</b>	<b>HOUSING AND INFRASTRUCTURE</b>	<b>9</b>
Formal and informal settlements – Homelessness - Housing standards for various income category – Housing development – Slum housing and redevelopment programmes – Sites and services schemes – Socio - economic and special aspects of housing – Community facilities.		
<b>UNIT IV</b>	<b>HOUSING DESIGN AND CONCEPTS</b>	<b>9</b>
Traditional housing, Row housing, Cluster housing - Affordable housing – Green house and eco-friendly housing – Gated community – Housing density – Layout preparation.		
<b>UNIT V</b>	<b>HOUSING GOVERNANCE</b>	<b>9</b>
National housing policy – Demand and supply – Housing development agencies and their role – Finance– Housing information system – Cost effective materials and technologies for housing.		

## COURSE OUTCOME:

**COURSE OUTCOME:** Students are introduced to

**C01 The evolution of settlements housing and community living**

**CO1** | The evolution of settlements housing and community living.  
**CO2** | Understand the types of housing during various time period

**CO3** Explore the past and relate with the technology and culture towards living environment of modern society.

**CQ4 | Understand the design concepts of housing**

**C04** Understand the design concepts of  
**C05** Comprehend housing governance

## REFERENCES

- REFERENCES:**

  1. Bridget Franklin, 'Housing Transformations Shaping the Space of Twenty-First Century Living, Routledge Publishers, UK, 2006.
  2. Constantinos A. Doxiadis, 'Ekistics', Hutchinson of London, 1968.
  3. Graham Towers, 'Introduction to Urban Housing Design, Routledge, London, 2005.
  4. Jain A.K, 'Urban Housing and Slums, Readworthy Publications, Delhi, 2009.
  5. Mark Tewdwr-Jones, 'Spatial Planning and Governance, Palgrave Macmillan Publication, London, 2012.
  6. Nair K. N. & G. Gopikuttan, 'Studies in Local-Level Development- Housing in Kerala: Impact of Investment, Technology and Institutions, Danish Books, Delhi, 2012.
  7. Sabir Ali, 'Environment and Resettlement Colonies of Delhi, Har-Anand Publications. New Delhi, 1995.

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

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

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

**EN3023**

**ENERGY MANAGEMENT IN INDUSTRIES**

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

**COURSE OBJECTIVES:**

- To provide an understanding of the basics of energy conservation method and energy auditing in industries
- To understand the environmental and economical benefits associated management.

**UNIT I INTRODUCTION**

**7**

Energy Scenario – India and World – Energy Resources in India – Energy consumption Pattern, Energy Conservation and Energy Efficiency – Needs and Advantages, Role of Energy Manager – Energy Conservation Act.

**UNIT II AUDITING AND INSTRUMENTATION IN ENERGY MANAGEMENT**

**10**

Energy Audit – Purpose, Types, Methodologies, Barriers with respect to Process Industries, Power Plants, Boilers and Certain Energy Intensive Industries; Energy Audit Questionnaire - Role of instrumentation in energy conservation - total energy systems - concept of total energy – advantages, limitations & Application.

**UNIT III ENERGY MANAGEMENT**

**12**

Thermal energy management-Various Energy management Measures in Steam Systems – Losses in Boiler – Methodology of upgrading Boiler programme – Energy Conservation in Refrigeration and Air-conditioning Systems - Electrical Energy management- Potential Areas for Electrical Energy management in Various Industries-Energy Management Opportunities in Electrical Heating, Lighting system, Cable selection - Energy Efficient Motors - Factors involved in Determination of Motor Efficiency Adjustable AC Drives, Applications & its use variable speed Drives/Belt Drives

**UNIT IV ENERGY ECONOMICS**

**8**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing, risk and Sensitivity Analysis, Financing Options, Energy Performance Contract and Role of ETCOS.

**UNIT V APPLICATIONS**

**8**

Case studies on sugar Industry –Co generation, Thermal power plant; Petrochemical Industries.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

On completion of this course, the students will be able to exhibit

- CO1.** Conceptual knowledge of the Energy consumption Pattern, Energy Conservation and Energy Efficiency
- CO2.** Understand the basics of energy conservation method and energy auditing.
- CO3.** Capability to integrate various options for energy management in various Industries.
- CO4.** Understand energy economics
- CO5.** Energy management studies with respect to industries

**REFERENCES:**

1. Handbook on Energy Efficiency, TERI, New Delhi, 2001
2. Jefferson W. Tester, Elisabeth M. Drake, Michael J Driscoll, Michael W. Golay, William A Peters, Sustainable Energy – Choosing among options, Prentice Hall of India, 2006
3. Murphy W.R. and Mckay G., Energy Management, Elsevier, 2007.
4. Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning, 2012.
5. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, Guide to Energy Management, 7th Ed., Keinndu Fairmant Press, 2011.

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

CO'	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	1	1	1	2	--
2	2	1	1	--	--	--	--	1	3	1	1	--	2	2	--
3	3	2	1	--	--	1	--	2	2	1	--	1	1	1	1
4	2	3	--	2	2	2	2	2	1	--	1	1	--	2	2
5	1	3	1	3	1	3	2	3	1	2	1	2	1	2	2
Avg	2	2	1	3	2	2	2	2	2	1	1	1	1	2	2

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

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

**EN3024 PUBLIC HEALTH ENGINEERING SERVICES IN BUILDINGS L T P C**

## **COURSE OBJECTIVES**

- To introduce and give knowledge about the different public health engineering services for human environment- water supply, sewerage, drainage, waste management and plumbing systems.
  - To give familiarity about sustainable practices and systems for public health engineering services.
  - To enable the conceptual design of large housing complexes for public health engineering services.

## **UNIT I      WATER SUPPLY**

9

Water supply system at macro level - sources, pumping, reservoirs, water treatment, tanks, piping systems and materials. Quantitative and qualitative requirements of water for different activities in a small building/campus of simple typologies. Overhead tanks, underground sumps, fire fighting storage, water meter, R.O. Plant, water heating systems, solar water heaters, fixtures and fittings for a small building/ campus. Design calculations for the same and related mechanical equipment. Sustainable practices and systems.

## **UNIT II**                   **SEWERAGE**

9

Sewage and sullage. Sewerage systems. Different types/stages of sewage treatment at city level-Sewer line, gradients, manholes, inspection chambers. One pipe/ two pipe plumbing systems. Sewage treatment at campus/ building level -sewage treatment plants, septic tank, leach pits. Sustainable practices and systems.

UNIT III DRAINAGE AND WASTE MANAGEMENT

9

Storm water drains at city level. Types of pipe. Storm water gutter. Drainage systems in small building and large housing complexes- Roof drainage. Rain water harvesting and storage sumps. Sustainable practices and systems.

Solid waste- types, segregation and refuse collection. Disposal - Incinerator, composting, vermicomposting, sanitary land filling, bio gas system, modern renewable energy system. Site visits with documentation in the form of sketches/ drawings/ photos.

## **UNIT IV PLUMBING SYSTEMS IN BUILDINGS**

9

Basic principles of plumbing. Plumbing, sanitary fittings and their requirements for a small building and large housing complexes- wash basins, water closets, urinals, bidets, sinks, gate valve, float valve, flap valve, ball valve, flush valve, etc, different types of taps, faucets, stop cocks, bib cocks, 'P', 'Q', 'S', floor/bottle traps. Understanding of products, product catalogues, service drawings.

**UNIT V DESIGN FOR ENVIRONMENTAL SERVICES****9**

Site planning, building and room design principles for water supply, sewage and storm water in an integrated manner for a small building and campus. Understanding of service drawings. Site visits and documentation in the form of sketches/ drawings. Conceptual design for a small building and large housing complexes

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

- CO1:** Ability to understand environmental services from macro to micro level human environment.
- CO2:** Ability to adopt sustainable practices and systems for public health engineering services.
- CO3:** Understand drainage systems in small building and large housing complexes
- CO4:** Understand Plumbing, sanitary fittings and their requirements for a small building and large housing complexes
- CO5 :**Ability to design environmental services in a small buildings and large housing complexes.

**TEXT BOOKS:**

1. Manual on "Sewerage and Sewage Treatment Systems Part A, Part B &Part C" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. AFE Wise, JA Swaffied Water, 'Sanitary and Waste Services in buildings', V Edition, Mitchell Publishing, Co. Ltd., 2002.
3. Punmia B.C, 'Waste Water Engineering', Laxmi Publications, 2009.
4. Arceivala S.J, 'Waste Water Treatment for Pollution Control', Tata McGraw Hill, 2008.
5. 'National Building Code', Bureau of Indian Standards.
6. 'Indian Standard Code of Practice for Water Supply in Buildings, IS :2065 – 1983'

**REFERENCES**

1. G.M. Fair, J.C. Geyer and D.Okin, 'Water and Waste Water Engineering Volume II', John Wiley and Sons, Inc. New York, 2010.
2. S.C.Rangwala, 'Water Supply and Sanitary Engineering', Charotar Publishing House, 2016.

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

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

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

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

**EN3025****ENVIRONMENTAL SYSTEM ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To introduce about ecological modeling, single and multi-species modeling on a brief.
- To educate about the modeling of CSTR and the kinetics of reaction taking place in it.
- Introduce the concepts of river and stream water modeling, water quality parameters modeling.
- To educate about the microbial energetic in various reactors systems.
- To elaborate the computational techniques for modeling

**UNIT I ECOLOGICAL SYSTEM**

9

Basic concepts in ecology and ecological modeling, Population Dynamics: Birth and death processes. Single species growth, Prey-predator models: Lotka-Volterra, Rosenzweig-MacArthur, Kolmogorov models. Multi-species modeling - Structural analysis and stability of complex ecosystems.

**UNIT II CONTINUOUS-FLOW REACTOR MODELING**

9

CSTR, Plug-Flow, Dispersion. A case study of a tubular reactor with axial dispersion, Parameter Calibration: Search algorithms for nonlinear dynamical models, Variance of estimated parameters. Application to Monod and Haldane kinetics.

**UNIT III WATER QUALITY MODELING**

9

Rivers and streams water quality modeling -dispersion and mixing- water quality modeling process model sensitivity-assessing model performance; Models for dissolved oxygen and pathogens Pollutant and nutrient dynamics -Dissolved Oxygen dynamics -Groundwater quality modeling.

**UNIT IV MICROBIAL DYNAMICS AND ENERGETICS**

9

Requirements for carbon and nutrient removal. Activated sludge: Process schemes: completely mixed, plug-flow, SBR, nutrient removal. Anaerobic digestion: process dynamics, Operational control of wastewater treatment processes.

**UNIT V COMPUTER BASED SOLUTIONS**

9

Formulation of linear optimization models. Linear programming. Sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models- simulation, parameter estimation and experimental design.

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

On completion of the course, the students are able to

- CO1** Understand the principle of system modeling
- CO2** Conceptualize the principle of reactor design
- CO3** Develop water quality models.
- CO4** Model microbial dynamics
- CO5** Apply the knowledge of soft computing techniques to environmental system modeling

**REFERENCES:**

1. Deaton, M.L and Winebrake, J.J., "Dynamic Modeling of Environmental Systems", Springer- Verlag, 2000
2. Orhon, D and Artan, N., "Modeling of Activated Sludge Systems, Technomic" Publ. Co., 1994.
3. Steven C. Chapra, "Surface Water Quality Modelling", Tata McGraw-Hill Companies, Inc., New Delhi 2018.

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

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

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

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

## VERTICAL V

### DIVERSIFIED COURSES

<b>EN3026</b>	<b>COASTAL ZONE MANAGEMENT</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

#### **COURSE OBJECTIVES:**

- At the end of the semester, the student shall be able to understand the coastal processes, coastal dynamics, impacts of structures like docks, harbours and quays leading to simple management perspectives along the coastal zone.

<b>UNIT I</b>	<b>COASTAL PROCESSES AND RESOURCES</b>	<b>9</b>
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Coastal zone – Beach profile – Surf zone – Off shore – Coastal waters – Estuaries – Wet lands and Lagoons – Erosion and depositional shore features – Methods of protection – Littoral currents Living resources – Non living resources.

<b>UNIT II</b>	<b>WAVE DYNAMICS</b>	<b>9</b>
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Wave classification – Airy's Linear Wave theory – Deep water waves – Shallow water waves – Wave pressure – Wave energy – Wave Decay – Reflection, Refraction and Diffraction of waves – Breaking of waves – Wave force on structures – Vertical – Sloping and stepped barriers – Force on piles.

<b>UNIT III</b>	<b>WAVE FORECASTING AND TIDES</b>	<b>9</b>
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Need for forecasting - SMB and PNJ methods of wave forecasting – Classification of tides – Darwin's equilibrium theory of tides – Effects on structures – seiches- Surges and Tsunamis .

<b>UNIT IV</b>	<b>COASTAL POLLUTION</b>	<b>8</b>
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Coastal Pollution – Causes – Effects - Coastal aquifers – Sea water intrusion – Marine Outfall - Impact of sewage disposal in seas.

<b>UNIT V</b>	<b>COASTAL ZONE MANAGEMENT</b>	<b>9</b>
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Pollution Control strategies – National and International Treaties, Coastal Zone Regulation – Total Maximum Daily Load applications – Protocols in Marine Pollution – ICZM and Sustainable Development

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

**The students completing the course will have ability to**

- CO1** Describe the Coastal zone regulations, coastal processes and wave dynamics
- CO2** Forecast waves and tides and plan coastal structures including harbours
- CO3** Identify natural, engineering and human components on the coast
- CO4** Functions of components and relationship between them
- CO5** Able to integrate the interpretation and analysis of coastal issues to determine appropriate approaches in coastal management and able to communicate effectively in speech and writings

#### **TEXTBOOKS:**

1. Richard Sylvester, "Coastal Engineering, Volume I and II", Elsevier Scientific Publishing Co., 1999
2. Quinn, A.D., "Design & Construction of Ports and Marine Structures", McGraw Hill Book Co., 1999

**REFERENCES:**

1. Ed. A.T. Ippen, "Coastline Hydrodynamics", McGraw-Hill Inc., New York, 1993
2. Dwivedi, S.N., Natarajan, R and Ramachandran, S., "Coastal Zone Management in Tamilnadu", Madras, 1991

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

C'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					3							3		
3	2	2				2			3				2	3	
4	2	3	3				2		3				3		2
5		3	3	2	3		3	1		2	3	2			2
Avg.	2	3	3	2	3	2	3	1	3	2	3	2	2	3	2

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

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

CAI334

**IRRIGATION WATER QUALITY AND WASTEWATER  
MANAGEMENT**
**L T P C**  
**3 0 0 3**
**COURSE OBJECTIVES:**

- To know the basics concepts of irrigation water quality
- To impart knowledge on water quality for irrigation purposes, besides relevant environmental problems and recycle and reuse concepts.
- To understand the importance of water quality for irrigation and major uses of water and the role environmental issues.

**UNIT I       WATER QUALITY****9**

Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – major ions –. Water quality investigation – Sampling design - Samplers and automatic samplers – Data collection platforms – Field kits – Water quality data storage, analysis and inference – Software packages

**UNIT II       IRRIGATION WATER QUALITY****9**

Water quality for irrigation – Salinity and permeability problem – Root zone salinity – Irrigation practices for poor quality water – Saline water irrigation – Future strategies

**UNIT III       WATER POLLUTION****9**

Sources and Types of pollution – Organic and inorganic pollutants - BOD – DO relationships – impacts on water resources – NPS pollution and its control – Eutrophication control - Water treatment technologies - Constructed wetland.

**UNIT IV       RECYCLING AND REUSE OF WATER****9**

Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation

**UNIT V       WATER QUALITY MANAGEMENT****9**

Principles of water quality – Water quality classification – Water quality standards - Water quality indices – TMDL Concepts – Water quality models

**TOTAL: 45 PERIODS**

### **TEXT BOOKS:**

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, "Waste water Engineering: Treatment and Reuse", McGraw-Hill, 2002
2. Vladimir Novonty, "Water Quality: Diffuse pollution and watershed Management", 2<sup>nd</sup> edition, John Wiley & Sons, , 2003
- 3 . Mackenzie L Davis, David A Cornwell, "Introduction to Environmental Engineering", McGraw-Hill 2006.
4. Stum, M and Morgan, A., "Aquatic Chemistry", Plenum Publishing company, USA, 1985
5. Lloyd, J.W. and Heathcote, J.A., "Natural inorganic chemistry" in relation to groundwater resources, Oxford University Press, Oxford, 1988

### **COURSE OUTCOMES**

- CO1** The students will be able to describe the parameters of water quality  
**CO2** The students will be able to describe the concepts of water quality for irrigation  
**CO3** The students will be able to describe the water pollution and quality considerations  
**CO4** The students will be able to describe the recycling and reuse of water  
**CO5** The students will be able to describe the management of water quality

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

PO/PSO	Course Outcome					Overall correlation of CO s to POs
	CO1	CO2	CO3	CO4	CO5	
PO1 Knowledge of Engineering Sciences	2	3	2	3	2	2
PO2 Problem Analysis	2	2	2	3	1	2
PO3 Design/ Development of Solutions	1	2	1	2	3	2
PO4 Investigations	2	2	3	2	2	2
PO5 Modern Tool Usage	3	3	3	2	3	3
PO6 Individual and Team work	2	2	3	1	3	2
PO7 Communication	2	2	3	1	2	2
PO8 The Engineer and Society	3	3	2	3	3	3
PO9 Ethics	2	1	2	3	2	2
PO10 Environment and Sustainability	2	3	2	1	1	2
PO11 Project Management and Finance	2	1	2	2	3	2
PO12 Life Long Learning	3	2	3	2	3	3
PSO1 To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	3	2	3	2	3	3
PSO2 To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	3	2	3	2	3	3
PSO3 To inculcate entrepreneurial skills through strong Industry-Institution linkage.	3	2	3	2	3	3

**CAI335**

**SOLAR AND WIND ENERGY SYSTEM**

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

**COURSE OBJECTIVES::**

- To learn about the fundamental aspects of solar energy availability, solar energy conversion technologies
- To understand about the fundamental aspects of wind energy availability and wind power generators
- To acquire the knowledge on the alternate sources of energy such as geothermal energy, wave energy, tidal energy, OTEC energy, fuel cells and energy storage

**UNIT I            SOLAR ENERGY RADIATION AND SOLAR THERMAL COLLECTORS      9**

Solar radiation availability - radiation measurement -transmittance - absorptance flat plate collectors - heat transfer correlations - collector efficiency - heat balance -absorber plate - types - selective surfaces. Solar driers types heat transfer performance of solar dryers agro industrial applications.

**UNIT II            SOLAR CONCENTRATING COLLECTORS AND PV TECHNOLOGY      9**

Optically concentrating collectors- types reflectors - solar thermal power stations principle and applications - solar stills- types- solar pond performance- characteristics applications. Photovoltaics types characteristic- load estimation batteries invertors operation system controls. PV system installations standalone systems- PV powered water pumping system sizing and optimization hybrid system solar technologies in green buildings.

**UNIT III            WIND MAPPING ANALYSIS AND CHARACTERISTICS OF WIND      9**

Nature of wind - wind structure and measurement - wind power laws - velocity and power duration curves- aero foil - tip speed ratio - torque and power characteristics power coefficients - Betz coefficient

**UNIT IV            WIND MILL DESIGN AND APPLICATIONS      9**

Turbines- Wind mill - classification - power curve. Upwind and downwind systems - transmission rotors - pumps - generators - standalone system - grid system -batteries. Wind energy storage - wind farms - wheeling and banking - testing and certification procedures.

**UNIT V            ALTERNATE ENERGY SOURCES      9**

Ocean energy - off shore and on shore ocean energy conversion technologies - OTEC principles - open and closed cycles. Tidal energy - high and low tides - tidal power - tidal energy conversion. Geothermal energy - resources - classification and types of geothermal power plants. Nuclear energy - reactions -fusion, fission, hybrid reactors. Fuel cell - principle and operation - classification and types. Energy storage- pumped hydro and underground pumped hydro - compressed air - battery - flywheel - thermal.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Rai., G.D. "Solar Energy Utilization" Khanna publishers, New Delhi, 2002.
2. More, H.S and R.C. Maheshwari, " Wind Energy Utilization in India" CIAE Publication – Bhopal, 1982.
3. Solanki, C.S. "Renewable Energy Technologies: A Practical guide for beginners". PHI learning Pvt. Ltd, New Delhi. 2008.

**REFERENCES**

1. Solanki, C.S. "Solar Photovoltaic Technology and Systems", PHI learning Pvt. Ltd., New Delhi, 2013.
2. Rai. G.D. "Non Conventional Sources of Energy", Khanna Publishers, New Delhi, 2002.
3. Rao. S and B.B. Parulekar. "Energy Technology – Non conventional, Renewable and Conventional". Khanna Publishers, Delhi, 2000.
4. Rajput. R.K. "Non- Conventional Energy Sources and Utilization", S. Chand & Company Pvt. Ltd, New Delhi, 2013.

### **COURSE OUTCOMES:**

- CO1** Understand the basics of solar energy and solar thermal energy conversion technologies and compare direct mode and indirect mode solar dryers
- CO2** Analyse the principles and applications of solar thermal power stations, solar pond, and solar stills
- CO3** Understand the wind power laws and calculate the torque and power characteristics of wind energy
- CO4** Design wind mills and test the units for certification
- CO5** Understand the principles of geothermal energy, wave energy, tidal energy, OTEC energy, fuel cells and analyse their applications

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

<b>PO/PSO</b>		<b>CO1</b>	<b>CO2</b>	<b>CO3</b>	<b>CO4</b>	<b>CO5</b>	<b>Overall Correlation of Cos with POs</b>
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis	2	2	2	2	3	
PO3	Design/ Development of Solutions	2	2	3	2	3	2
PO4	Conduct Investigations of Complex Problems	1	1	1	1	1	
PO5	Modern Tool Usage	1	3	3	3	3	
PO6	The Engineer and Society	3	3	3	3	3	
PO7	Environment and Sustainability	3	2	3	3	3	
PO8	Ethics	2	2	2	2	2	
PO9	Individual and team work:	2	2	2	2	2	
PO10	Communication	1	1	1	1	1	
PO11	Project management and finance	3	3	3	3	3	3
PO12	Life-long learning:	3	3	3	3	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	2	2	2	2	2	2
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	2	2	2	2	2
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	2	2	2	2	2	2

**EN3027 EPIDEMIOLOGY AND CONTROL OF COMMUNICABLE DISEASES L T P C  
3 0 0 3**

### **COURSE OBJECTIVES:**

- To impart knowledge on diseases transmitted through air, water, food, vectors and pollution sources as well as major components of health services

### **UNIT I GENERAL**

**9**

Definitions - Dynamics of disease Transmission - Investigation of disasters - Survey - Chain of transmission of diseases - disease control - control of source - control of mode of transmission - susceptible host - typical epidemic control - Investigations.

**UNIT II RESPIRATORY, WATER, AND FOOD BORNE DISEASES 9**

Respiratory diseases - Definition - Group - control of source. Water and Food borne diseases – General reservoir of infection — agents - food decomposition - vehicle or transmission of diseases -control of water and food-borne diseases.

**UNIT III VECTOR BORNE DISEASES 9**

Vector borne diseases and Zoo noses — Infections from mosquitoes, house flies, rats, louse, pubic louse and other insects - General, insect borne diseases, zoo noses and their spread - control at source - control of mode of transmission.

**UNIT IV MISCELLANEOUS DISEASES AND ILLNESSES 9**

Miscellaneous diseases and illnesses - Ringworm, hookworm infections, ancylostomiasis, tetanus, amoebiasis. Other illnesses associated with environment and food - Lead poisoning, carbon monoxide poisoning - mercury poisoning - illnesses associated with air pollution - nutritional deficiency diseases — Illness associated with building material

**UNIT V ASPECTS OF HEALTH SERVICES 9**

The Organization of Health services – Tasks for the health services - the major components of health services (curative, preventive, special services, statistics and health education) - resources for the health services – community participation in health services. Declaration of ALMA-ATA.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students completing the course will have the ability to

**CO1:** Outline the dynamics of disease transmission and different aspects of health services

**CO2:** Explain the different types of diseases transmitted through air, water and food ,

**CO3:** Comprehend miscellaneous diseases and illnesses

**CO4:** Understand the mode of transmission and control of vector borne diseases

**CO5:** Understand major components of health services

**TEXTBOOK:**

1. Park J. E . and Park K., " Text Book of Preventive and Social Medicine ", X Edition, 1989

**REFERENCES:**

1. Rieman Hans, "Food borne infections and intoxications", Academic Press, New York, 1969.

2. Roger Y. Stanier, John L. Ingraham, Mark. L. Wheelis and Pagr. R. Painter, General Microbiology, MacMillan Press Ltd., 1995

3. Dubey, R. C and Maheswari, D.K, "A Text Book of Microbiology" S. Chand and Company Ltd., New Delhi, 2002.

**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					2			2				2		
<b>2</b>	2					3							3		
<b>3</b>	2	2				2			3				2	3	
<b>4</b>	2	3	3				2		3				3		2
<b>5</b>		3	3	2	3		3	1		2	3	2			2
<b>Avg.</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>

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

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

**EN3028**      **CLEANER PRODUCTION**      **L T P C**  
**3 0 0 3**

## **COURSE OBJECTIVES:**

- To introduce the importance, and different approaches of cleaner production in industries and to impart knowledge on environmental management tools applying cleaner production principle.

## **UNIT I                    INTRODUCTION**

9

Sustainable development – Indicators of Sustainability – Sustainability Strategies – Barriers to Sustainability – Industrial activities and Environment – Industrialization and sustainable development – Industrial Ecology – Cleaner Production (CP) in Achieving Sustainability – Prevention versus Control of Industrial Pollution – Environmental Policies and Legislations – Regulation to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market Based Approaches.

## **UNIT II                    CLEANER PRODUCTION**

9

Definition – methodology – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Government and Institutions – Environmental Management Hierarchy – Relation of CP and EMS – Integrated prevention and pollution limitation – Best Available Technology concept (BAT) – Internet information & Other CP Resources.

## **UNIT III            CLEANER PRODUCTION PROJECT DEVELOPMENT & IMPLEMENTATION**

9

Overview of CP – Assessment Steps and Skills – Preparing for the Site, Visit, Information gathering, and Process Flow Diagram – Material Balance – CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives – Total Cost Analysis – CP Financing – Establishing a Program – Organizing a Program – Preparing a Program Plan – Measuring Progress – Pollution Prevention and Cleaner Production Awareness Plan

UNIT IV SUPPORT INSTRUMENTS OF PREVENTION METHODS

9

Life cycle analysis - Elements of LCA – Life Cycle Costing – Eco Labelling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit – Environmental statement.

## UNIT V CASE STUDIES

9

## **UNIT V CASE STUDIES**

### Industrial Applications of CP, LCA, EMS and Environmental Audits

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

The students completing the course will have

- The students completing the course will have

  - CO1** Ability to describe and comment the evolution of corporate environmental management strategies and its relation to the concept of sustainable development
  - CO2** Ability to describe Cleaner Production measures applicable to different industries
  - CO3** Ability to conduct energy and material balances for processes as part of a Cleaner Production assessment
  - CO4** Understand integrated pollution prevention
  - CO5** Implementation of cleaner production project development

## **TEXTBOOKS:**

1. Paul L. Bishop, „Pollution Prevention: Fundamentals and Practice”, McGraw Hill International, 2000.

2. Prasad modak C. Visvanathan and Mandar parasnis , „Cleaner Production Audit”, Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok, 1995

## **REFERENCES:**

1. World Bank Group „Pollution Prevention and Abatement Handbook – Towards Cleaner Production”, World Bank and UNEP, Washington D. C., 1998.

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

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

## **EN3029 ORGANIC FARMING FOR SUSTAINABLE AGRICULTURAL PRODUCTION**

L T P C  
3 0 0 3

### **COURSE OBJECTIVES**

- To educate the students about the fundamental principles of organic farming, the ways to design resource efficient farming system and sustain food production adequate for the world's population.

### **UNIT I INTRODUCTION TO ORGANIC FARMING 9**

Definition of organic farming – Need of organic farming — Conventional Vs. organic farming – Benefits of organic farming – Social and market aspects of organic farming – Global status (growth, land distribution, share and major producers) of organic farming – Organic farming suitability in India – Challenges of organic farming - Future prospects - Success stories

### **UNIT II COMPONENTS, CONCEPTS AND PRINCIPLES OF ORGANIC FARMING 9**

Concept of sustainable development – Principles of organic farming – Key objectives of organic farming - Incorporation of crop residues – Crop rotation – Intercropping - Farmyard manure – Animal manures – Green manuring – Concentrated organic manures - Compost – Vermicompost – Biofertilizers – Biopesticides – Steps to a successful organic transition

### **UNIT III ORGANIC CROP PRODUCTION 9**

Crop production plan – Conversion requirements and duration – Landscape - Choice of crops and varieties – Diversity in crop production and management plan – Nutrient management – Pest, disease and weed management – Contamination control – Soil and water conservation – Products/ additional inputs for use in fertilising, soil conditioning, pest, disease and weed control

### **UNIT IV ORGANIC ANIMAL HUSBANDRY, FOOD PROCESSING AND HANDLING 9**

Livestock living condition – Length of conversion period – Animal sources/origin – Breeds and breeding – Mutilations – Animal nutrition – Veterinary medicine – Transport and slaughter – Bee keeping – Food processing ingredients and methods – Storage pest management – Packaging – Labelling - Cleaning and sanitizing of food processing facilities

**UNIT V ORGANIC CERTIFICATION AND MARKETING****9**

Guidelines and procedures for organic certification – Organic certification agencies – Grower group certification for organic agriculture – Tamil Nadu Organic Certification Department – Agricultural and Processed Food Products Export Development Authority – National Programme for Organic Production standards – Organic food marketing, growing opportunities and regulations

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

On completion of the course, the student is expected to be able to

- CO1** Define 'organic farming' from multiple perspectives
- CO2** Understand about the concepts, principles and components of organic farming
- CO3** Get knowledge on the organic crop production practices for sustainable agriculture
- CO4** Suggest the sustainable ways of animal production and know about the standard requirements for the processing, handling and storage of organic foods
- CO5** Learn about organic certification systems, process to be followed for domestic sales/ exports, and opportunities/ challenges in marketing of organic produce

**REFERENCES**

1. Organic Farming Theory & Practice, S. P. Palaniappan and K. Annadurai (Eds.), Scientific Publishers, 2018.
2. Sustainable Development of Organic Agriculture: Historical Perspectives, E. Kimberly (Eds.), CRC Press, 2017.
3. Organic Farming for Sustainable Agriculture, D. Nandwani (Eds.), Springer, 2016.
4. Science and Technology of Organic Farming, A.V. Barker (Eds.), CRC Press, 2016.
5. Organic Crop Production: Ambitions and Limitations, H. Kirchmann and L. Bergström (Eds.), Springer, 2008.
6. Organic Farming: Policies and Prospects, S. Dabbert et al. (Eds.), Zed Books, 2004.

**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

**EN3030****PROJECT FORMULATION AND IMPLEMENTATION****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To Examine the techniques and procedures relevant for project planning and implementation in developing countries, especially infrastructure projects pertaining to environmental sector
- To enable the students to understand about project identification, feasibility analysis, design, financing, implementation, monitoring and evaluation

**UNIT I****INTRODUCTION TO PROJECT FORMULATION****9**

Overview of the project cycle – Planning Process and project planning – Search for Project ideas –Strategies in Capital allocation – Key elements in project formulation – Methods and tools for Project formulation – Project identification and selection – Preparation of feasibility reports as per Government policies (AMRUT / JnNURM)

**UNIT II PROJECT ANALYSIS 8**

Capital Cost Estimation – Market and demand analysis – Technical analysis – Environmental analysis – Financial and economic analysis – Cash flow generation

**UNIT III PROJECT APPRAISAL 10**

Time and value of money – Investment Criteria – Internal Rate of Return – Net Present Value,Cost Benefit Analysis, and social cost benefit analysis – Project risk analysis – Appraisal of marketing strategy – Pricing and credit worthiness and management capabilities

**UNIT IV PROJECT FINACING AND IMPLEMENTATION 10**

Funding options for urban and rural development projects – Tender Procedure – Transparency in Government Tender rules – Organizational aspects in Project management – Network techniques for project management – Resource management - Risk management

**UNIT V PROJECT MONITORING AND EVALUATION 8**

Need and techniques for monitoring – Service Level Benchmark Performance and process monitoring – Monitoring Schedules – Penalty and Bonus points

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**On completion of the course, the student is expected to be able to**

**CO1:** Understand key elements of project formulation

**CO2:** Develop knowledge on important aspects of project formulation

**CO3:** Develop criteria for project appraisal,

**CO4:** know about the funding agencies and project management

**CO5 :** Get an idea about service level bench mark performances, Penalty and bonus clauses and itsimportance in project execution

**REFERENCES:**

1. Clifford F Gray, Erik W Larson , “Project Management-The Managerial Process” Tata Mcgraw-Hill Publishing Co Ltd
2. Jack Meredith, Samuel J. Mantel Jr. “Project Management- A Managerial Approach”John Wiley and Sons
3. John M Nicholas “Project Management For Business And Technology” Prentice Hall OfIndia Pvt Ltd
4. James P Lewis “ Project Planning ,Scheduling And Control” Tata Mcgraw-Hill
5. Detailed Project Report : Preparation Toolkit (Sub-mission for Urban Infrastructure andGovernance), Government of India
6. www.india.gov.in national portal for India

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

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

## **MANDATORY COURSES I**

<b>MX3081</b>	<b>INTRODUCTION TO WOMEN AND GENDER STUDIES</b>	<b>L T P C</b>
		<b>3 0 0 0</b>

### **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**

<b>MX3082</b>	<b>ELEMENTS OF LITERATURE</b>	<b>L T P C</b>
		<b>3 0 0 0</b>

#### **OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

### **1. COURSE CONTENTS**

Introduction to Elements of Literature

#### **1. Relevance of literature**

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

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

- Fiction, fact and literary truth.
- Fictional modes and patterns.
- Plot character and perspective.

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

- Emotions and imaginations.
- Figurative language.
- (Simile, metaphor, conceit, symbol, pun and irony).

- 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 Univ Press, 1991.
  4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
  5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.
- 3.1 Textbook:  
 3.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

#### **4. OTHER SESSION:**

- 4.1\*Tutorials:  
 4.2\*Laboratory:  
 4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

#### **5.\*ASSESSMENT:**

- 5.1 HA:  
 5.2 Quizzes-HA:  
 5.3 Periodical Examination: one  
 5.4 Project/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.  
 5.5 Final 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.

**MX3083**

**FILM APPRECIATION**

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

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

**Theme - A: The Component of Films**

- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making... structure of a film

**Theme - B: Evolution of Film Language**

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

**Theme - C: Film Theories and Criticism/Appreciation**

- C-1: Realist theory; 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.

MX3084	DISASTER RISK REDUCTION AND MANAGEMENT	L T P C 3 0 0 0
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**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 HAZRADS, 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 context 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:

**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

**CO4:** Enhance awareness of institutional processes for Disaster Response in the country and  
**CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

## **CO's – PO's & PSO's MAPPING**

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

## **MANDATORY COURSES II**

**MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA  
AND SIDDHA L T P C  
3 0 0 0**

## **COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
  - To adapt a few lifestyle changes that will prevent many health disorders
  - To be cool and handbill every emotion very smoothly in every walk of life
  - To learn to eat cost effective but healthy foods that are rich in essential nutrients
  - To develop immunity naturally that will improve resistance against many health disorders

**UNIT I            HEALTH AND ITS IMPORTANCE**

2+4

**Health: Definition - Importance of maintaining health - More importance on prevention than treatment**

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

## **UNIT II**

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 - Pancheekarana 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, Dharmpal, 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?

**TOTAL : 45 PERIODS**

**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.

**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

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.

**TOTAL : 45 PERIODS**

### **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>

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

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	PS O1	PS O2	PS O3
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**

### COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the importance, principles, and search methods of AI
- Provide knowledge on predicate logic and Prolog.
- Introduce machine learning fundamentals
- Study of supervised learning algorithms.
- 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**

**30 PERIODS**

#### **PRACTICAL EXERCISES:**

##### **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.

**COURSE OUTCOMES:**

- CO1:** Understand the foundations of AI and the structure of Intelligent Agents  
**CO2:** Use appropriate search algorithms for any AI problem  
**CO3:** Study of learning methods  
**CO4:** Solving problem using Supervised learning  
**CO5:** Solving problem using Unsupervised learning

**TOTAL PERIODS: 60****TEXT BOOK**

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

**REFERENCES**

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligence", Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352****IOT CONCEPTS AND APPLICATIONS****L T P C  
2 0 2 3****COURSE 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

### **COURSE OUTCOMES:**

**CO1:** Explain the concept of IoT.

**CO2:** Understand the communication models and various protocols for IoT.

**CO3:** Design portable IoT using Arduino/Raspberry Pi /open platform

**CO4:** Apply data analytics and use cloud offerings related to IoT.

**CO5:** 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 Hersistent, 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. Arshdeep Bahga, Vijay Madisetti, "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 PERIODS: 60**

**TEXT BOOKS**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

**REFERENCES**

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

<b>CCS333</b>	<b>AUGMENTED REALITY/VIRTUAL REALITY</b>	<b>L T P C</b>
		<b>2 0 2 3</b>

**COURSE OBJECTIVES:**

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I INTRODUCTION** **7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies- Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

**UNIT II VR MODELING** **6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**UNIT III VR PROGRAMMING** **6**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS** **6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY** **5**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS**

**PRACTICAL EXERCISES:****30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL PERIODS:60****COURSE OUTCOMES:****On completion of the course, the students will be able to:**

- CO1:** Understand the basic concepts of AR and VR  
**CO2:** Understand the tools and technologies related to AR/VR  
**CO3:** Know the working principle of AR/VR related Sensor devices  
**CO4:** Design of various models using modeling techniques  
**CO5:** Develop AR/VR applications in different domains

**TEXTBOOKS:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003'

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2
2	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2
3	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2
4	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2
5	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3
AVg.	3.00	2.60	2.40	2.00	3.00	-	-	-	2.80	2.20	1.80	2.60	2.80	1.80	2.20

**OPEN ELCTIVE III****OHS351****ENGLISH FOR COMPETITIVE EXAMINATIONS****L T P C****3 0 0 3****Course Description:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

**COURSE 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

**CO1** expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required

**CO2** identify errors with precision and write with clarity and coherence

**CO3** understand the importance of task fulfilment and the usage of task-appropriate vocabulary

**CO4** communicate effectively in group discussions, presentations and interviews

**CO5** write topic based essays with precision and accuracy

**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.

#### **REFERENCES:**

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/>

#### **CO's-PO's & PSO's 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.

**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**

**COURSE 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 development
- CO3** present strategies for NGOs in attaining sustainable development
- CO4** recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO5** understand the environmental legislations

**REFERENCES**

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.

<b>OMG353</b>	<b>DEMOCRACY AND GOOD GOVERNANCE</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**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**

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- 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**

**COURSE OUTCOMES:**

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

**CO1** Discuss the Indian and global energy scenario.

**CO2** Describe the various solar energy technologies and its applications.

**CO3** Explain the various wind energy technologies.

**CO4** Explore the various bio-energy technologies.

**CO5** Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

1. 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
2. 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's-PO's & PSO's MAPPING**

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

**OME354**

**APPLIED DESIGN THINKING**

**L T P C**

**3 0 0 3**

**COURSE 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

<b>UNIT I</b>	<b>DESIGN THINKING PRINCIPLES</b>	<b>9</b>
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		
<b>UNIT II</b>	<b>ENDUSER-CENTRIC INNOVATION</b>	<b>9</b>
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		
<b>UNIT III</b>	<b>APPLIED DESIGN THINKING TOOLS</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>CONCEPT GENERATION</b>	<b>9</b>
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		
<b>UNIT V</b>	<b>SYSTEM THINKING</b>	<b>9</b>
System Thinking, Understanding Systems, Examples and Understandings, Complex Systems		
<b>TOTAL: 45 PERIODS</b>		

### **Course Outcomes**

**At the end of the course, learners will be able to:**

- CO1** Define & test various hypotheses to mitigate the inherent risks in product innovations.
- CO2** Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- CO3** Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- CO4** 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 Papadakos, (2014), *Value Proposition Canvas*
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

### **REFERENCES**

1. <https://www.ideo.com/pages/design-thinking#process>
2. [https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86\\_24](https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86_24)
3. <https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356>
4. <https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e>
5. <https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd>
6. <https://blog.forgeforward.in/star-tup-failure-is-like-true-lie-7812cdfe9b85>

**MF3003**

**REVERSE ENGINEERING**

**L T 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**

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**

.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**

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**

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**

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:

- CO1** Apply the fundamental concepts and principles of reverse engineering in product design and development.
- CO2** Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- CO3** Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- CO4** Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- CO5** Analyze the various legal aspect
- CO6** 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.

**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.

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

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															

**AU3791****ELECTRIC AND HYBRID VEHICLES****L T P C****3 0 0 3****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

**CO1** Understand the operation and architecture of electric and hybrid vehicles

**CO2** Identify various energy source options like battery and fuel cell

**CO3** Select suitable electric motor for applications in hybrid and electric vehicles.

**CO4** Explain the role of power electronics in hybrid and electric vehicles

**CO5** Analyze the energy and design requirement for hybrid and electric vehicles.

### **TEXT BOOKS:**

1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.

### **REFERENCES:**

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron Hodkinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005

### **CO's-PO's & PSO's 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
Avg	1	1	2	1		3	2						2		1	3

**OAS352****SPACE ENGINEERING****L T P C  
3 0 0 3****COURSE 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****COURSE OUTCOMES:**

- CO1** Illustrate the history of aviation & developments over the years  
**CO2** Ability to identify the types & classifications of components and control systems  
**CO3** Explain the basic concepts of flight & Physical properties of Atmosphere  
**CO4** Identify the types of fuselage and constructions.  
**CO5** Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective" American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

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

**OIM351****INDUSTRIAL MANAGEMENT****L T 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 GROUPDYNAMICS** 9

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS** 9

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Understand the basic concepts of industrial management

**CO2:** Identify the group conflicts and its causes.

**CO3:** Perform swot analysis

**CO4 :** Analyze the learning curves

**CO5 :** Understand the placement and performance appraisal

**REFERENCE:**

Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

## 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											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
Avg.	2	2.2	2.3	3									1.8	2	2.6

OIE354

QUALITY ENGINEERING

L T P C  
3 0 0 3

### COURSE OBJECTIVES

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

### UNIT I INTRODUCTION

9

Quality Dimensions—Quality definitions—Inspection—Quality control—Quality Assurance—Quality planning—Quality costs—Economics of quality—Quality loss function

### UNIT II CONTROLCHARTS

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 ACCEPTANCESAMPLING

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 & IS2500 standards.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

Students will be able to:

- CO1:** Control the quality of processes using control charts for variables in manufacturing industries.
- CO2:** Control the occurrence of defective product and the defects in manufacturing companies.
- CO3:** Control the occurrence of defects in services.
- CO4:** Analyzing and understanding the process capability study.
- CO5:** Developing the acceptance sampling procedures for incoming raw material.

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

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

3. 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.
4. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.
5. 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
6. Frank R. Spellman, Nancy E. Whiting,"The Handbook of Safety Engineering: Principles and Applications", 2009

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-
Avg.	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-

**OML351****INTRODUCTION TO NON-DESTRUCTIVE TESTING****L T P C****3 0 0 3****COURSE OBJECTIVES:**

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

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.

- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

**UNIT I INTRODUCTION TO NDT & VISUAL TESTING** 9

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

**UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING** 9

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.

Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

**UNIT III EDDY CURRENT TESTING & THERMOGRAPHY** 9

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

**UNIT IV ULTRASONIC TESTING & AET** 9

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V RADIOGRAPHY TESTING** 9

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to **CO1** Realize the importance of NDT in various engineering fields.

**CO2** Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.

**CO3** Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.

**CO4** Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.

**CO5** Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCES:**

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C01	2	2	2	3			2	2				2	1	2	
C02	3	1	2	2			2	2				2	2	2	1
C03	3	2	1	2			2	2				2	2	2	
C04	3	1	2	2			2	2				2	2	2	2
C05	3	2	2	2			2	2				2	2	2	1
Avg	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

OMR351

MECHATRONICS

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

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

- Selecting sensors to develop mechatronics systems.
- Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
- Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
- Applying PLC as a controller in mechatronics system.
- 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.

<b>UNIT III</b>	<b>PROGRAMMABLE PERIPHERAL INTERFACE</b>	<b>9</b>
Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.		
<b>UNIT IV</b>	<b>PROGRAMMABLE LOGIC CONTROLLER</b>	<b>9</b>
Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.		
<b>UNIT V</b>	<b>ACTUATORS AND MECHATRONICS SYSTEM DESIGN</b>	<b>9</b>
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.
- CO4:** Apply PLC as a controller in mechatronics system.
- CO5:** Design and develop the apt mechatronics system for an application.

#### **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. Histand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaiqour 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.

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

<b>COs/POs &amp; PSOs</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	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:**

- To study the kinematics, drive systems and programming of robots.
- To study the basics of robot laws and transmission systems.
- To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
- To familiarize students with the various Programming and Machine Vision application in robots.
- 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. Gonaz 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.

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

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															

OAE352

**FUNDAMENTALS OF AERONAUTICAL ENGINEERING**L T P C  
3 0 0 3**OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT**

8

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS**

10

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

**UNIT III BASICS OF AERODYNAMICS**

9

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment.

Aerofoils, Mach number, Maneuvers.

## **UNIT IV            BASICS OF AIRCRAFT STRUCTURES**

9

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.

## **UNIT V                    BASICS OF PROPULSION**

9

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

TOTAL : 45 PERIODS

## **COURSE OUTCOMES:**

- CO1** Illustrate the history of aircraft & developments over the years
  - CO2** Ability to identify the types & classifications of components and control systems
  - CO3** Explain the basic concepts of flight & Physical properties of Atmosphere
  - CO4** Identify the types of fuselage and constructions.
  - CO5** 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

OGI351

## REMOTE SENSING CONCEPTS

L T P C  
3 003

## COURSE 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

**CHAPTER – 1 REMOTE SENSING AND ELECTROMAGNETIC RADIATION**  
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
- CO1** Understand the concepts and laws related to remote sensing  
**CO2** Understand the interaction of electromagnetic radiation with atmosphere and earth material  
**CO3** Acquire knowledge about satellite orbits and different types of satellites  
**CO4** Understand the different types of remote sensors  
**CO5** 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 Photogrammetry, 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's-PO's & PSO's 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						

PO7	Environment and Sustainability					
PO8	Ethics					
PO9	Individual and Team Work					
PO10	Communication					
PO11	Project Management and Finance					
PO12	Life-long Learning	3	3	3	3	3
PSO1	Knowledge of Geoinformatics discipline	3	3	3	3	3
PSO2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3
PSO3	Conceptualization and evaluation of Design solutions	3	3	3	3	3

OAI351

## URBAN AGRICULTURE

L T P C

3 0 0 3

### COURSE 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

**CO1** Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops

**CO2** Explain different methods of crop production on roof tops

**CO3** Explain nutrient and pest management for crop production on roof tops

**CO4** Illustrate crop water requirement and irrigation water management on roof tops

**CO5** 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's-PO's & PSO's MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2
PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2
PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

OCE353	<b>LEAN CONCEPTS, TOOLS AND PRACTICES</b>	L T P C 3 0 0 3
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**COURSE 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**

**COURSE OUTCOMES:**

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 Luebring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

## 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

UNIT II : **POWER CONVERTERS**  
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

**UNIT III : CONTROL OF DC AND AC MOTOR DRIVES**  
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS

9

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes

## **UNIT V      MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES**

9

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power split mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

TOTAL : 45 PERIODS

## COURSE OUTCOMES:

## **COURSE OUTCOMES:**

**CO1:** Able to understand the principles of conventional and special electric power systems  
**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

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

	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:

- Understand basic PLC terminologies digital principles, PLC architecture and operation.
- Familiarize different programming language of PLC.
- Develop PLC logic for simple applications using ladder logic.
- Understand the hardware and software behind PLC and SCADA.
- 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.

<b>UNIT III</b>	<b>PLC PROGRAMMING</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>COMMUNICATION OF PLC AND SCADA</b>	<b>9</b>
Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures		
<b>UNIT V</b>	<b>CASE STUDIES</b>	<b>9</b>
Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems		

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)  
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)  
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)  
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchanndMitra 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/>

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

<del>PO, PSO CO</del>	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
<b>CO1</b>	3	2	1					1		1					
<b>CO2</b>	3	3	2					1		1	2				2
<b>CO3</b>	3	3	3	3	1			1		1					
<b>CO4</b>	3	3		3	3			1		1			3	3	
<b>CO5</b>	3	3	3	2	1			1		1			3	3	3
<b>Avg</b>	3	2.9	2.2	2.6	1.6			1		1			3	3	2.9

OCH351

NANO TECHNOLOGY

L T P C  
3 0 0 3

### UNIT I INTRODUCTION

General definition and size effects—important nano structured materials and nano particles—importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

### UNIT II SYNTHESIS OF NANOMATERIALS

8

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

### UNIT III NANO COMPOSITES

10

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

### UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES

10

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

### UNIT V APPLICATIONS OF NANO MATERIALS

9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES:

**CO1** understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.

**CO2** able to acquire knowledge about the different types of nano material synthesis

**CO3** describes about the shape, size, structure of composite nano materials and their interference

**CO4** understand the different characterization techniques for nanomaterials

**CO5** develop a deeper knowledge in the application of nanomaterials in different fields.

## TEXT BOOKS

1. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" Imperial College Press, 2004
3. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3<sup>rd</sup> Edition, CRC Taylor and Francis group 2012.

## REFERENCES

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd., Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co
3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

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

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	PS O1	PS O2	PS O3	
<b>CO1</b>	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3	
<b>CO2</b>	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3	
<b>CO3</b>	describes about the shape, size,structure of composite nano materials and their interference	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3	
<b>CO4</b>	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	1	-	1	3	1	1	3
<b>CO5</b>	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	1	-	1	3	2	1	3
Overall CO		3	2	2	1	3	3	1	1	1	1	1	1	1	3	2	1

<b>OCH352</b>	<b>FUNCTIONAL MATERIALS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVE:**

- The course emphasis on the molecular safe assembly and materials for polymer electronics

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
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Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

<b>UNIT II</b>	<b>MOLECULAR SELF ASSEMBLY</b>	<b>9</b>
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Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

<b>UNIT III</b>	<b>BIO-INSPIRED MATERIALS</b>	<b>9</b>
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Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, ‘Bionics’-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomaterialization- En route to Nanotechnology.

<b>UNIT IV</b>	<b>SMART OR INTELLIGENT MATERIALS</b>	<b>9</b>
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Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

<b>UNIT V</b>	<b>MATERIALS FOR POLYMER ELECTRONICS</b>	<b>9</b>
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Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohanan K. Pillai and MeeraParthasarathy, “Functional Materials: A chemist’s perspective”, Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne “Biomimetic Materials Chemistry” Wiley-VCH Newyork, 1966.

<b>OFD352</b>	<b>TRADITIONAL INDIAN FOODS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE 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.

<b>OFD353</b>	<b>INTRODUCTION TO FOOD PROCESSING</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE 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.

<b>UNIT I</b>	<b>PROCESSING OF FOOD AND ITS IMPORTANCE</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>METHODS OF FOOD HANDLING AND STORAGE</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>LARGE-SCALE FOOD PROCESSING</b>	<b>12</b>
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.		
<b>UNIT IV</b>	<b>FOOD WASTES IN VARIOUS PROCESSES</b>	<b>6</b>
Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.		
<b>UNIT V</b>	<b>FOOD HYGIENE</b>	<b>9</b>
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.

<b>OPY352</b>	<b>IPR FOR PHARMA INDUSTRY</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

#### **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

**CO1** Understand and differentiate the categories of intellectual property rights.

**CO2** Describe about patents and procedure for obtaining patents.

**CO3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.

**CO4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.

**CO5** Provide different organizations role and responsibilities in the protection of IPR in the international level.

**CO6** Understand the interrelationships between different Intellectual Property Rights on International Society

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

	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**

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

#### **COURSE 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 - calendering, 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**

#### **COURSE OUTCOMES:**

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

**CO1** Basics of Resin Finishing Process.

**CO2** Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

**CO3** Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

**CO4** Concept of Mechanical finishing.

**CO5** 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**

**COURSE 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. Work aids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

**COURSE 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

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

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	PS O1	PS O2	PS O3
CO1	Fundamental concepts of industrialEngineering 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

**OTT353**

**BASICS OF TEXTILE MANUFACTURE**

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

**COURSE OBJECTIVES:**

- To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

<b>UNIT I</b>	<b>NATURAL FIBRES</b>	<b>9</b>
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..		
<b>UNIT II</b>	<b>REGENERATED AND SYNTHETIC FIBRES</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>BASICS OF SPINNING</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>BASICS OF WEAVING</b>	<b>9</b>
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,		
<b>UNIT V</b>	<b>BASICS OF KNITTING AND NONWOVEN</b>	<b>9</b>
Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.		

**TOTAL : 45 PERIODS**

#### **COURSE OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

- CO1:** Classification of fibres and production of natural fibres
- CO2:** Regenerated and synthetic fibres
- CO3:** Yarn spinning
- CO4:** Weaving
- CO5:** Knitting and nonwoven

#### **TEXTBOOKS**

1. Mishra S. P. , "A Text Book of Fibre Science and Technology", New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., "Principles of Weaving", The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., "Knitting Technology", III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

#### **REFERENCES:**

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., "Clothing Technology: From Fibre to Fabric", Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., "Motivate Series-Textiles", Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., "The Technology of Clothing Manufacture" Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., "The Rieter Manual of Spinning, Vol.1", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., "The Rieter Manual of Spinning, Vol.2", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., "The Rieter Manual of Spinning, Vol.1-3", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.

6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., "Weaving: Machines, Mechanisms, Management", Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., "Textile Science", CBS Publishers and distributors, 1987, ISBN 0582685958

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

<b>Course Outcomes</b>	<b>Statement</b>	<b>Program Outcome</b>														
		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	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

**OPE351**

**INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS**

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

#### **COURSE 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****COURSE 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

**CPE334****ENERGY CONSERVATION AND MANAGEMENT**L T P C  
3 0 0 3**COURSE 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 & Usage: 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****COURSE 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.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

**OPT351****BASICS OF PLASTICS PROCESSING****L T P C****3 0 0 3****COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

**UNIT I INTRODUCTION TO PLASTICS PROCESSING**

9

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers,

UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

**UNIT II EXTRUSION** 9

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

**UNIT III INJECTION MOLDING** 9

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

**UNIT IV COMPRESSION AND TRANSFER MOLDING** 9

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

**UNIT V BLOW MOLDING, THERMOFORMING AND CASTING** 9

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

**TOTAL 45 PERIODS**

**COURSE OUTCOMES**

- CO1** Ability to find out the correlation between various processing techniques with product properties.
- CO2** Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- CO3** Acquire knowledge on additives for plastic compounding and methods employed for the same
- CO4** Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- CO5** 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 Nostrand 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:**

- Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
- Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

**REFERENCES :**

- B. P. Lathi, "Principles of Linear Systems and Signals", 2<sup>nd</sup> Edition, Oxford, 2009.
- M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
- John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

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

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	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>CO</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's – PO's & PSO's MAPPING**

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

PROGRESS THROUGH KNOWLEDGE

**CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C  
3 0 0 3**
**COURSE 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

<b>UNIT I</b>	<b>BASICS OF PRODUCT DEVELOPMENT</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>REQUIREMENTS AND SYSTEM DESIGN</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>DESIGN AND TESTING</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT</b>	<b>9</b>
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		
<b>UNIT V</b>	<b>BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY</b>	<b>9</b>
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**

#### **COURSE OUTCOMES:**

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

- CO1** Define, formulate, and analyze a problem
- CO2** Solve specific problems independently or as part of a team
- CO3** Gain knowledge of the Innovation & Product Development process in the Business Context
- CO4** Work independently as well as in teams
- CO5** 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 Newstrom 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

#### COURSE 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**

#### COURSE 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

- Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
- Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
- 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 MAPPING

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.	3	1	1	1	1										

OMA352

OPERATIONS RESEARCH

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

### UNIT I LINEAR PROGRAMMING 9

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

### UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS 9

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

### UNIT III INTEGER PROGRAMMING 9

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

### UNIT IV DYNAMIC PROGRAMMING PROBLEMS 9

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

**UNIT V            NON - LINEAR PROGRAMMING PROBLEMS****9**

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

**TOTAL:45 PERIODS****COURSE 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.

**CO's – PO's & PSO's MAPPING**

	<b>PO 01</b>	<b>PO 02</b>	<b>PO 03</b>	<b>PO 04</b>	<b>PO 05</b>	<b>PO 06</b>	<b>PO 07</b>	<b>PO 08</b>	<b>PO 09</b>	<b>PO 10</b>	<b>PO 11</b>	<b>PO 12</b>	<b>PS O1</b>	<b>PS O2</b>	<b>PS O3</b>
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	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****COURSE 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****COURSE OUTCOMES :**

**CO1** Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

**CO2** Demonstrate accurate and efficient use of advanced algebraic techniques.

**CO3** 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.

**CO's – PO's & PSO's 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	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

**CO1** Test the consistency and solve system of linear equations.

**CO2** Find the basis and dimension of vector space.

**CO3** Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.

**CO4** Find orthonormal basis of inner product space and find least square approximation.

**CO5** 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.

## **CO's – PO's & PSO's 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
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

OBT352

# **BASICS OF MICROBIAL TECHNOLOGY**

L T P C  
3 003

## **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**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Funqi.

UNIT II MICROBIAL TECHNIQUES

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

UNIT III PATHOGENIC MICROBES

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengue, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

UNIT IV BENEFICIAL MICROBES ROUGH KNOWLEDGE

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology

UNIT V PRODUCTS FROM MICROBES

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

## **CO1 Microbes and their types**

### **CO<sub>2</sub> Cultivation of microbes**

### **CO3 Pathogens and control measures for safety**

#### **CO4 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****COURSE OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES 9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS 9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN. 9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

**UNIT IV NUCLEIC ACIDS 9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature- DNA double helix (Watson and crick) model, types of DNA, RNA.

**UNIT V VITAMINS AND HORMONES 9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

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

**CO1** Students will learn about various kinds of biomolecules and their physiological role.

**CO2** 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., etal., "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**

## **COURSE 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

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

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**

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transport mechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

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**UNIT IV**      **CELL CYCLE**

Cell cycle- Cell division by mitosis and meiosis, Comparision 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**

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**

## **COURSE OUTCOMES:**

## **CO1 Understanding of cell at structural and functional level.**

**CO2** Understand the central dogma of life and its significance.

**CO3** 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" IIInd Edition, Tata McGraw-Hill, 2003.

**REFERENCES:**

1. Lodish H, Berk A, MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. etal., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Recee and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.
4. Alberts, Bruce etal., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.

**OPEN ELECTIVE IV****OHS352****PROJECT REPORT WRITING****L T P C**  
**3 0 0 3****COURSE OBJECTIVE**

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

**UNIT I****9**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

**UNIT II****9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

**UNIT III****9**

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

**UNIT IV****9**

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations -Recommendations – Conclusion – Bibliography.

**UNIT V****9**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

## COURSE OUTCOMES

By the end of the course, learners will be able to

**CO1** Write effective project reports.

**CO2** Use statistical tools with confidence.

**CO3** Explain the purpose and intension of the proposed project coherently and with clarity.

**CO4** Create writing texts to suit achieve the intended purpose.

**CO5** Master the art of writing winning proposals and projects.

## 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)
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

## CO's – PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>1</b>	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
<b>2</b>	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
<b>3</b>	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
<b>4</b>	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	-	-	-
<b>Avg.</b>	<b>2.4</b>	<b>2.2</b>	<b>2.4</b>	<b>2.2</b>	<b>2</b>	<b>2.6</b>	<b>2.4</b>	<b>2.2</b>	<b>2.6</b>	<b>3</b>	<b>2.6</b>	<b>3</b>	-	-	-

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

OMA355

ADVANCED NUMERICAL METHODS

L T P C  
3 0 0 3

## COURSE 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****COURSE 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<sup>th</sup> 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.

**CO's – PO's & PSO's 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
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

**OMA356****RANDOM PROCESSES****L T P C  
3 0 0 3****COURSE 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****COURSE OUTCOMES**

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

- CO1** Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- CO2** Apply the concept random processes in engineering disciplines.
- CO3** Understand and apply the concept of correlation and spectral densities.
- CO4** Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- CO5** 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.

#### **CO's – PO's & PSO's MAPPING**

	<b>PO 01</b>	<b>PO 02</b>	<b>PO 03</b>	<b>PO 04</b>	<b>PO 05</b>	<b>PO 06</b>	<b>PO 07</b>	<b>PO 08</b>	<b>PO 09</b>	<b>PO 10</b>	<b>PO 11</b>	<b>PO 12</b>	<b>PS O1</b>	<b>PS O2</b>	<b>PS O3</b>
<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**

#### **COURSE 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**

#### **COURSE OUTCOMES**

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

- CO1** Enable the students to apply the concept of random processes in engineering disciplines.
- CO2** Students acquire skills in analyzing various queueing models.

- CO3** Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- CO4** Students can analyze reliability of the systems for various probability distributions.
- CO5** Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

### TEXT BOOKS

- Shortle J.F, Gross D, Thompson J.M,Harris C.M., "Fundamentals of Queueing Theory", John Wiley and Sons, New York,2018.
- Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

### REFERENCES

- Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
- Taha, H.A., "Operations Research", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
- Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> Edition, John Wiley and Sons, 2002.
- Govil A.K., "Reliability Engineering", Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

### CO's – PO's & PSO's 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	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	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

#### COURSE 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**

**COURSE OUTCOMES**

Upon completion of this course the learners will be able :

**CO1** To understand the basics and functions of Production and Operation Management for business owners.

**CO2** To learn about the Production & Operation Systems.

**CO3** To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

**CO4** To known about the Production & Operations Management Processes in organisations.

**CO5** 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.

<b>OMG355</b>	<b>MULTIVARIATE DATA ANALYSIS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE 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.

<b>UNIT II</b>	<b>PREPARING FOR MULTIVARIATE ANALYSIS</b>	<b>9</b>
Conceptualization of research model with variables, collection of data —Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.		
<b>UNIT III</b>	<b>MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS</b>	<b>9</b>
Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.		
<b>UNIT IV</b>	<b>LATENT VARIABLE TECHNIQUES</b>	<b>9</b>
Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.		
<b>UNIT V</b>	<b>ADVANCED MULTIVARIATE TECHNIQUES</b>	<b>9</b>
Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.		

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES :**

- CO1** 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.
- CO2** Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- CO3** Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- CO4** Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- CO5** Make better business decisions by using advanced techniques in data analytics. ‘

#### **REFERENCES :**

1. Joseph F Hair, Ralph 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 Sweeney, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

<b>OME352</b>	<b>ADDITIVE MANUFACTURING</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

#### **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.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>VAT POLYMERIZATION AND MATERIAL EXTRUSION</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>POWDER BED FUSION AND BINDER JETTING</b>	<b>9</b>
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.		
<b>UNIT IV</b>	<b>MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION</b>	<b>9</b>
Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.		
Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery -Materials -Benefits -Applications.		
<b>UNIT V</b>	<b>SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY</b>	<b>9</b>
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", 1<sup>st</sup> 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**

LTPC  
3003

## COURSE OBJECTIVES

- To introduce the fundamental concepts of the new product development
  - To develop material specifications, analysis and process.
  - To Learn the Feasibility Studies & reporting of new product development.
  - To study the New product qualification and Market Survey on similar products of new product development
  - To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT I FUNDAMENTALS OF NPD**

9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS

9

**UNIT II MATERIALS OF CONSTRUCTION, ANALYSIS & PROCESS**  
Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT III      ESSENTIALS OF NPD

9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

## **UNIT IV CRITERIONS OF NPD**

9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

## **UNIT V REPORTING & FORWARD-THINKING OF NPD**

9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in

shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS**

### **COURSE OUTCOMES:**

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

- CO1** Discuss fundamental concepts and customer specific requirements of the New Product development
- CO2** Discuss the Material specification standards, analysis and fabrication, manufacturing process Develop Feasibility Studies & reporting of New Product development
- CO3** Analyzing the New product qualification and Market Survey on similar products of new product development
- CO4** Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

### **TEXT BOOKS:**

Product Development – Sten Jonsson

Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

### **REFERENCES:**

Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark

Change by Design

Toyota Product Development System – James Morgan & Jeffrey K. Liker

Winning at New Products – Robert Brands 3rd Edition

Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

### **CO's – PO's & PSO's 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**

### **COURSE 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

<b>UNIT I</b>	<b>UI/UX</b>	<b>9</b>
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		
<b>UNIT II</b>	<b>APP DEVELOPMENT</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>INDUSTRIAL DESIGN</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>MECHANICAL RAPID PROTOTYPING</b>	<b>9</b>
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		
<b>UNIT V</b>	<b>ELECTRONIC RAPID PROTOTYPING</b>	<b>9</b>
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:**

- CO1** Create quick UI/UX prototypes for customer needs
- CO2** Develop web application to test product traction / product feature
- CO3** Develop 3D models for prototyping various product ideas
- CO4** 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

**CO1** Select suitable precision machine tools and operate

**CO2** Apply the macro and micro components for fabrication of micro systems.

**CO3** Apply suitable machining process

**CO4** Able to work with miniature models of existing machine tools/robots and other instruments.

**CO5** 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 Manufacturingll, New Age International, New Delhi, 2005



## **REFERENCES:**

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
  2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
  3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
  4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
  5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

AU3002

## BATTERIES AND MANAGEMENT SYSTEM

L T P C  
3 0 0 3

## **COURSE OBJECTIVES:**

The objective of this course is to make the students

- To understand the working and characteristics of different types of batteries and their management .

# **UNIT I**                   **ADVANCED BATTERIES**

9

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics- SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

## **UNIT II                    BATTERY PACK**

9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

UNIT III BATTERY MODELLING

9

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

UNIT IV BATTERY STATE ESTIMATION

9

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method Kalman filter. Estimation Algorithms

UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS

9

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1  
Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

TOTAL -45 PERIODS

#### **COURSE OUTCOMES:**

**COURSE OUTCOMES:**  
At the end of this course, students will be able to

**CO1** Acquire knowledge of different Li-ion Batteries performance

- CO1 Acquire knowledge of different Li-ion Batteries per unit
- CO2 Design a Battery Pack and make related calculations

- CO2 Design a Battery Pack and Make Related Calculations
- CO3 Demonstrate a Battery Model or Simulation

**CO3** Demonstrate a Battery Model or Simulation.  
**CO4** Estimate State-of-Charge in a Battery Pack.

**C04** Estimate State-of-Charges in a Battery Pack.  
**C05** Approach different BMS architectures during real world usage.

## **TEXT BOOKS**

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea , "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

## **REFERENCES**

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic NCR18650B- DataSheet
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

<b>AU3008</b>	<b>SENSORS AND ACTUATORS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

## **COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

### **UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards-Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error-Propagation of error- Odds and uncertainty- principle of transduction- Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers-Dynamic characteristics of first and second order transducers for standard test inputs.

### **UNIT II VARIABLE RESISTANCE AND INDUCTANCE SENSORS 9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

### **UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers- Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

### **UNIT IV AUTOMOTIVE ACTUATORS 9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

### **UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL :45 PERIODS**

## **COURSE OUTCOMES:**

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

**CO1** List common types of sensor and actuators used in vehicles.

**CO2** Design measuring equipment's for the measurement of pressure force, temperature and flow.

- CO3** Generate new ideas in designing the sensors and actuators for automotive application  
**CO4** Understand the operation of the sensors, actuators and electronic control.  
**CO5** Design temperature control actuators for vehicles.

#### **TEXT BOOKS:**

1. Doebeлин's Measurement Systems: 7th Edition (SIE), Ernest O. Doebeлин Dhanesh N. Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001
3. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

#### **REFERENCES:**

1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

**OAS353**

**SPACE VEHICLES**

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

#### **COURSE 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****COURSE OUTCOMES:**

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

- CO1** Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- CO2** Apply knowledge in selecting the appropriate rocket propulsion systems.
- CO3** interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- CO4** Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- CO5** Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**OIM352****MANAGEMENT SCIENCE****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

Of this course are

- To introduce fundamental concepts of management and organization to students.
- To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
- To make students familiarize with the concepts of human resources management.
- To acquaint students with the concepts of project management and cost analysis.
- 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 TheoryY-Hertzberg 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 ProductLifeCycle.

**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 organization to carryout production operations through Work-study.

**CO2:** Survey the markets, customers and competition better and price the given products appropriatey

**CO3:** Ensure quality for a given product or service.

**CO4:** Plan, schedule and control projects through PERTandCPM.

**CO5:** Evaluate strategyforabusiness orserviceorganisation.

**TEXTBOOKS:**

1. KanishkaBedi, Production and Operations Management,Oxford University Press,2007.
2. Stoner,Freeman, Gilbert, Management,6<sup>th</sup> Ed, PearsonEducation,NewDelhi,2004.
3. ThomasN.Duening & John M.Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012.

**REFERECEES:**

1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. KoontzandWeirich: Essentials of Management, McGrawHill, 2012.
3. Lawrence RJauch,R.Guptaand William F. Glueck: Business Policy and Strategic Management Science,McGrawHill,2012.
4. SamuelC.Certo: Modern Management,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	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

**OIM353****PRODUCTION PLANNING AND CONTROL****L T P C  
3 0 0 3****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 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		1				1		3		
2	3	2			3									2	
3		2			3									2	
4		2	2												
5	3	3	2											1	
Avg.	3	2.6	2		3		1				1		3	1.8	

OIE353

OPERATIONS MANAGEMENT

L T P C  
3 0 0 3**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT 9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

<b>UNIT II</b>	<b>FORECASTING, CAPACITY AND FACILITY DESIGN</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS</b>	<b>9</b>
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.		
<b>UNIT IV</b>	<b>MATERIALS MANAGEMENT</b>	<b>9</b>
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.		
<b>UNIT V</b>	<b>SCHEDULING AND PROJECT MANAGEMENT</b>	<b>9</b>
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.

#### **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 CengageLearning, 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.

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

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

OSF352

INDUSTRIAL HYGIENE

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

#### UNIT I : INTRODUCTION AND SCOPE

9

Occupational Health and Environmental Safety Management - Principles practices. Comm on 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 Wiley and Sons, New York

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth-Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

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

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

**OSF353**

**CHEMICAL PROCESS SAFETY**

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

**COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.

- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

**UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES** 9

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

**UNIT II CHEMICAL REACTION HAZARDS** 9

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

**UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS** 9

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

**UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS** 9

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards - standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

**UNIT V SAFETY AND ANALYSIS** 9

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Students able to**

- CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
- CO2** Develop thorough knowledge about safety in the operation of chemical plants.
- CO3** Apply the principles of safety in the storage and handling of gases.
- CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.
- CO5** Develop thorough knowledge about

**TEXT BOOK**

- 1 David A Crowl& Joseph F Louvar,"Chemical Process safety", Pearson publication, 3<sup>rd</sup> Edition,2014
- 2 Maurice Jones .A,"Fire Protection Systems,2<sup>nd</sup> edition, Jones & Bartlett Publishers,2015

## REFERENCES:

1. Ralph King and Ron Hirst,"King's safety in the process industries", Arnold, London, 1998.
  2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
  3. National Safety Council," Accident prevention manual for industrial operations". Chicago, 1982.
  4. Lewis, Richard. J., Sr,"Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
  5. Roy E Sanders, "Chemical Process Safety",3<sup>rd</sup> Edition, Gulf professional publishing, 2006

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
AVg.	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

OML352

ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS

L T P C

3003

## COURSE OBJECTIVES:

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

- Understanding the importance of various materials used in electrical, electronics and magnetic applications
  - Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
  - Gaining knowledge on the selection of suitable materials for the given application
  - Knowing the fundamental concepts in Semiconducting materials
  - 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

**UNIT III - SEMICONDUCTOR MATERIALS**  
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, bimetallic 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

**CO1** Understand various types of dielectric materials, their properties in various conditions.  
**CO2** Evaluate magnetic materials and their behavior.

**CO3** Evaluate semiconductor materials and technologies.

**CO4** Select suitable materials for electrical engineering applications.

**CO5** Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, taylor and Francis, 2 nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

**REFERENCES:**

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).

**CO's – PO's & PSO's MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C01	3	2	2	3									2	2	1
C02	3	1	2	2									2	2	1
C03	3	2	1	2									2	2	1
C04	3	2	1	2									2	2	2
C05	3	2	2	2									2	2	1
Avg	3	1.8	1.6	2.2									2	2	1.2

**OML353****NANOMATERIALS AND APPLICATIONS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

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

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications

- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

**UNIT I NANOMATERIALS 9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

**UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS 9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

**UNIT III PROCESSING 9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS 9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS 9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

- CO1** Evaluate nanomaterials and understand the different types of nanomaterials
- CO2** Recognise the effects of dimensionality of materials on the properties
- CO3** Process different nanomaterials and use them in engineering applications
- CO4** Use appropriate techniques for characterising nanomaterials
- CO5** Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

1. Bhushan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

### CO's – PO's & PSO's MAPPING

	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO 8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
C04	3	1		2								2	2	2	2
C05	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

OMR352

HYDRAULICS AND PNEUMATICS

L T P C

3 0 0 3

#### COURSE OBJECTIVES:

- To knowledge on fluid power principles and working of hydraulic pumps
- To obtain the knowledge in hydraulic actuators and control components
- To understand the basics in hydraulic circuits and systems
- To obtain the knowledge in pneumatic and electro pneumatic systems
- To apply the concepts to solve the trouble shooting

#### UNIT I            FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS            9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

#### UNIT II            HYDRAULIC ACTUATORS AND CONTROL COMPONENTS            9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

#### UNIT III            HYDRAULIC CIRCUITS AND SYSTEMS            9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

#### UNIT IV            PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS            9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

#### UNIT V            TROUBLE SHOOTING AND APPLICATIONS            9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface

grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES

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

- CO1:** Analyze the methods in fluid power principles and working of hydraulic pumps
- CO2:** Recognize the concepts in hydraulic actuators and control components
- CO3:** Obtain the knowledge in basics of hydraulic circuits and systems
- CO4:** Know about the basics concept in pneumatic and electro pneumatic systems
- CO5:** Apply the concepts to solve the trouble shooting hydraulic and pneumatics

### TEXT BOOKS

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

### REFERENCES

1. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McG Raw Hill, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987
5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

### CO's – PO's & PSO's MAPPING

COs/POs & PSOs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	3	2	1		2	2							1	2	2	1
CO2	3	2	1		2	2							1	2	2	1
CO3	3	2	1		2	2							1	2	2	1
CO4	3	2	1		2	2							1	2	2	1
CO5	3	2	1		2	2							1	2	2	1
CO/PO & PSO Average	3	2	1		2	2							1	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

OMR353

**SENSORS**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- 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.

**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. Histand, "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.

#### **CO's – PO's & PSO's MAPPING**

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

**ORA352**

**CONCEPTS IN MOBILE ROBOTS**

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

#### **COURSE OBJECTIVES**

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

#### **UNIT I INTRODUCTION TO MOBILE ROBOTICS** **9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

#### **UNIT II KINEMATICS** **9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

#### **UNIT III PERCEPTION** **9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

#### **UNIT IV LOCALIZATION** **9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

#### **UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS** **9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

## **COURSE OUTCOMES:**

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

**CO1:** Evaluate the appropriate mobile robots for the desired application.

**CO2:** Create the kinematics for given wheeled and legged robot.

**CO3:** Analyse the sensors for the intelligence of mobile robotics.

**CO4:** Create the localization strategies and mapping technique for mobile robot.

**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

## **TEXTBOOK**

1. Roland Siegwart and Illah R. Nourbakhsh, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

## **REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. Mohanta Jagadish 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**

## **COURSE OBJECTIVES:**

- To impart knowledge on basics of propulsion system and ship dynamic movements
- To educate them on basic layout and propulsion equipment's
- To impart basic knowledge on performance of the ship
- To impart basic knowledge on Ship propeller and its types
- 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.

**CO's – PO's & PSO's MAPPING**

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO0	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1			1	1									1		1
5	1			1	1									1		1
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

**OMV351****MARINE MERCHANT VESSELS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

**At the end of the course, students are expected to acquire**

- Knowledge on basics of Hydrostatics
- Familiarization on types of merchant ships
- Knowledge on Shipbuilding Materials
- Knowledge on marine propeller and rudder
- Awareness on governing bodies in shipping industry

<b>UNIT I</b>	<b>INTRODUCTION to HYDROSTATICS</b>	<b>9</b>
Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.		
<b>UNIT II</b>	<b>TYPES OF SHIP</b>	<b>10</b>
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		
<b>UNIT III</b>	<b>SHIPBUILDING MATERIALS</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>MARINE PROPELLER AND RUDDER</b>	<b>8</b>
Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller		
<b>UNIT V</b>	<b>GOVERNING BODIES FOR SHIPPING INDUSTRY</b>	<b>9</b>
Role of <b>IMO</b> (International Maritime Organization), <b>SOLAS</b> (International Convention for the Safety of Life at Sea), <b>MARPOL</b> (International Convention for the Prevention of Pollution from Ships ), <b>MLC</b> (Maritime Labour Convention), <b>STCW 2010</b> (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities		

**TOTAL: 45 PERIODS**

#### **COURSE OUTCOMES:**

Upon completion of this course, students would

- CO1** Acquire Knowledge on floatation of ships
- CO2** Acquire Knowledge on features of various ships
- CO3** Acquire Knowledge of Shipbuilding Materials
- CO4** Acquire Knowledge to identify the different types of marine propeller and rudder
- CO5** 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

<b>OMV352</b>	<b>ELEMENTS OF MARINE ENGINEERING</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

#### **COURSE OBJECTIVES:**

**At the end of the course, students are expected to**

- Understand the role of Marine machinery systems
- Be familiar with Marine propulsion machinery system
- Acquaint with Marine Auxiliary machinery system

- Have acquired basics of Marine Auxiliary boiler system
- 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 Propeller 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**

**COURSE OUTCOMES:**

**At the end of the course, students should able to,**

- CO1** Distinguish the role of various marine machinery systems
- CO2** Relate the components of marine propulsion machinery system
- CO3** Explain the importance of marine auxiliary machinery system
- CO4** Acquire knowledge of marine boiler system
- CO5** Understand the importance of ship propellers and steering system

**TEXT BOOKS:**

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

**REFERENCES:**

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

**CRA332**

**DRONE TECHNOLOGIES**

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

**COURSE OBJECTIVES:**

- To understand the basics of drone concepts
- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- 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:** Create the programs for various drones

**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. Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

## CO's – PO's & PSO's MAPPING

COs/Pos&PSOs	Mapping of COs with POs and PSOs														
	POs											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

**OGI352**

**GEOGRAPHICAL INFORMATION SYSTEM**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVE:

- 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.

**REFERENCE:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO's – PO's & PSO's 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	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team Work						
PO10	Communication						
PO11	Project Management and Finance						
PO12	Life-long Learning						
PSO1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

**OAI352****AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT****L T P C****3 0 0 3****COURSE 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 programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE 9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control- Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payout 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.

**UNITV ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT 9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

- CO1** Judge about agricultural finance, banking and cooperation
- CO2** Evaluate basic concepts, principles and functions of financial management
- CO3** Improve the skills on basic banking and insurance schemes available to customers
- CO4** Analyze various financial data for efficient farm management
- CO5** 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's – PO's & PSO's 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

## COURSE OBJECTIVES

- To introduce the interdisciplinary approach of water management.
  - To develop knowledge base and capacity building on IWRM.

<b>UNIT I</b>	<b>OVERVIEW OF IWRM</b>	<b>9</b>
Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.		
<b>UNIT II</b>	<b>WATER USE SECTORS: IMPACTS AND SOLUTION</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>WATER ECONOMICS</b>	<b>9</b>
Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.		
<b>UNIT IV</b>	<b>RECENT TRENDS IN WATER MANAGEMENT</b>	<b>9</b>
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.		
<b>UNIT V</b>	<b>IMPLEMENTATION OF IWRM</b>	<b>9</b>
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.		
<b>TOTAL: 45 PERIODS</b>		
<b>COURSE OUTCOMES</b>		
<ul style="list-style-type: none"> <li>• On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.</li> </ul>		
<b>CO1</b>	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.	
<b>CO2</b>	Discuss on the different water uses; how it is impacted and ways to tackle these impacts.	
<b>CO3</b>	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.	
<b>CO4</b>	Illustrate the recent trends in water management.	
<b>CO5</b>	Understand the implementation hitches and the institutional frameworks	

## TEXT BOOKS

- 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. Bhave, 2011, Water Resources Systems, Narosa Publishers.
  5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

**OEE353**

**INTRODUCTION TO CONTROL SYSTEMS**

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

**COURSE 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 & ROOTLOCUSTECHNIQUE 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**

**COURSE 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.

## CO's – PO's & PSO's MAPPING

	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

## **COURSE OBJECTIVES:**

- To educate on design of signal conditioning circuits for various applications.
  - To Introduce signal transmission techniques and their design.
  - Study of components used in data acquisition systems interface techniques
  - To educate on the components used in distributed control systems
  - 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

M

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. Petruzzella, "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://realspars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

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

<b>CO's</b>	<b>PO's</b>												<b>PSO's</b>		
	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

**OCH353**

**ENERGY TECHNOLOGY**

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

### **UNIT I INTRODUCTION**

**8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY** 8

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY** 10

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY** 10

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

**UNIT V ENERGY CONSERVATION** 9

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

- CO1:** Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
- CO2:** Students will excel as professionals in the various fields of energy engineering
- CO3:** Compare different renewable energy technologies and choose the most appropriate based on local conditions.
- CO4:** Explain the technological basis for harnessing renewable energy sources.
- CO5:** Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

**TEXT BOOKS**

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

**REFERENCES**

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

## CO's – PO's & PSO's MAPPING

Course Outcome S	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	P O1 1	P O1 2	PS O1	PS O2	PS O3
CO1	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
OVERALL CO		2	2	1	3	3	2	2	1	1	1	1	3	2	1	3

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

OCH354

SURFACE SCIENCE

L T P C  
3 0 0 3

### COURSE OBJECTIVE:

- To enable the students to analyze properties of surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

### UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES

9

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

<b>UNIT II</b>	<b>ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES</b>	<b>9</b>
Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods		
<b>UNIT III</b>	<b>LIQUID INTERFACES</b>	<b>9</b>
Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells		
<b>UNIT IV</b>	<b>HETEROGENEOUS CATALYSIS</b>	<b>9</b>
Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation		
<b>UNIT V</b>	<b>EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES</b>	<b>9</b>
Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.		
<b>TOTAL: 45 PERIODS</b>		

## **COURSE OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

## **TEXT BOOK:**

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

## **REFERENCE:**

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

OFD354

# FUNDAMENTALS OF FOOD ENGINEERING

L T P C  
3003

## COURSE 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.

<b>UNIT II</b>	<b>9</b>
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	9
<b>UNIT III</b>	<b>9</b>
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)	9
<b>UNIT IV</b>	<b>9</b>
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 low- 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.	9
<b>UNIT V</b>	<b>9</b>
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.	9

**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.

**OFD355****FOOD SAFETY AND QUALITY REGULATION****L T P C  
3 0 0 3****COURSE 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

**OPY353****NUTRACEUTICALS****L T P C  
3 0 0 3****COURSE 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", 2<sup>nd</sup> 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 OUTCOMES**

- CO1** acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
- CO2** acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
- CO3** attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
- CO4** distinguish the various *In vitro* and *In vivo* assessment of Antioxidant activity of compounds from plant sources.
- CO5** gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
- CO6** Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

### **CO's – PO's & PSO's MAPPING**

<b>Course outcome</b>	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
<b>CO 1</b>	3											1
<b>CO 2</b>	3											1
<b>CO 3</b>	3					2						
<b>CO 4</b>	3											
<b>CO 5</b>	3					2						1
<b>CO 6</b>	3							2				1

**OTT354**

**BASICS OF DYEING AND PRINTING**

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

### **COURSE 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, Substantivity, 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 dying- 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****COURSE 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.

**CO's – PO's & PSO's MAPPING**

Course Outcomes	Program Outcome														
	Statement 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 0	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b> Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO2</b> Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO3</b> Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO4</b> Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO5</b> 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

**FT3201**

**FIBRE SCIENCE**

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

**COURSE OBJECTIVE**

- 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

**CO1** Understand the process sequence of various fibres

**CO2** Understand the properties of various fibres

**TEXT BOOKS:**

1. 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
2. Meredith R., and Hearle J. W. S., "Physical Methods of Investigation of Textiles", Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
3. Mukhopadhyay S. K., "Advances in Fibre Science", The Textile Institute, 1992, ISBN: 1870812379

**REFERENCES:**

1. Meredith R., "Mechanical Properties of Textile Fibres", North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. 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.
3. Raheel M. (ed.), "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. 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

**OTT355**

**GARMENT MANUFACTURING TECHNOLOGY**

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

**COURSE 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 care labelling

**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. Peggal H., "The Complete Dress Maker", Marshall Cavendish, 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 MAPPING

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
Avg	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

OPE353

INDUSTRIAL SAFETY

L T P C  
3 0 0 3

### COURSE 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:

**CO1** Describe, with example, the common work-related diseases and accidents in occupational setting

**CO2** Name essential members of the Occupational Health team

**CO3** 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

<b>OPE354</b>	<b>UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

**UNIT I FLUID MECHANICS CONCEPTS 9**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

**UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS 9**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

**UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER 9**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

**UNIT IV BASICS OF MASS TRANSFER 9**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

**UNIT V MASS TRANSFER OPERATIONS 9**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

## **COURSE OUTCOMES:**

At the end of the course the student will be able to:

**CO1** State and describe the nature and properties of the fluids.

**CO2** Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.

**CO3** Comprehend the laws governing the heat and mass transfer operations to solve the problems.

**CO4** Design the heat transfer equipment suitable for specific requirement.

## **TEXTBOOK(S)**

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchero, J.T., Tata McGraw Hill New York 1997

## **REFERENCES**

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352**

**PLASTIC MATERIALS FOR ENGINEERS**

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

## **COURSE OBJECTIVES**

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

### **UNIT I INTRODUCTION TO PLASTIC MATERIALS**

**9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

### **UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS**

**9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

### **UNIT III THERMOSETTING PLASTICS**

**9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

**UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9**  
Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9**  
Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanoates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

- CO1** To study the importance, advantages and classification of plastic materials  
**CO2** Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics  
**CO3** To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins  
**CO4** Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU  
**CO5** 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**

**CO1** Understand the relevance of standards and specifications.

**CO2** Summarize the various test methods for evaluating the mechanical properties of the polymers.

**CO3** To know the thermal, electrical & optical properties of polymers.

**CO4** Identify various techniques used for characterizing polymers.

**CO5** 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 Plastics, 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****COURSE 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****COURSE 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

**CO's – PO's & PSO's MAPPING**

CO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>1</b>	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
<b>2</b>	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
<b>3</b>	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
<b>4</b>	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
<b>5</b>	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
<b>Av</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>

**CBM370**

**WEARABLE DEVICES**

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

**COURSE 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.															

CBM356

MEDICAL INFORMATICS

L T P C  
3 0 0 3

### Preamble:

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

### UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

### UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

### UNIT III COMPUTERISED PATIENT RECORD 9

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

### UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer-assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

### UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health-Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

- CO1** Explain the structure and functional capabilities of Hospital Information System.
- CO2** Describe the need of computers in medical imaging and automated clinical laboratory.
- CO3** Articulate the functioning of information storage and retrieval in computerized patient record system.
- CO4** Apply the suitable decision support system for automated clinical diagnosis.
- CO5** 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

**REFERENCE:**

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.															

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

<b>UNIT IV</b>	<b>CHEMICALS AND ENZYME PRODUCTION FROM WASTES</b>	<b>9</b>
Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases		
<b>UNIT V</b>	<b>BIOCOPROCESSING OF ORGANIC WASTES</b>	<b>9</b>
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		
<b>TOTAL: 45 PERIODS</b>		

## **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.

## REFERENCES

- REFERENCES**

  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  
3 003

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>CANCER</b>	<b>9</b>
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment		
<b>UNIT III</b>	<b>CARDIOVASCULAR DISEASES</b>	<b>9</b>
Coronoary 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

<b>OBT357</b>	<b>BIOTECHNOLOGY IN HEALTH CARE</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**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.

- Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
- 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.

## **REFERENCES**

- Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
- Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
- Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

## **VERTICAL 1: FINTECH AND BLOCK CHAIN**

<b>CMG331</b>	<b>FINANCIAL MANAGEMENT</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

### **COURSE OBJECTIVES**

- To acquire the knowledge of the decision areas in finance.
- To learn the various sources of Finance
- To describe about capital budgeting and cost of capital.
- To discuss on how to construct a robust capital structure and dividend policy
- 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

<b>CMG332</b>	<b>FUNDAMENTALS OF INVESTMENT</b>	<b>L T P C</b> <b>3 0 0 3</b>
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**COURSE OBJECTIVES:**

- Describe the investment environment in which investment decisions are taken.
- Explain how to Value bonds and equities
- Explain the various approaches to value securities
- Describe how to create efficient portfolios through diversification
- Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT 9**

The investment decision process, Types of Investments – Commodities, Real Estate and FinancialAssets, the Indian securities market, the market participants and trading of securities, securitymarket indices, sources of financial information, Concept of return and risk, Impact of Taxes andInflationonreturn.

**UNIT II FIXED INCOME SECURITIES 9**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, defaultrisk andcreditrating.

**UNIT III APPROACHES TOEQUITYANALYSIS 9**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION 9**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness andactivism

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 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, Pitabus Mohanty, Investments, McGraw Hill Education (India), 11 Edition(SIE), 2019

<b>CMG333</b>	<b>BANKING, FINANCIAL SERVICES AND INSURANCE</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

### **COURSE 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

<b>CMG334</b>	<b>INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

### **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. Arshdeep Bahga, Vijay Madisetti, "Blockchain Applications: A Hands On Approach", VPT, 2017.

**CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS LTPC  
3003**

UNIT I CURRENCY EXCHANGE AND PAYMENT

9

Understand the concept of Cryptocurrency- 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 Cryptocurrencies, 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

<b>UNIT IV</b>	<b>PEER TO PEER LENDING</b>	<b>9</b>
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		

<b>UNIT V</b>	<b>REGULATORY ISSUES</b>	<b>9</b>
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

**CMG336**

**INTRODUCTION TO FINTECH**

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

**COURSE OBJECTIVES:**

- To learn about history, importance and evolution of Fintech
- To acquire the knowledge of Fintech in payment industry
- To acquire the knowledge of Fintech in insurance industry
- To learn the Fintech developments around the world
- To know about the future of Fintech

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
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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.

<b>UNIT II</b>	<b>PAYMENT INDUSTRY</b>	<b>9</b>
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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

**PROGRESS THROUGH KNOWLEDGE**

**VERTICAL 2: ENTREPRENEURSHIP**

<b>CMG337</b>	<b>FOUNDATIONS OF ENTREPRENEURSHIP</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

#### **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**

**COURSE OUTCOMES:**

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

**CO1** Learn the basics of Entrepreneurship

**CO2** Understand the business ownership patterns and environment

**CO3** Understand the Job opportunities in Industries relating to Technopreneurship

**CO4** Learn about applications of entrepreneurship and successful entrepreneurs

**CO5** 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) Donald 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 0 0 3

**COURSE OBJECTIVES**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented 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**

**COURSE OUTCOMES:**

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

**CO1** Learn the basics of managing teams for business.

**CO2** Understand developing effective teams for business management.

**CO3** Understand the fundamentals of leadership for running a business.

**CO4** Learn about the importance of leadership for business development.

**CO5** 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. Katzenbach, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

**CMG339      CREATIVITY & INNOVATION IN ENTREPRENEURSHIP**

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

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

**UNIT I      CREATIVITY**

**9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

**UNIT II      CREATIVE INTELLIGENCE**

**9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III      INNOVATION**

**9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV      INNOVATION AND ENTREPRENEURSHIP**

**9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V      INNOVATIVE BUSINESS MODELS**

**9**

Innovative Business Models: Customer Discovery-Customer Segments-Psychographic 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**

**COURSE OUTCOMES:**

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

- CO1** Learn the basics of creativity for developing Entrepreneurship
- CO2** Understand the importance of creative intelligence for business growth
- CO3** Understand the advances through Innovation in Industries
- CO4** Learn about applications of innovation in building successful ventures
- CO5** Acquaint with developing innovative business models to run the business efficiently and effectively

**Suggested Readings:**

Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand

Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.

Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.  
A. Dale Timpe, Creativity, Jaico Publishing House, 2003.  
Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.  
Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

**UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9**

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

**UNIT II MARKETING ENVIRONMENT 9**

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

**UNIT III PRODUCT AND PRICING MANAGEMENT 9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

**UNIT IV PROMOTION AND DISTRIBUTION MANAGEMENT 9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

**UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Have the awareness of marketing management process

**CO2** Understand the marketing environment

**CO3** Acquaint about product and pricing strategies

**CO4** Knowledge of promotion and distribution in marketing management.

**CO5** 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 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS</b>	<b>L T P C</b>
	<b>3 0 0 3</b>

**COURSE OBJECTIVES:**

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- 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**

**COURSE OUTCOMES:**

Upon completion of this course the learners will be able:

**CO1** To understand the Evolution of HRM and Challenges faced by HR Managers

**CO2** To learn about the HR Planning Methods and practices.

**CO3** To acquaint about the Recruitment and Selection Techniques followed in Industries.

**CO4** To known about the methods of Training and Employee Development.

**CO5** To comprehend the techniques of controlling human resources in organisations.

## REFERENCES

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**CMG342**

**FINANCING NEW BUSINESS VENTURES**

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

## COURSE OBJECTIVES

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and quity financing.
- To empower the learners towards fund rasiing for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINES 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 Dent 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**

## COURSE OUTCOMES:

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

**CO1** Learn the basics of starting a new business venture.

**CO2** Understand the basics of venture financing.

**CO3** Understand the sources of debt financing.

**CO4** Understand the sources of equity financing.

**CO5** 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; Hardymon, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

#### **VERTICAL 3: PUBLIC ADMINISTRATION**

**CMG343**

**PRINCIPLES OF PUBLIC ADMINISTRATION**

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

#### **UNIT I**

**(9)**

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****UNIT I**

(9)

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT II**

(9)

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT III**

(9)

1. President
2. Parliament
3. Supreme Court

**UNIT IV**

(9)

1. Governor
2. State Legislature
3. High Court

**UNIT V**

(9)

1. Secularism
2. Social Justice
3. Minority Safeguards

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

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

CMG345	PUBLIC PERSONNEL ADMINISTRATION	L T P C 3 0 0 3
<b>UNIT I</b>		(9)
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		

TOTAL: 45 PERIODS

## REFERENCES

- REFERENCES:**

  1. Stahl Glean O: Public Personnel Administration
  2. Parnandikar Pai V.A: Personnel System for Development Administration.
  3. Bhambhiru . P: Bureaucracy and Policy in India.
  4. Dwivedi O.P and Jain R.B: India's Administrative state.
  5. Muttalis M.A: Union Public Service Commission.
  6. Bhakara Rao .V: Employer Employee Relations in India.
  7. Davar R.S. Personnel Management & Industrial Relations

## **UNIT II** **(9)**

Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory

- ### **UNIT III** (9) Organization goals and Behaviour, Groups in organization and group dynamics,

**UNIT III** (9)  
Organization goals and Behaviour, Groups in organization and group dynamics,  
Organizational Design.

**UNIT IV****(9)**

Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V****(9)**

Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

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

1. Crozior M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347****INDIAN ADMINISTRATIVE SYSTEM****L T P C  
3 0 0 3****UNIT I****(9)**

Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II****(9)**

Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III****(9)**

Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV****(9)**

Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V****(9)**

Corruption – Ombudsman, Lok Pal & Lok Ayuktha

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

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348**

**PUBLIC POLICY ADMINISTRATION**

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

**UNIT I**

**(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT II**

**(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT III**

**(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation –Policy Evaluation.

**UNIT IV**

**(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT V**

**(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyut Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

**VERTICAL 4: BUSINESS DATA ANALYTICS**

**CMG349**

**STATISTICS FOR MANAGEMENT**

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

**COURSE OBJECTIVE:**

- To learn the applications of statistics in business decision making.

**UNIT I INTRODUCTION**

**9**

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

**UNIT II SAMPLING DISTRIBUTION AND ESTIMATION**

**9**

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

**UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS**

**9**

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS** 9

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION** 9

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

**CO1** To facilitate objective solutions in business decision making.

**CO2** understand and solve business problems

**CO3** To apply statistical techniques to data sets, and correctly interpret the results.

**CO4** To develop skill-set that is in demand in both the research and business environments

**CO5** To enable the students to apply the statistical techniques in a work setting.

**REFERENCES:**

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

<b>CMG350</b>	<b>DATAMINING FOR BUSINESS INTELLIGENCE</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE OBJECTIVES :**

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION** 9

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

**UNIT II DATA MINING PROCESS** 9

Datamining process – KDD, CRISP-DM, SEMMA

Prediction performance measures

**UNIT III PREDICTION TECHNIQUES** 9

Data visualization, Time series – ARIMA, Winter Holts,

**UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES** 9

Classification, Association, Clustering.

**UNIT V MACHINE LEARNING AND AI** 9

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1** Learn to apply various data mining techniques into various areas of different domains.  
**CO2** Be able to interact competently on the topic of data mining for business intelligence.  
**CO3** Apply various prediction techniques.  
**CO4** Learn about supervised and unsupervised learning technique.  
**CO5** Develop and implement machine learning algorithms

**REFERENCES :**

1. Jaiwei Han 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****COURSE 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.

<b>UNIT IV</b>	<b>HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION</b>	<b>9</b>
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.		
<b>UNIT V</b>	<b>HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT</b>	<b>9</b>
Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix		
<b>TOTAL: 45 PERIODS</b>		

## **COURSE OUTCOME:**

**CO1** The learners will be conversant about HR metrics and ready to apply at work settings.

**CO2** 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 Metrices, HBR, 2001.

**CMG352** MARKETING AND SOCIAL MEDIA WEB ANALYTICS L T P C  
PROGRESS THROUGH KNOWLEDGE 3 0 0 3

## **COURSE 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.

<b>UNIT IV</b>	<b>WEB ANALYTICS</b>	<b>9</b>
Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.		
<b>UNIT V</b>	<b>SEARCH ANALYTICS</b>	<b>9</b>
Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.		

## **COURSE 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 Moriuchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

## **COURSE 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.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.		
<b>UNIT II</b>	<b>WAREHOUSING DECISIONS</b>	<b>9</b>
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.		
<b>UNIT III</b>	<b>INVENTORY MANAGEMENT</b>	<b>9</b>
Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.		
<b>UNIT IV</b>	<b>TRANSPORTATION NETWORK MODELS</b>	<b>9</b>
Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.		
<b>UNIT V</b>	<b>MCDM MODELS</b>	<b>9</b>
Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.		
		<b>TOTAL : 45 PERIODS</b>

**COURSE OUTCOME:**

**CO1** To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

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

<b>CMG354</b>	<b>FINANCIAL ANALYTICS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**COURSE 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**

**COURSE OUTCOME**

**CO1** 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

<b>CES331</b>	<b>SUSTAINABLE INFRASTRUCTURE DEVELOPMENT</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

### **COURSE 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**

### **COURSE 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, KarliVergheze, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

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

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

**CES332**

**SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL  
MANAGEMENT**

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

**COURSE 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**

**COURSE 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'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

**CES333**

**SUSTAINABLE BIOMATERIALS**

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

#### **COURSE 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-pyrolytic 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 BIOMATERIALS**

**9**

General properties- Bio ceramics -Silicate glass - Alumina ( $\text{Al}_2\text{O}_3$ ) -Zirconia ( $\text{ZrO}_2$ )-Carbon-Calcium phosphates ( $\text{CaP}$ )- 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 NANOBIOMATERIALS****9**

Metalllicnanobiomaterials–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****COURSE OUTCOMES**

- CO1** Students will gain familiarity with Biomaterials and they will understand their importance.
- CO2** Students will get an overview of different biopolymers and their properties
- CO3** Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- CO4** Students gain knowledge on metals as biomaterials
- CO5** 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.Arinezeh “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, Jeyabalal Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**CES334****MATERIALS FOR ENERGY SUSTAINABILITY****L T P C****3 0 0 3****COURSE 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, Sodiated 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 - benzene – fullerenes - boron subphthalocyanine- tin (II) phthalocyanine)

**UNIT V SUPERCAPACITORS 9**

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite- conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

**CO1** Students will acquire knowledge about energy sustainability.

**CO2** Students understand the principles of different electrochemical devices.

**CO3** Students learn about the working of fuel cells and their application.

**CO4** Students will learn about various Photovoltaic applications and the materials used.

**CO5** 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, Newnham, 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 Venkataraman Thangadurai, 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**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

<b>CES336</b>	<b>ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

## **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) & RISK ASSESSMENT**

**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 soild 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.

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

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:**

- To create awareness on the energy scenario of India with respect to world
- To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
- Familiarisation on the concept of sustainable development and its benefits
- Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
- Acquainting with energy policies and energy planning for sustainable development

<b>UNIT I</b>	<b>ENERGY SCENARIO</b>	<b>9</b>
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		
<b>UNIT II</b>	<b>ENERGY AND ENVIRONMENT</b>	<b>9</b>
Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls		
<b>UNIT III</b>	<b>SUSTAINABLE DEVELOPMENT</b>	<b>9</b>
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.		
<b>UNIT IV</b>	<b>RENEWABLE ENERGY TECHNOLOGY</b>	<b>9</b>
Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits		
<b>UNIT V</b>	<b>ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT</b>	<b>9</b>
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

**CO1** Understand the world and Indian energy scenario

**CO2** Analyse energy projects, its impact on environment and suggest control strategies

**CO3** Recognise the need of Sustainable development and its impact on human resource development

**CO4** Apply renewable energy technologies for sustainable development

**CO5** 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>

## **COURSE OBJECTIVES:**

- To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
  - To create awareness on energy audit and its impacts
  - To acquaint the techniques adopted for performance evaluation of thermal utilities
  - To familiarise on the procedures adopted for performance evaluation of electrical utilities
  - To learn the concept of sustainable development and the implication of energy usage

# **UNIT I ENERGY AND ENVIRONMENT**

9

## Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

## **UNIT II ENERGY AUDITING**

9

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES

9

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

UNIT IV ENERGY CONSERVATION IN ELECTRICAL UTILITIES

9

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

UNIT V SUSTAINABLE DEVELOPMENT

9

**Sustainable Development:** Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty.

TOTAL : 45 PERIODS

## COURSE OUTCOMES:

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

#### **CO1 Understand the prevailing energy scenario**

**CO<sub>2</sub>** Familiarise on energy audits and its relevance

**CO3 Apply the concept of energy audit on thermal utilities**

**CO4** Employ relevant techniques for energy improvement in electrical utilities

#### **CO5 Understand Sustainable development and its impact on human resource development**

## REFERENCES:

- REFERENCES:**

  1. Energy Manager Training Manual (4Volumes) available at <http://www.eema.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.

