



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

**B.E. MATERIALS SCIENCE AND ENGINEERING**

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

- I. To prepare students to excel in research and to succeed in the areas of materials science and metallurgical engineering.
- II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve materials science and metallurgical engineering problems
- III. To train students to have sound knowledge on the production, processing, characterization, structural properties correlation and application of all different engineering materials.
- IV. To inculcate students with professional and ethical attitude, effective communication skills, teamwork skills and multidisciplinary approach.
- V. To develop student with an academic excellence, leadership qualities, leading to life-long learning for a successful professional career

**PROGRAM OUTCOMES (POs)**

**PO Graduate Attribute**

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

- norms of the engineering practice.
- 9 **Individual and team work:** 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)

1. Graduates will have an ability to identify, analyse and provide solution to the problems related to Materials and metallurgical engineering
2. Graduates will have the ability to implement/use appropriate characterisation techniques, analytical skills, and latest/recent development in materials technology to solve engineering problems related to materials selection and design.
3. Graduates will be able to design and develop materials and processing techniques to meet the industry needs within the realistic constraints economic, environmental, social, ethical, health and safety, manufacturability and sustainability

### PEO's – PO's & PSO's MAPPING:

PEO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I.	3	2	2	2	2	1	1	1				2	3	2	2
II.	3	3	3	3	3							2	3	2	2
III.	3	3	3	3	3							2	3	2	2
IV.	2	2	1	1		3	3	3	3	3		2	2	1	1
V.	2	2	1	1		2	2	2	2	2	3	3	2	1	1

## PROGRAM ARTICULATION MATRIX

Year	Sem	Course name	PO												PSO			
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
I	I	Professional English- I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-	
		Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-	
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-	
		Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-	
		Problem Solving and Python Programming	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-	
		தமிழர் மரபு /Heritage of Tamils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-	
		Physics and Chemistry Laboratory	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-	-
	II	Professional English- II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-	
		Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-	
		Materials Science	3	2	1.6	1.4	1.8	1.2	1	-	-	-	-	1	-	-	-	
		Basic Electrical and Electronics Engineering	2	1.8	1					1				2			1	
		Engineering Graphics	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-	
		தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Engineering Practices Laboratory	3	2		1	1	1	-	-	-	-	-	2	2	1	1	
		Basic Electrical and Electronics Engineering Laboratory	3	3	2	1	1	-	-	1.5	2	-	-	-	-	-	1	
II	III	Transforms And Partial Differential Equations	3	3	2	2	1	-	-	-	1	-	-	1	3	3	1	
		Polymer Science and Engineering	3	2	1	1	1.2	0	1.6	2.5	2	0	0	2	1	1.8	3	
		Metallurgical Thermodynamics	3	2	1	1	1.2	0	1.6	0	0	0	0	2	1	1.8	3	
		Mechanics of Solids	3	3	3	1.8	1.8	0	0	0	0	0	0	1	3	2	1	
		Engineering Mechanics	3	2	2.6	1	0	0	0	0	0	0	0	2	3	1	1.6	
		Physical Metallurgy	3	2	2	2	2							1.6	3	2.4	2.25	
		Microstructural Analysis Laboratory	2.4	3	3	3	3		1		3	1	2	1.2	2.2	2.2	1	
		Strength of Materials Laboratory																
II	IV	Characterization of Materials	3	2.2	3	2.2	2		1					2	3	3	1	
		Iron and Steel Making	3	3	3	3	2	1.2	1					2	3	2	1	
		Mechanical Behaviour of Materials	2.8	2.5	2.2	2.2	3	2	1					1	3	2	2	
		Heat Treatment of Metals and Alloys	3	2	2.8	2.6	2	1	1					2	3	2	1	
		Fluid Mechanics and Machinery																
		Environmental Science and Sustainability																
		Materials Characterization Laboratory	3	3	3	3	3				2	1	2	3	3	3	3	
		Heat Treatment Laboratory	3	2.4	2.8	1.75	2		1		2	1		1	2	3	2	
III	V	Metal and Powder Forming Techniques	3	1.4	1	1	2	1	1			1		3	2	1.4	1.4	
		Foundry Metallurgy	2.8	2.2	1.8	2.2	3		1					2	1.8	2.6	3	
		Non-Ferrous Metallurgy	3	2	2	1	2		1					2	3	2	2	
		Metal and Powder Forming Laboratory	3	2	1	2.2	2		2		2	1	1	1	1.4	1.6	1	
III	VI	Welding Technology	3	3	3	2.6	1.7	1	1					2	3	3	3	
		Foundry and Welding Laboratory	3	3	1.8	2.3	2.7	1						2	2.4	3	3	
IV	VII	Non-destructive Evaluation of Materials	2.6	2	2.6	2	2	2	1.6	2.3	1	2		2	3	2	3	
		Surface Engineering	2.2	2.4	2.2	2.2	2.2	1	3					2	3	3	3	
		Non-Destructive testing Laboratory	3	3	1.8	2.3	2.7	1						2	2.4	3	3	
Vertical 1	Vertical 1	Fracture Mechanics and Failure Analysis	2.6	2.2	2	2.4	2.2								1.6	2	1.6	
		Creep and Fatigue Behaviour of materials	3	3	2.6	2.6	3	2.6	1					3	2.6	2	2.6	
		Electron Microscopy	3	2.2	2	2.4	2.2							2	1.6	2	1.6	

		X-ray Diffraction and associated techniques	3	2.4	2	2.4	2.2						2	1.6	2	1.6	
		Advanced Metallographic techniques	2.6	2.2	2	2.4	2.2							1.6	2	1.6	
		Finite Element Analysis	3	2	3	3	2					2		3	2	1.8	
		Modelling and simulation in Materials Engineering	2.6	2.2	2	2.4	2.2						2	2	2.25	2.5	
		Phase Transformations	3	2.2	2.2	2.4							2	3	3	2	
	Vertical 2	Fundamentals of Nano Science	2.8	2	1.8	1.8	2.4	1	1					1.8	1.8	2	2
		Metallurgy of Tool materials and special steels	3	1.8	2	2	2							2	3	2.2	2
		Automotive materials	2.6	2.2	2	2.4	2.2							2	2	2.25	2.5
		Additive manufacturing	3	1.2	2.2	3	2.2		1.8	2	2.4		1	3	3	1.8	2.2
		Cryogenic Treatment of Materials	2.8	2	2	1.6								2	1.2	1	1.3
		Nuclear Materials	3	2	2	1.6		3	3					2	1.2	2	1.3
		Composite Materials	2	1	1.8	1	1	1.2	1					2	3	2.8	2
		Advanced Ceramics	3	1	1.4	1	1	1.2	1.4					2	3	1.6	2
	Vertical 3	Smart materials	3	2	2.4	1.8		2	2					2	2.4	2.4	3
		Energy Storage Devices	3	2	1	1	1		2	2				2	3	1	1
		Fuel Cell Technology	3	2	3	2	2							1		1	1
		Semiconductors and optoelectronic Materials and Devices	3	1.8	3	2	2							1	2	1	1
		Advanced Materials Characterisation	3	1.8	3	2	2							1	2	1	1
		Thin Film technology	3	1.6	1.2	1.8	1							2.2	2.4	2.2	1
		MEMS and Nanotechnology	3	1.2	2.2	1				2				2	2.4	1	1.4
		Micro and Nano fabrication	3	1.2	2.2	1					2			2	2.4	1	1.4
	Non-Vertical	Introduction to Transport Phenomena	2.6	1.8	2	2.4	2.2							2	2	2.25	2.5
		Materials Selection and design	3	3	3	3	2	2	2					2	3	3	3
		Materials for Green Engineering	3	1.6	1.2	1.8	1							1.8	2.8	2.2	1
		Unconventional Machining processes	3	2	1.75	2	1.5	1	1					2	3	3	3
		Laser processing of materials	3	1.6	1.2	1.8	1.2							1.8	2.4	2.2	1
		Making and Metallurgy of Stainless steels	3	2.2	2.2	2	1.6		2					1.8	2.8	2.6	1.6
		Fuels, Furnaces and refractories	3	1.5	1.7	1	2	2	3					2	3	2	1.3
		High temperature materials	3	1.6	1.2	1.8	1							1.8	2.4	1.6	1
	Open Elective	Introduction to non-destructive testing	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3
		Electrical, Electronic and Magnetic materials	3	1.8	1.6	2.2								2	2	2	1.2
		Nanomaterials and applications	2.8	1.6	1.7	2.2								2	1.8	2	1.3

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**CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII**  
**SEMESTER I**

SL. 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>PRACTICAL</b>								
7	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
9	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>

**SEMESTER II**

SL. 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.	CY3202	Solid State Chemistry	BSC	3	0	0	3	3
4.	BE3251	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils	HSMC	1	0	0	1	1
7.		NCC Credit Course Level 1*	-	2	0	0	2	2
<b>PRACTICAL</b>								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3271	Basic Electrical and Electronics 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>

\* 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.	MA3351	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	ML3301	Polymer Science and Engineering	ESC	3	0	0	3	3
3.	ML3302	Metallurgical Thermodynamics	PCC	4	0	0	4	4
4.	ML3391	Mechanics of Solids	ESC	3	0	0	3	3
5.	ME3351	Engineering Mechanics	ESC	3	0	0	3	3
6.	ML3303	Physical Metallurgy	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	ML3311	Microstructural Analysis Laboratory	PCC	0	0	4	4	2
8.	CE3312	Strength of Materials Laboratory	ESC	0	0	4	4	2
9.	GE3361	Professional Development <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>19</b>	<b>1</b>	<b>10</b>	<b>30</b>	<b>25</b>

<sup>§</sup> 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.	ML3401	Characterisation of Materials	PCC	3	0	0	3	3
2.	ML3402	Iron and Steel Making	PCC	3	0	0	3	3
3.	ML3403	Mechanical Behavior of Materials	PCC	3	0	0	3	3
4.	ML3404	Heat Treatment of Metals and Alloys	PCC	3	0	0	3	3
5.	CE3391	Fluid Mechanics and Machinery	ESC	3	1	0	4	4
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	ML3411	Materials Characterization Laboratory	PCC	0	0	4	4	2
9.	ML3412	Heat Treatment Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				<b>17</b>	<b>1</b>	<b>8</b>	<b>26</b>	<b>22</b>

<sup>#</sup> 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.	ML3591	Metal and Powder Forming Techniques	PCC	3	0	0	3	3
2.	ML3501	Foundry Metallurgy	PCC	3	0	0	3	3
3.	ML3502	Non-Ferrous Metallurgy	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	-	-	-	-	3
5.		Professional Elective II	PEC	-	-	-	-	3
6.		Professional Elective III	PEC	-	-	-	-	3
7.		Mandatory Course-I <sup>&amp;</sup>	MC	3	0	0	3	Non-Credit Course
<b>PRACTICALS</b>								
8.	ML3511	Summer Internship-I*	EEC	0	0	0	0	1
9.	ML3512	Metal and Powder Forming Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				-	-	-	-	<b>21</b>

\*Two weeks Summer Internship carries one credit and it will be done during IV semester summer vacation and same will be evaluated in V semester.

<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.	ML3601	Welding Technology	PCC	3	0	0	3	3
2.		Open Elective – I*	OEC	3	0	0	3	3
3.		Professional Elective IV	PEC	-	-	-	-	3
4.		Professional Elective V	PEC	-	-	-	-	3
5.		Professional Elective VI	PEC	-	-	-	-	3
6.		Professional Elective VII	PEC	-	-	-	-	3
7.		Mandatory Course-II**	MC	3	0	0	3	Non-Credit Course
8.		NCC Credit Course Level 3***		3	0	0	3	3#
<b>PRACTICALS</b>								
9.	ML3611	Foundry and Welding Laboratory	PCC	0	0	4	4	2
<b>TOTAL</b>				-	-	-	-	<b>20</b>

\*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.	ML3701	Non-destructive Evaluation of Materials	PCC	3	0	0	3	3
2.	CME397	Surface Engineering	PCC	3	0	0	3	3
3.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
4.		Elective – Management <sup>#</sup>	HSMC	3	0	0	3	3
5.		Open Elective – II <sup>**</sup>	OEC	3	0	0	3	3
6.		Open Elective – III <sup>***</sup>	OEC	3	0	0	3	3
7.		Open Elective – IV <sup>***</sup>	OEC	3	0	0	3	3
<b>PRACTICALS</b>								
8.	ML3711	Non-Destructive Testing Laboratory	PCC	0	0	4	4	2
9.	ML3712	Summer Internship-II*	EEC	0	0	0	0	1
<b>TOTAL</b>				<b>20</b>	<b>0</b>	<b>4</b>	<b>24</b>	<b>23</b>

#Two weeks Summer Internship carries one credit and it will be done during VI semester summer vacation and same will be evaluated in VII semester.

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

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

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

#Elective – management shall be chosen from the Elective – Management Courses

**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.	ML3811	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 = 166**



### ELECTIVE – MANAGEMENT COURSES

Sl. No.	Course Code	Course Title	Category	Periods per week			Total Contact Periods	Credits
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

### MANDATORY COURSES I\*

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

\*Mandatory Courses are offered as Non-Credit courses

### MANDATORY COURSES II\*

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

\*Mandatory Courses are offered as Non-Credit courses

<b>PROFESSIONAL ELECTIVE COURSES: VERTICALS</b>			
<b>Vertical 1</b>	<b>Vertical 2</b>	<b>Vertical 3</b>	<b>Vertical 4</b>
<b>MECHANICAL BEHAVIOUR AND MATERIALS CHARACTERIZATION</b>	<b>ADVANCED MATERIALS AND PROCESSING</b>	<b>MATERIALS FOR ELECTRICAL, ELECTRONIC AND MAGNETIC APPLICATIONS</b>	<b>DIVERSIFIED COURSES GROUP 1</b>
Fracture Mechanics and Failure Analysis	Fundamentals of Nano Science	Smart Materials	Introduction to Transport Phenomena
Creep and Fatigue Behaviour of Materials	Metallurgy of Tool Materials and Special Steels	Energy Storage Devices	Materials Selection and design
Electron Microscopy	Automotive Materials	Fuel Cell Technology	Materials for Green Engineering
X-ray Diffraction and Associated Techniques	Additive Manufacturing	Semiconductors and optoelectronic Materials and Devices	Unconventional Machining Processes
Advanced Metallographic Techniques	Cryogenic Treatment of Materials	Advanced Materials Characterisation	Laser Processing of Materials
Finite Element Analysis	Nuclear Materials	Thin Film Technology	Making and Metallurgy of Stainless steels
Modelling and Simulation in Materials Engineering	Composite Materials	MEMS and Nanotechnology	Fuels, Furnaces and Refractories
Phase Transformations	Advanced Ceramics	Micro and Nano Fabrication	High Temperature Materials

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

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

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL 1: MECHANICAL BEHAVIOUR AND MATERIALS CHARACTERIZATION

Sl. No.	Course code	Course title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	ML3001	Fracture Mechanics and Failure Analysis	PEC	3	0	0	3	3
2.	ML3002	Creep and Fatigue Behaviour of Materials	PEC	3	0	0	3	3
3.	ML3003	Electron Microscopy	PEC	3	0	0	3	3
4.	ML3004	X-ray Diffraction and Associated Techniques	PEC	3	0	0	3	3
5.	ML3005	Advanced Metallographic Techniques	PEC	3	0	0	3	3
6.	CPR332	Finite Element Analysis	PEC	3	0	0	3	3
7.	ML3006	Modelling and Simulation in Materials Engineering	PEC	3	0	0	3	3
8.	ML3007	Phase Transformations	PEC	3	0	0	3	3

### VERTICAL 2: ADVANCED MATERIALS AND PROCESSING

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1.	CML331	Fundamentals of Nano Science	PEC	3	0	0	3	3
2.	ML3008	Metallurgy of Tool Materials and Special Steels	PEC	3	0	0	3	3
3.	ML3009	Automotive Materials	PEC	3	0	0	3	3
4.	CME339	Additive Manufacturing	PEC	2	0	2	4	3
5.	ML3010	Cryogenic Treatment of Materials	PEC	3	0	0	3	3
6.	ML3011	Nuclear Materials	PEC	3	0	0	3	3
7.	ML3012	Composite Materials	PEC	3	0	0	3	3
8.	ML3013	Advanced Ceramics	PEC	3	0	0	3	3

### VERTICAL 3: MATERIALS FOR ELECTRICAL, ELECTRONIC AND MAGNETIC APPLICATIONS

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	ML3014	Smart Materials	PEC	3	0	0	3	3
2.	CME364	Energy Storage Devices	PEC	3	0	0	3	3
3.	ML3026	Fuel Cell Technology	PEC	3	0	0	3	3
4.	ML3015	Semiconductors and optoelectronic Materials and Devices	PEC	3	0	0	3	3
5.	ML3016	Advanced Materials Characterisation	PEC	3	0	0	3	3
6.	ML3017	Thin Film Technology	PEC	3	0	0	3	3
7.	ML3018	MEMS and Nanotechnology	PEC	3	0	0	3	3
8.	ML3019	Micro and Nano Fabrication	PEC	3	0	0	3	3

**VERTICAL 4: DIVERSIFIED COURSES GROUP 1**

Sl. No.	Course code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	ML3020	Introduction to Transport Phenomena	PEC	3	0	0	3	3
2.	ML3021	Materials Selection and Design	PEC	3	0	0	3	3
3.	ML3022	Materials for Green Engineering	PEC	3	0	0	3	3
4.	CMF339	Unconventional Machining Processes	PEC	3	0	0	3	3
5.	ML3023	Laser Processing of Materials	PEC	3	0	0	3	3
6.	ML3024	Making and Metallurgy of Stainless steels	PEC	3	0	0	3	3
7.	ML3025	Fuels, Furnaces and Refractories	PEC	3	0	0	3	3
8.	CAS331	High Temperature Materials	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.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
5.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
7.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
8.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OIE354	Quality Engineering	OEC	3	0	0	3	3
13.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	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	CATEGORY	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.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME356	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
11.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3

13.	AU3002	Batteries and Management system	OEC	3	0	0	3	3
14.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OIE353	Operations Management	OEC	3	0	0	3	3
19.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
20.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
21.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
22.	OMR353	Sensors	OEC	3	0	0	3	3
23.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
24.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
25.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
26.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
27.	CRA332	Drone Technologies	OEC	3	0	0	3	3
28.	OGI352	Geographical Information System	OEC	3	0	0	3	3
29.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
30.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
31.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
32.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
33.	OCH353	Energy Technology	OEC	3	0	0	3	3
34.	OCH354	Surface Science	OEC	3	0	0	3	3
35.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
36.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
37.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
38.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
39.	FT3201	Fibre Science	OEC	3	0	0	3	3
40.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
41.	OPE353	Industrial Safety	OEC	3	0	0	3	3
42.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
43.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
44.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
45.	OEC353	VLSI Design	OEC	3	0	0	3	3
46.	CBM370	Wearable devices	OEC	3	0	0	3	3
47.	CBM356	Medical Informatics	OEC	3	0	0	3	3
48.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
49.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
50.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

## SUMMARY

<b>B.E. MATERIALS SCIENCE AND ENGINEERING</b>										
<b><u>S.No</u></b>	<b>Subject Area</b>	<b>Credits per Semester</b>								<b>Total Credits</b>
		<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>	<b>VI</b>	<b>VII/VIII</b>	<b>VIII/VII</b>	
<b><u>1</u></b>	<b>HSMC</b>	<b>4</b>	<b>3</b>					<b>5</b>		<b>12</b>
<b><u>2</u></b>	<b>BSC</b>	<b>12</b>	<b>7</b>	<b>4</b>	<b>2</b>					<b>25</b>
<b><u>3</u></b>	<b>ESC</b>	<b>5</b>	<b>11</b>	<b>8</b>	<b>4</b>					<b>28</b>
<b><u>4</u></b>	<b>PCC</b>			<b>13</b>	<b>16</b>	<b>11</b>	<b>5</b>	<b>8</b>		<b>53</b>
<b><u>5</u></b>	<b>PEC</b>					<b>9</b>	<b>12</b>			<b>21</b>
<b><u>6</u></b>	<b>OEC</b>						<b>3</b>	<b>9</b>		<b>12</b>
<b><u>7</u></b>	<b>EEC</b>	<b>1</b>	<b>2</b>			<b>1</b>		<b>1</b>	<b>10</b>	<b>15</b>
<b><u>8</u></b>	<b>Non-Credit /(Mandatory)</b>					√	√			
<b>Total</b>		<b>22</b>	<b>23</b>	<b>25</b>	<b>22</b>	<b>21</b>	<b>20</b>	<b>23</b>	<b>10</b>	<b>166</b>



### **ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)**

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) 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 Entrepreneurs	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

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

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

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

**VERTICAL 2: ENTREPRENEURSHIP**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building 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 Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

### VERTICAL 3: PUBLIC ADMINISTRATION

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

### VERTICAL 4: BUSINESS DATA ANALYTICS

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

### VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDIT S
				L	T	P		
10.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
11.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
12.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
13.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
14.	CES335	Green Technology	PEC	3	0	0	3	3
15.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
16.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
17.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

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

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

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

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

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

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

(i) Physical Activity

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

(ii) Creative Arts

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

(iii) Universal Human Values

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

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

(iv) Literary Activity

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

(v) Proficiency Modules

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

(vi) Lectures by Eminent People

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

(vii) Visits to Local Area

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

(viii) Familiarization to Dept./Branch & Innovations

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

(ix) Department Specific Activities

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

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

References:

Guide to Induction program from AICTE

**OBJECTIVES :**

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

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1**

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

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Why/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

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

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9**

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

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

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

**UNIT V EXPRESSION 9**

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

**TOTAL : 45 PERIODS**

## LEARNING OUTCOMES:

At the end of the course, learners will be able

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

## TEXT BOOKS :

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

## REFERENCE BOOKS:

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

## ASSESSMENT PATTERN

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

### CO-PO & PSO MAPPING

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

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

**COURSE OBJECTIVES:**

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

**UNIT - I MATRICES 9 + 3**

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

**UNIT - II DIFFERENTIAL CALCULUS 9 + 3**

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

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

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

**UNIT - IV INTEGRAL CALCULUS 9 + 3**

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

**UNIT - V MULTIPLE INTEGRALS 9 + 3**

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

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

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

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

**TEXT BOOKS:**

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



## REFERENCES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

PH3151

ENGINEERING PHYSICS

L T P C  
3 0 0 3

## COURSE OBJECTIVES

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

## UNIT I MECHANICS

9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

## UNIT II ELECTROMAGNETIC WAVES

9

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

## UNIT III OSCILLATIONS, OPTICS AND LASERS

9

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS****9**

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

**UNIT V APPLIED QUANTUM MECHANICS****9**

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

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

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

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

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

**COURSE OBJECTIVES:**

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

**UNIT I WATER AND ITS TREATMENT 9**

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, 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 demineralization and zeolite process.

**UNIT II NANOCHEMISTRY 9**

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

**UNIT III PHASE RULE AND COMPOSITES 9**

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

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

**UNIT IV FUELS AND COMBUSTION 9**

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

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO<sub>2</sub> emission and carbon foot print.

**UNIT V ENERGY SOURCES AND STORAGE DEVICES 9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles – working principles; Fuel cells: H<sub>2</sub>-O<sub>2</sub> fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

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

- To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To apply the knowledge of phase rule and composites for material selection requirements.
- To recommend suitable fuels for engineering processes and applications.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

## TEXT BOOKS:

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

## REFERENCES:

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

## CO-PO & PSO MAPPING

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

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

**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	-	-
AVg.	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-

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

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:** 3  
 தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்:** 3  
 தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:** 3  
 இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்புகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிக்கல்கள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

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

**GE3152**

**HERITAGE OF TAMILS**

**L T P C**

**1 0 0 1**

**UNIT I LANGUAGE AND LITERATURE**

**3**

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

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3**  
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making -  
- Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical  
instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and  
Economic Life of Tamils.

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

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

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

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

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



**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", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

## REFERENCES:

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

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

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

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

**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  $\text{Na}_2\text{CO}_3$  as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
  - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles ( $\text{TiO}_2/\text{ZnO}/\text{CuO}$ ) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

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

**TEXT BOOK:**

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

**CO-PO & PSO MAPPING**

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

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

**GE3172**

**ENGLISH LABORATORY**

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

**OBJECTIVES :**

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

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION**

**6**

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

**UNIT II NARRATION AND SUMMATION**

**6**

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

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT**

**6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS**

**6**

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

**UNIT V EXPRESSION**

**6**

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

**TOTAL : 30 PERIODS**

## LEARNING OUTCOMES:

At the end of the course, learners will be able

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

## ASSESSMENT PATTERN

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

## CO-PO & PSO MAPPING

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

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

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

HS3252

PROFESSIONAL ENGLISH - II

L T P C

2 0 0 2

## OBJECTIVES :

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

## UNIT I MAKING COMPARISONS

6

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

## UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING

6

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

## UNIT III PROBLEM SOLVING

6

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

**UNIT IV REPORTING OF EVENTS AND RESEARCH 6**

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

**UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6**

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

**TOTAL : 30 PERIODS****OUTCOMES:**

At the end of the course, learners will be able

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

**TEXT BOOKS :**

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

**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, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

**ASSESSMENT PATTERN**

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

**CO-PO & PSO MAPPING**

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

**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:

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

**TEXT BOOKS:**

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

**REFERENCES:**

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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

**CY3202****SOLID STATE CHEMISTRY****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To understand and apply the basics of principles of solid state chemistry.
- To identify and apply the concepts involved in the syntheses, structure and physical properties of crystalline inorganic solids.
- To apply various techniques for the preparation of different types of solids.
- To understand the principles of solid characterization techniques.

**UNIT I CRYSTAL STRUCTURE****9**

Solids-Types-Crystalline, Amorphous and poly crystalline; Properties: Isotropy and anisotropy-interfacial angles-symmetry in crystal systems-elements of symmetry – space lattice and unit cell, Bravais lattice-seven crystal systems. Bond types: molecular, covalent, metallic and ionic. Born-Heber Cycle, Lattice energy, Imperfections in crystal-stoichiometric defects-Schottky, Frenkel, Non-stoichiometric defects-Colour Centre, F-Centre

**UNIT II ELECTRICAL PROPERTIES****9**

Band theory of solids -metals and their properties; semiconductors – extrinsic and intrinsic, insulators – dielectric, ferroelectric, pyroelectric and piezoelectric properties, multiferroics. Superconductivity: Basics, discovery and high T<sub>c</sub> materials.



**UNIT III MAGNETIC PROPERTIES 9**

Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials such as spinels, garnets and perovskites, hexaferrites and lanthanide-transition metal compounds; magneto resistance

**UNIT IV SYNTHETIC METHODS 9**

Thin film-Electro chemical methods, PVD & CVD: Crystal growth-Thermal methods-Bridgman, Stockbarger and Zone refining, High temperature ceramic methods. Particle size reduction, precursor method. Sol-Gel, Co-precipitation, microwave assisted synthesis, combustion synthesis, High pressure methods for preparing single crystals-Czochralski, molecular beam epitaxy-Flame and plasma fusion methods, intercalated compounds.

**UNIT V SOLID CHARACTERIZATION TECHNIQUES 9**

Powder x-ray diffraction, indexing the powder XRD patterns, Systematic absences, Structure factor, determination of lattice type, unit cell parameter and density for fcc, bcc and hcp metals, Thermal analysis: TGA, DTA, DSC

**COURSE OUTCOME:**

At the end of the course, the learners should be able to:

- Arrive at the chemical compositions based on unit cell contents and fractional coordinates.

**TEXT BOOKS:**

1. West, Antony R. Solid state chemistry, An introduction". 1st Edn. John Wiley & Sons, Singapore 2003
2. E. Smart and E. A. Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012.

**REFERENCES:**

1. V. Keer, Principles of the Solid State, 2nd Edition, New Age International, 2017.
2. Sandra E. Dann, "Reactions and Characterisation of solids". 1st Edn. The Royal Society of Chemistry, Cambridge, 2000.
3. Weller, T. Overton, J. Rourke, and F. Armstrong, Inorganic Chemistry, 6th Edition, Oxford University Press, 2014. (South Asia Edition 2015)

**CO-PO & PSO MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	1	-	-	-	1	-	-	-	-	-	3	2	2
2	2	1	-	-	-	-	1	1	-	-	-	1	3	2	2
3	2	1	-	-	-	1	2	-	-	-	-	-	3	1	2
4	3	-	2	-	-	2	1	-	-	-	-	1	2	3	1
5	3	-	-	1	-	1	1	-	-	-	-	-	3	3	2
<b>Avg.</b>	<b>2.6</b>	<b>1</b>	<b>1.5</b>	<b>1</b>	<b>-</b>	<b>1.3</b>	<b>1.2</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2.8</b>	<b>2.2</b>	<b>1.8</b>

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

**COURSE OBJECTIVES:**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To educate on the fundamental concepts of digital electronics
- To introduce the functional elements and working of measuring instruments

**UNIT I ELECTRICAL CIRCUITS 9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – 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)

**UNIT II ELECTRICAL MACHINES 9**

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

**UNIT III ANALOG ELECTRONICS 9**

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

**UNIT IV DIGITAL ELECTRONICS 9**

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps (Simple Problems only)

**UNIT V MEASUREMENTS AND INSTRUMENTATION 9**

Functional elements of an instrument, Standards and calibration, Operating Principle, types -Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram- Data acquisition.

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

After completing this course, the students will be able to

1. Compute the electric circuit parameters for simple problems
2. Explain the working principle and applications of electrical machines
3. Analyze the characteristics of analog electronic devices
4. Explain the basic concepts of digital electronics
5. Explain the operating principles of measuring instruments

**TEXT BOOKS:**

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.

**REFERENCES:**

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11<sup>th</sup> Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7<sup>th</sup> edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

Mapping of COs with POs and PSOs															
COs/POs&PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1					1				2			1
CO2	2	2	1					1				2			1
CO3	2	1	1					1				2			1
CO4	2	2	1					1				2			1
CO5	2	2	1					1				2			1
CO/PO & PSO Average	2	1.8	1					1				2			1
1 – Slight, 2 – Moderate, 3 – Substantial															

**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:

1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. 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

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

**TEXT BOOK:**

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

**REFERENCES:**

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

**Publication of Bureau of Indian Standards:**

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

**Special points applicable to University Examinations on Engineering Graphics:**

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

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

GE3252

**தமிழரும் தொழில்நுட்பமும்**

L T P C

1 0 0 1

**அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3**  
சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3**  
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்: 3**  
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: 3**  
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குழுவித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:**

**3**

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

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

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

**GE3252**

**TAMILS AND TECHNOLOGY**

**L T P C**

**1 0 0 1**

**UNIT I WEAVING AND CERAMIC TECHNOLOGY**

**3**

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

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY**

**3**

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

**UNIT III MANUFACTURING TECHNOLOGY 3**

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

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3**

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

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3**

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

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. 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.

## NCC CREDIT COURSE LEVEL 1\*

(ARMY WING) NCC CREDIT COURSE LEVEL - I		L	T	P	C
NX3251		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\*

NX3252	(NAVAL 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**

## 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**

**COURSE OBJECTIVES:**

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

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

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

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

**WOOD WORK:**

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

Wood Work Study:

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

**PART II ELECTRICAL ENGINEERING PRACTICES 15**

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

**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.

**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:

1. 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.
2. Wire various electrical joints in common household electrical wire work.
3. 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.
4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

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

**BE3271 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**

L	T	P	C
0	0	4	2

**COURSE OBJECTIVES:**

- To train the students in conducting load tests on electrical machines
- To gain practical experience in characterizing electronic devices
- To train the students to use DSO for measurements.

**LIST OF EXPERIMENTS**

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Self Excited DC Generator
4. Load test on Single phase Transformer
5. Load Test on Induction Motor
6. Characteristics of PN and Zener Diodes
7. Characteristics of BJT, SCR and MOSFET
8. Half wave and Full Wave rectifiers
9. Study of Logic Gates
10. Implementation of Binary Adder and Subtractor
11. Study of DSO

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

After completing this course, the students will be able to

1. Use experimental methods to verify the Ohm's and Kirchhoff's Laws.
2. Analyze experimentally the load characteristics of electrical machines
3. Analyze the characteristics of basic electronic devices
4. Use DSO to measure the various parameters

<b>Mapping of COs with POs and PSOs</b>															
<b>COs/POs&amp;P SOs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
<b>CO1</b>	3	3	2	1	1			1.5	2						1
<b>CO2</b>	3	3	2	1	1			1.5	2						1
<b>CO3</b>	3	3	2	1	1			1.5	2						1
<b>CO4</b>	3	3	2	1	1			1.5	2						1
<b>CO5</b>	3	3	2	1	1			1.5	2						1
<b>CO/PO &amp; PSO Average</b>	3	3	2	1	1			1.5	2						1
1 – Slight, 2 – Moderate, 3 – Substantial															

**OBJECTIVES**

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

**UNIT I****12**

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

**UNIT II****12**

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

**UNIT III****12**

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

**UNIT IV****12**

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

**UNIT V****12**

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

**TOTAL: 60 PERIODS****LEARNING OUTCOMES**

At the end of the course, learners will be able

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

**Assessment Pattern**

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

**CO-PO & PSO MAPPING**

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

**MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS****L T P C**  
**3 1 0 4****COURSE OBJECTIVES:**

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

**UNIT I PARTIAL DIFFERENTIAL EQUATIONS****9+3**

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

**UNIT II FOURIER SERIES****9+3**

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

**UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS****9+3**

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

**UNIT IV FOURIER TRANSFORMS****9+3**

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

**UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS****9+3**

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

**TOTAL: 60 PERIODS**

## COURSE OUTCOMES:

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

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

## TEXT BOOKS:

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

## REFERENCES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-

**ML3301**

**POLYMER SCIENCE AND ENGINEERING**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVES:

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

1. Understanding the basics of polymers, its formation and polymerization types.
2. Getting acquainted with the significance and the molecular weights of polymers.
3. Characterizing the polymers for their thermal behaviour and solution properties.
4. Gaining knowledge on the thermodynamics of polymer dissolution and the factors influencing them.
5. Identifying suitable polymer processing methods for polymer products.





	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2			1		2					2	1	1	3
CO2	3	2	1		1		2					2	1	2	3
CO3	3	2	1		1		1					2	1	2	3
CO4	3	2	1		1		2	2	2			2	1	2	3
CO5	3	2	1	1	2		1	3	2			2	1	2	3
Avg	3	2	1	1	1.2		1.6	2.5	2			2	1	1.8	3

**ML3302**

**METALLURGICAL THERMODYNAMICS**

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

**COURSE OBJECTIVES:**

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

1. Having an overview on the fundamental concepts in metallurgical thermodynamics
2. Gaining knowledge about the state functions such as internal energy, entropy and criteria of equilibrium.
3. Getting an insight to the auxiliary functions, heat capacities and thermodynamic potentials.
4. Knowing the essentials of thermodynamic behaviour of solutions,
5. Having an exposure on thermodynamics of electrochemical cells, surfaces and defects.

**UNIT I FUNDAMENTAL CONCEPTS**

**9+3**

Definition of thermodynamic terms; concept of states, systems and surroundings, Types of systems, equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous, micro-macro systems. Phase diagrams and its classification, Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

**UNIT II INTERNAL ENERGY AND ENTROPY**

**9+3**

First law of Thermodynamics: Relation between Heat and work, Internal energy and Enthalpy. The Second law of thermodynamics: Spontaneous process, Degree of measure of reversibility and irreversibility, Maximum work, criteria of equilibrium. Combined statement of first and second laws on thermodynamics. Statistical interpretation of entropy: Concept of microstate, most probable microstate, Thermal equilibrium, Boltzman equation, configurational entropy

**UNIT III AUXILLARY FUNCTIONS AND THERMODYNAMIC POTENTIALS**

**9+3**

Auxiliary functions: Helmholtz, Gibbs free energy, Maxwell's equation, Gibbs-Helmholtz equations. Concept of Third law, temperature dependence of entropy, Einstein's and Debye's concepts of heat capacity, relation between  $C_p$  and  $C_v$ , Nernst heat theorem, Consequences of third law, Hess's law, Le Chatelier's principle and Kirchoff's law. Zeroth law of thermodynamics and its applications. Thermodynamic potentials: Fugacity, Activity and Equilibrium constant. Clausius - Clayperon and Vant Hoff's equations.

**UNIT IV THERMODYNAMICS OF SOLUTIONS**

**9+3**

Solutions, Mole fraction, Dalton's law, partial molar quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. Change of standard state. Phase relations and phase rule, its applications. Ellingham diagram and its use. Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines. Effect of pressure on phase transformation and phase equilibria.

**UNIT V THERMODYNAMICS OF REACTIONS****9+3**

Thermodynamics of electrochemical cells, solid electrolytes. Pourbaix diagrams. Thermodynamics of Surfaces: Adsorption isotherms, Effect of surface energy on pressure and phase transformation temperature. Thermodynamics of Defects in solids: Point defects, vacancies and interstitials in solid metals.

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

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

1. Recognize the nature of the system and properties.
2. Explain the concept of internal energy, entropy and criteria for equilibrium.
3. Realize the importance of auxiliary functions and thermodynamic potentials
4. Apply the concepts of thermodynamics in the behaviour of solutions.
5. Outline the thermodynamic approaches towards electrochemical cells, surfaces and defects.

**TEXT BOOKS:**

1. David R Gaskell & David E Laughlin, "Introduction to the Thermodynamics of materials", CRC press, Sixth edition, 2017.
2. Subir Kumar Bose & Sanat Kumar Roy, "Principles of Metallurgical Thermodynamics", Universities press, 2014.

**REFERENCES:**

1. Ahindra Ghosh, Textbook of Materials and Metallurgical Thermodynamics, Prentice hall of India, 2002.
2. Boris.S. Bokstein, Mikhail I. Mendeleev, David J. Srolovitz, "Thermodynamics and Kinetics in Materials science", Oxford University Press 2005.
3. Prasad, Krishna Kant, Ray, H. S. and Abraham, K. P., "Chemical and Metallurgical Thermodynamics", New Age International, 2012.
4. Shamsuddin M, "Physical Chemistry of Metallurgical process", John Wiley, 2016
5. Upadhyaya, G. S. and Dube, R. K., "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon Press, London, 1977.

	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>CO1</b>	3	2			1		2					2	1	1	3
<b>CO2</b>	3	2	1		1		2					2	1	2	3
<b>CO3</b>	3	2	1		1		1					2	1	2	3
<b>CO4</b>	3	2	1		1		2					2	1	2	3
<b>CO5</b>	3	2	1	1	2		1					2	1	2	3
<b>Avg</b>	3	2	1	1	1.2		1.6					2	1	1.8	3

**COURSE OBJECTIVES:**

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

1. Applying the principle concepts behind stress, strain and deformation of solids for various engineering applications.
2. Analysing the transverse loading on beams and stresses in beam for various engineering applications.
3. Understanding the torsion principles on shafts and springs for various engineering applications.
4. Acquiring knowledge on the deflection of beams for various engineering applications.
5. Interpreting the thin and thick shells and principal stresses in beam for various engineering applications

**UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9**

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses and Strains: Tensile, Compressive and Shear – Material Behaviour- Elastic Vs Plastic – Response of Real Materials: Tensile Test, Compressive Test, Shear Test, Cyclic Tests - strain gauges and rosettes – Deformation of Statically determinate and Indeterminate bars of variable cross-section & Composite section under axial load – Thermal stress – Elastic constants – Plane Strain – Volumetric Strain.

**UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9**

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– Bending stress distribution – Flitched beams – Shear stress distribution.

**UNIT III TORSION 9**

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, – Closed and Open Coiled helical springs – springs in series and parallel, carriage springs.

**UNIT IV DEFLECTION OF BEAMS 9**

Slope, Deflection and Radius of Curvature – Methods of Determination of Slope and Deflection- Double Integration method – Macaulay's method – Area moment Theorems for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

**UNIT V THICK & THIN SHELLS & PRINCIPAL STRESSES 9**

Stresses in thin cylindrical shell due to internal pressure, circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lamé's theory – Application of theories of failure – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Apply the principle concepts behind stress, strain and deformation of solids for various engineering applications.
2. Analyse the transverse loading on beams and stresses in beam for various engineering applications.
3. Solve problems based on the torsion principles involved in shafts and springs for various engineering applications.
4. Interpret the results of the deflection of beams.
5. Analyse the thin and thick shells and principal stresses in beam for various engineering applications

**TEXT BOOKS:**

1. Egor P. Popov, Toader A. Balan., "Engineering Mechanics of Solids", Pearson India Education Services, 2018.
2. Ferdinand P. Beer, E. Russell Johnston, Jr., John T. DeWolf, David Mazurek "Mechanics of Materials", McGraw-Hill Education, 2015.

**REFERENCES:**

1. R. K. Bansal, "A Textbook of Strength of Materials" Laxmi Publications 2010.
2. R. K. Rajput., "Strength of Materials", Shree Publishers, 2015.
3. Hibbeler, R.C., Mechanics of Materials, Pearson Education, 2018.
4. Subramanian R., Strength of Materials, oxford University Press, Oxford Higher Education Series, 2010
5. Nash, W.A., "Theory and Problems in Strength of Materials", 6th Edition, Schaum Outline Series, McGraw-Hill Book Co, 2013.

	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>CO1</b>	3	3	3	1	1							1	3	2	1
<b>CO2</b>	3	3	3	2	2							1	3	2	1
<b>CO3</b>	3	3	3	2	2							1	3	2	1
<b>CO4</b>	3	3	3	2	2							1	3	2	1
<b>CO5</b>	3	3	3	2	2							1	3	2	1
<b>Avg</b>	3	3	3	1.8	1.8							1	3	2	1

**ME3351****ENGINEERING MECHANICS**

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

**COURSE OBJECTIVES:**

- 1 To Learn the use scalar and vector analytical techniques for analysing forces in statically determinate structures
- 2 To introduce the equilibrium of rigid bodies , vector methods and free body diagram
- 3 To study and understand the distributed forces, surface, loading on beam and intensity.
- 4 To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
- 5 To develop basic dynamics concepts – force, momentum, work and energy;

**UNIT – I STATICS OF PARTICLES****9**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles - Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

**UNIT – II EQUILIBRIUM OF RIGID BODIES****9**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

**UNIT III DISTRIBUTED FORCES****9**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

**UNIT IV FRICTION****9**

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

**UNIT V DYNAMICS OF PARTICLES****9**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

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

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

1. Illustrate the vector and scalar representation of forces and moments
2. Analyse the rigid body in equilibrium
3. Evaluate the properties of distributed forces
4. Determine the friction and the effects by the laws of friction
5. Calculate dynamic forces exerted in rigid body

**TEXT BOOKS:**

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12thEdition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

**REFERENCES:**

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeler, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

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

**ML3303**

**PHYSICAL METALLURGY**

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

**COURSE OBJECTIVES:**

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

1. Acquiring a sound background in predicting the behaviour of a metallic material to a certain application.
2. Understanding the fundamental principles of Physical Metallurgy
3. Getting familiarized with the interpretation of phase diagrams.
4. Having an insight on the thermodynamics aspect of physical metallurgy
5. Gaining knowledge on the various strengthening mechanisms in materials

**UNIT I STRUCTURE OF SOLIDS & SOLIDIFICATION OF PURE METALS 9**

Atomic Bonding & Crystal Structure: Metallic bond, unit cell, atomic packing, interstitial sites, Miller indices, crystal orientation, stereographic projection.

Phase rule, Concept of Free Energy, Entropy, Surface Energy (grain boundary) & under cooling, Nucleation & Growth, homogeneous & heterogeneous nucleation, directional solidification. Mechanisms (slip & twin), critical resolved shear stress, single crystal tensile test (FCC), theoretical strength of ideal crystal.

**UNIT II CRYSTAL IMPERFECTIONS AND DIFFUSION 9**

Vacancy, interstitial, substitutional, free energy of mixing, dislocation (elementary concepts only), edge / screw dislocation, partial dislocation, stacking fault, dislocation lock, dislocation pile up, Hall Petch relation, grain boundary structure.

Elementary concepts of phenomenological & atomistic approaches in Diffusion

**UNIT III SOLIDIFICATION OF BINARY ALLOYS 9**

Limits of solubility, isomorphous system, lever rule, constitutional super cooling, effect of non-equilibrium cooling, eutectic, peritectic, eutectoid & peritectoid system, complex phase diagram, ternary diagram, structure of cast metal, segregation & porosity, iron-carbon diagram, steel & cast iron. Phase Diagrams of common commercial alloys: Cu-Ni, Ni-Cr, Al-Si, Al-Zn, Cu-Zn, Cu-Al, Ti-Al, Ti-V, interpretation of microstructure & properties.

**UNIT IV COLD WORKING, ANNEALING AND PRECIPITATION 9**

Recovery, recrystallization & grain growth, phenomenological & mechanistic approaches. Thermodynamics & kinetics of precipitation, precipitation hardening. Need for Heat treatments. Introduction to various Heat treatment processes.

**UNIT V APPLICATIONS OF PHYSICAL METALLURGY 9**

Strengthening mechanism, strength vs. toughness (ductility), thermo-mechanical processing, micro alloyed steel, ultra-high strength steel, superalloy, control of texture.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the Course, the students will be able to

1. Recognize the basic nomenclature, microstructure, and associated terms with the appropriate structure / phenomena and differentiate between related structure / phenomena.
2. Perform simple calculations to quantify material properties and microstructural characteristics.
3. Interpret the effect of composition and microstructure on material properties.
4. Perform phase equilibrium calculation and construct phase diagram.
5. Discuss on the various strengthening mechanisms and thermal mechanical processing.

**TEXT BOOKS**

1. V. Raghavan, "Materials Science and Engineering", Prentice –Hall of India Pvt. Ltd., 2015
2. William D. Callister, Jr., "Materials Science and Engineering an Introduction", 9/e Edition, John Wiley & Sons, Inc., 2014.

**REFERENCES:**

1. Donald R. Askeland, Pradeep P. Phule, "The Science and Engineering of Materials", 7<sup>th</sup> Edition, Thomson Learning, 2015.
2. F. N. Billmeyer, "Test Book of polymer science", John Wiley & Sons, New York, 1994.
3. Kingery, W. D., Bowen H. K. and Uhlmann, D. R., "Introduction to Ceramics", 2<sup>nd</sup> Edition, John Wiley & Sons, New York, 1976.
4. Sidney H. Avner, "Introduction to Physical Metallurgy", Tata Mc-Graw-Hill Inc, 2/e, 1997.
5. Vijendra Singh, "Physical Metallurgy", Standard Publishers Distributors, New Delhi, 2012.
6. William F. Smith, "Structure and Properties of Engineering Alloys", Mc-Graw-Hill Inc., U.S.A, 2nd edition, 1993.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1								2	3	2	2
CO2	3	3	2	3	2							2	3	3	2
CO3	3	1	1	3	2							1	3	3	2
CO4	3	2	2	2								1	3	3	
CO5	3	2	3	1								2	3	1	3
Avg	3	2	2	2	2							1.6	3	2.4	2.25



**COURSE OBJECTIVES:**

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

1. Having hands on experience on the preparation of samples for microscopic examination.
2. Analysing the microstructure of plain carbon steels and its influence on the properties of materials
3. Interpreting the microstructure of the cast irons and its effect on the mechanical properties.
4. Distinguishing the microstructures of the different stainless steels and high-speed steels.
5. Examining the banded structures in steels, structure of welded joints and copper alloys.

**LIST OF EXPERIMENTS**

1. Mounting and preparation of metallurgical samples.
2. Study of metallurgical microscope and sample preparation.
3. Quantitative Metallography & image analysis.
4. Macro etching - cast, forged and welded components.
5. Electrolytic Etching and Polishing
6. Microscopic examination of cast irons - Gray, White, Malleable and Nodular types
7. Microscopic examination of Plain carbon steels (low carbon, medium carbon, high carbon steels).
8. Microscopic examination of Austenitic Stainless steels and High Speed Steels.
9. Microscopic examination of welded joints.
10. Microscopic examination of Copper alloys

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

Upon completion of the Course, the students will be able to:

1. Prepare the samples for microscopic examination
2. Recognize the microstructures of various ferrous and non-ferrous materials
3. Differentiate the different types of cast irons based on their morphology and analyse the effect of the processing on the microstructure.
4. Interpret the microstructures of various materials and also understand the effect of the various phase constituents on the properties of the materials
5. Perform a quantitative analysis on any given microstructure.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3			1		3	1	2	1	2	1	1
CO2	3	3	3	3			1		3	1	2	1	2	1	1
CO3	3	3	3	3	3		1		3	1	2	1	2	3	1
CO4	2	3	3	3	3		1		3	1	2	2	2	3	1
CO5	1	3	3	3	3		1		3	1	2	1	3	3	1
Avg	2.4	3	3	3	3		1		3	1	2	1.2	2.2	2.2	1

**COURSE OBJECTIVES:**

To study the mechanical properties of metals, wood and spring by testing in laboratory

**LIST OF EXPERIMENTS**

1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Compression test on wood
4. Deflection test on metal beam
5. Double shear test on metal
6. Impact test on metal specimen (Izod and Charpy)
7. Hardness test on metal (Rockwell and Brinell Hardness)
8. Compression test on helical spring
9. Deflection test on carriage spring

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

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

- CO1 Determine the tensile and torsion properties of steel rod by testing
- CO2 Determine the elastic modulus of a metal beam by conducting deflection test
- CO3 Determine the shear strength and impact strength of metals.
- CO4 Determine the hardness of various metals.
- CO5 Determine the stiffness properties of helical and carriage spring.

**CO – PO Mapping – STRENGTH OF MATERIALS LABORATORY**

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

**OBJECTIVES:**

To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

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

**MS WORD:****10 Hours**

Create and format a document

Working with tables

Working with Bullets and Lists

Working with styles, shapes, smart art, charts

Inserting objects, charts and importing objects from other office tools

Creating and Using document templates

Inserting equations, symbols and special characters

Working with Table of contents and References, citations

Insert and review comments

Create bookmarks, hyperlinks, endnotes footnote

Viewing document in different modes

Working with document protection and security

Inspect document for accessibility

**MS EXCEL:****10 Hours**

Create worksheets, insert and format data

Work with different types of data: text, currency, date, numeric etc.

Split, validate, consolidate, Convert data

Sort and filter data

Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.)

Work with Lookup and reference formulae

Create and Work with different types of charts

Use pivot tables to summarize and analyse data

Perform data analysis using own formulae and functions

Combine data from multiple worksheets using own formulae and built-in functions to generate results

Export data and sheets to other file formats

Working with macros

Protecting data and Securing the workbook

**MS POWERPOINT:****10 Hours**

Select slide templates, layout and themes

Formatting slide content and using bullets and numbering

Insert and format images, smart art, tables, charts

Using Slide master, notes and handout master

Working with animation and transitions

Organize and Group slides

Import or create and use media objects: audio, video, animation

Perform slideshow recording and Record narration and create presentable videos

**TOTAL: 30 PERIODS**

## OUTCOMES:

On successful completion the students will be able to

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

**ML3401**

## CHARACTERISATION OF MATERIALS

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

### COURSE OBJECTIVES:

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

1. Understanding the various techniques of structural characterization of materials.
2. Interpreting the microstructure, crystal structure and surface structure of materials.
3. on X-Ray diffraction techniques and analysis
4. To impart knowledge on different electron microscopy techniques used for characterisation
5. To impart knowledge on different electron microscopy techniques used for characterisation
6. To impart knowledge on techniques of elemental chemical composition and structure of surface.

### UNIT I METALLOGRAPHIC TECHNIQUES 9

Macro examination -applications, metallurgical microscope - construction and principle of working, specimen preparation, light material interaction – Rayleigh Scattering, Abbes theory; magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources; lenses aberrations and their remedial measures, Principles of microscopy -bright field , dark field, phase-contrast, polarization, differential interference contrast, high temperature microscopy; Quantitative metallography – Image analysis for grain size distribution and grain/precipitate shape.

### UNIT II X-RAY DIFFRACTION TECHNIQUES 9

Reciprocal lattice, Stereographic projection, X-ray generation, absorption edges, characteristic and continuous spectrum, Bragg's law, Ewald's Sphere, Diffraction methods – Laue, rotating crystal and powder methods. Intensity of diffracted beams –structure factor calculations and other factors. Diffractometer – General features and optics, Counters - Proportional, Scintillating, Geiger counters and semiconductor based.

### UNIT III ANALYSIS OF X-RAY DIFFRACTION 9

Line broadening-crystallite size, residual stress; Texture Analysis; Crystal structure determination-indexing -Phase identification- ASTM catalogue of Materials identification, quantitative phase estimation, Phase diagram determination, Precise lattice parameter calculation, Determination of residual stress – double angle diffraction.

### UNIT IV ELECTRON MICROSCOPY 9

Electron specimen interaction; Construction and operation of Transmission electron microscope (TEM) – specimen preparation techniques- Diffraction mode and image mode, Sources of contrast-Selected Area Electron Diffraction, Zone axis, indexing ; Construction, modes of operation and sources of contrast of Scanning electron microscope(SEM), Electron probe micro analysis, Basics of Field ion microscopy (FIB), Scanning Tunnelling Microscope (STM) and Atomic Force Microscope(AFM).

### UNIT V SURFACE ANALYSIS 9

X-ray emission spectroscopy - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy- Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Electron Energy Analysers, Secondary ion mass spectrometry - Quadrupole mass spectrometer ; Surface Structure -Unit meshes of five types of surface nets -

diffraction from diperiodic structures - Low Energy Electron Diffraction (LEED)- Reflection High Energy Electron Diffraction (RHEED).

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of course, the student will be able to

1. Describe the principle of metallography and its application.
2. Explain the principle of XRD and its scope for metallurgical analysis.
3. Interpret and analyse the XRD results.
4. Discuss the various techniques of electron microscopy and their applications.
5. Describe the different techniques for the analysis of elemental chemical composition and structure of surface.

**TEXT BOOKS:**

1. Angelo, P.C., "Materials Characterisation", 1<sup>st</sup> Edition Cengage Publication, 2016.
2. Cullity, B. D., Stock, S.R. "Elements of X-ray diffraction", Pearson New International Edition, 3rd Edition, 2014

**REFERENCES:**

1. Brandon D. G, "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986.
2. D. A. Skoog, F. James Leary and T. A. Nieman, "Principles of Instrumental Analysis", 7th edition, Cengage Learning, 2017.
3. Thomas G., "Transmission electron microscopy of metals", John Wiley, 1996.
4. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation ", Nineth Edition, ASM international, USA, 1986.
5. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Hong Kong University of Science and Technology, John Wiley & Sons (Asia) Pte Ltd. 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	2	3	2	2		1					2	3	3	1
<b>CO2</b>	3	2	3	2	2		1					2	3	3	1
<b>CO3</b>	3	3	3	3	2							2	3	3	
<b>CO4</b>	3	2	3	2	2							2	3	3	
<b>CO5</b>	3	2	3	2	2							2	3	3	
<b>Avg</b>	3	2.2	3	2.2	2		1					2	3	3	1

**ML3402**

**IRON AND STEEL MAKING**

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

**COURSE OBJECTIVES:**

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

1. Acquiring the basic knowledge on the need for the beneficiation of iron ores and the different preliminary treatments given to the iron ores.
2. Discussing the various parts of blast furnace and the reactions that take place in the various zones of blast furnace
3. Understanding the principles and kinetics of pig iron production as well as steel making.
4. Getting insight on the various primary and secondary processes employed for making of steel
5. Producing the different types of steels by adopting the ladle metallurgy technique.

**UNIT I RAW MATERIALS AND BURDEN PREPARATION 9**

Iron ore classification, Indian iron ores, limestone and coking coal deposits, problems associated with Indian raw materials, Iron ore beneficiation and agglomeration, Briquetting, sintering, Nodulising and pelletizing, testing of burden materials, burden distribution on blast furnace performance.

**UNIT II PRINCIPLES AND PROCESSES OF IRON MAKING 9**

Blast furnace parts, construction and design aspects, ancillary equipment for charging, preheating the blast, hot blast stoves, gas cleaning, Blast furnace operation, irregularities and remedies, Blast furnace instrumentation and control of furnace Compositional control of metal and slag in blast furnace, modern trends in blast furnace practice.

Reduction of iron ores and oxides of iron by solid and gaseous reductions-thermodynamics and kinetics study of direct and indirect reduction, Gruner's theorem, blast furnace reactions. C-O and Fe-C-O equilibria, Rist diagrams, Ellingham diagram, material and heat balance- Sponge Iron making.

**UNIT III PRINCIPLES OF STEEL MAKING 9**

Development of steel making processes, physico-chemical principles and kinetic aspects of steel making, carbon boil, oxygen-transport mechanism, desulphurisation, dephosphorisation, Slag Theories, slag-functions, composition, properties and theories, raw materials for steelmaking and plant layout.

**UNIT IV STEEL MAKING PROCESSES 9**

Open Hearth process- constructional features, process types, operation, modified processes, Duplexing, pre-treatment of hot metal. Bessemer processes, Side Blown Converter, Top Blown processes-L. D, L.D.A.C., Bottom blown processes, combined blown processes, Rotating oxygen processes - Kaldo and Rotor, Modern trends in oxygen steel making processes-Electric Arc and Induction furnace-constructional features. Steel Classifications and Standards-National and International- Alloy Designation.

**UNIT V LADLE METALLURGY 9**

Production practice for plain carbon steels, stainless steels, tool steels and special steels, Secondary steel making processes, continuous steel casting process – Deoxidation and teeming practice. Principle, methods and their comparison, Killed, Rimmed and Capped steels, Degassing practices, ingot production, ingot defects and remedies. Recent trends in steel making technology.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Identify the suitable preliminary treatments to be given to the iron ore for the beneficiation of ores.
2. Discuss the construction of Blast furnace, its operation and the various reactions that takes place in the various zones of blast furnace.
3. Interpret the slag theories and slag functions in the steel making processes.
4. Compare the various steel making processes and analyse the advantages and limitations of the different processes.
5. Select the suitable secondary refining processes for producing a good quality steel.

**TEXT BOOKS:**

1. Dipak Mazumdar, "A First Course in Iron and Steel Making", Universities press – IIM, Series in Metallurgy and Materials Science, India, 2015.
2. Tupkary, R. H.&Tupkary V.R., "An Introduction to Modern Iron Making", Khanna Publishers, 4<sup>th</sup> edition, 2016 & "An Introduction to Modern Steel Making", Khanna Publishers, New Delhi, 2000.

**REFERENCES:**

1. Ahindra Ghosh and Amit chatterjee, "Iron Making and Steel Making – Theory and Practice", Prentice Hall of India Private Ltd., New Delhi 2008.
2. Biswas, A. K., "Principles of blast furnace iron making: theory and practice", SBA Publications, Kolkata, 1994.
3. Bashforth, G. R., "Manufacture of Iron and Steel", Vol. I, Chapman and Hall London, 1964. Bashforth, G. R., "Manufacture of Iron and Steel", Vol.2, 3rd Edition, Chapman & Hall, London, 1964.
4. "Making, Shaping and Treating of Steel", US Steel Corporation, 11th edition, 1994.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3		1	1					2	3		
CO2	3	3	3	3	2	2	1					2	3	2	1
CO3	3	3	3	3	2	1	1					2	3		
CO4	3	3	3	3	2	1	1					2	3	2	1
CO5	3	3	3	3	2	1	1					2	3	2	1
Avg	3	3	3	3	2	1.2	1					2	3	2	1

**ML3403****MECHANICAL BEHAVIOUR OF MATERIALS**

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

**COURSE OBJECTIVES:**

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

1. Having an overview of elastic and plastic behaviour of materials
2. Getting enlightened with the different strengthening mechanisms.
3. Obtaining an insight into the types of fracture and mechanics of fracture.
4. Interpreting the fatigue behaviour of materials.
5. Having an insight on the high temperature behaviour of materials.

**UNIT I ELASTIC AND PLASTIC BEHAVIOUR****9**

Elastic behaviour of materials - Hooke's law, plastic behaviour: dislocation theory, Types of dislocations- Burger's vectors and dislocation loops, dislocations in the FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, dislocation climb, intersections of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning. Methods of observing dislocations

**UNIT II STRENGTHENING MECHANISMS****9**

Elementary discussion of cold working, grain boundary strengthening. Solid solution strengthening, Martensitic strengthening, Precipitation strengthening, Particulate Strengthening, Dispersion strengthening, Fibre strengthening, Yield point phenomenon, strain aging and dynamic strain aging

**UNIT III FRACTURE AND FRACTURE MECHANICS****9**

Types of fracture, Basic mechanisms of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, Determination of DBTT. Fracture mechanics-Introduction, Modes of fracture, Stress intensity factor, Fracture toughness and Determination of KIC.

**UNIT IV FATIGUE BEHAVIOUR AND TESTING****9**

Fatigue: Stress cycles, S-N curves, Effect of mean stress, Factors affecting Fatigue, Structural changes accompanying fatigue, Cumulative damage- Miner law, HCF / LCF, creep- fatigue interactions, micro-mechanisms of fatigue crack initiation and growth, fatigue testing machines- Pari's Equation, Residual life prediction under Fatigue. Macro, Microstructural features of fatigue fracture.

**UNIT V CREEP BEHAVIOUR AND TESTING****9**

Creep curve, Stages in creep curve and explanation, Structural changes during creep, Creep mechanisms, Metallurgical factors affecting creep, High temperature alloys, Stress rupture testing, Creep testing machines, creep life prediction-Omega (Damage rate) method, Larson-Miller (parametric) method. Deformation Mechanism Maps according to Frost/Ashby, Super plasticity.

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

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

1. Identify the role of dislocations and the mechanisms of plastic deformation.
2. Explain the strengthening mechanisms of polycrystalline and composite materials.
3. Analyse the nature of fracture and its underlying mechanism.
4. Appraise the micro-mechanics, factors and life predictions of components under fatigue loading.
5. Assess the behaviour of materials under high temperature, metallurgical factors and life prediction of high temperature materials.

**TEXT BOOKS:**

1. Dieter, G. E., "Mechanical Metallurgy", McGraw-Hill Co., SI Edition, 1995
2. Thomas H. Courtney, " Mechanical Behaviour of Materials", Waveland Press, 2nd edition, 2005

**REFERENCES:**

1. Bhargava A K & Sharma C P, "Mechanical behaviour and Testing of materials" PHI learning 2011.
2. Norman E Dowling, "Mechanical Behaviour of Materials, Pearson 2013.
3. Prashant Kumar, "Elements of Fracture Mechanics", McGraw-Hill, 2009.
4. Shetty M N, Dislocations and mechanical behaviour of materials", PHI learning 2013.
5. William Hosford., "Mechanical behaviour of Materials", Cambridge University press, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>C01</b>	3	3	2	2								1	3		
<b>C02</b>	3		2	2		2						1	3		
<b>C03</b>	3	2	3	3	3							1	3	2	
<b>CO4</b>	2	3	2	2			1					1	3	2	2
<b>CO5</b>	3	2	2	2	3		1					1	3	2	2
<b>Avg</b>	2.8	2.5	2.2	2.2	3	2	1					1	3	2	2



**COURSE OBJECTIVES:**

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

1. Having necessary background to design/select the necessary heat treatment for attaining the appropriate microstructure for the desired properties.
2. Getting a comprehensive understanding of the various transformation reactions associated with the changes in microstructures and properties that occur due to controlled heat treatment.
3. Understanding different case hardening techniques used in industries
4. Distinguishing the various Heat treatment furnaces, Quenching media and the heat treatment of some special alloys.
5. Getting an insight on the heat treatments employed for special alloys

**UNIT I TRANSFORMATIONS IN STEELS 9**

Allotropic changes in Iron, Iron-Iron carbide equilibrium diagram – transformations on heating and cooling - influence of alloying elements – general principles of heat treatment of steels – isothermal and continuous cooling transformations in steels – Time-Temperature-Transformation curves (TTT-diagrams), continuous cooling transformations – CCT-diagrams– effect of alloying additions on TTT diagrams, mechanism and kinetics of pearlitic, bainitic and martensitic transformations – habit plane – Bain distortion model

**UNIT II HEAT TREATMENT PROCESSES 9**

Annealing- Types, Normalising, Hardening & Quenching –Mechanisms-hardenability studies– Jominy end-quench test, Grossman’s experiments, tempering – Hollomon& Jaffe tempering correlations, retained austenite, tempering – Stages – effects of alloying elements on tempering, austempering and martempering, precipitation hardening, thermo-mechanical treatment, intercritical heat treatment, sub-zero treatment – cryogenic quenching, patenting

**UNIT III CASE HARDENING 9**

Introduction, carburisation – principle – carbon potential – mechanism – application of Fick’s law– depth of carburisation and its control – methods of carburising – heat treatment after carburizing – structure, properties and defects in carburising, nitriding – mechanism -- effect of microstructure – nitriding methods, ion-nitriding and nitro-carburising, boronising, chromising, cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam welding – principles – methods – operating variables, measurement of case depth.

**UNIT IV FURNACES, ATMOSPHERE AND PROCESS CONTROL 9**

Various heating atmosphere used for heat treatment, temperature and atmosphere control– carburising atmosphere and carbon potential measurement, Temperature Measurement Control devices – Nitriding gas atmospheres, quenching media and their characteristics, Stages of Quenching, polymer quenching, Various Heat Treatment furnaces- Roller and Mesh type continuous furnaces- fluidised bed furnaces, cryo-chamber, cryo-treatment of steels, sealed quench furnace, Vacuum furnace, Plasma equipment-Elements of Process control systems-PLC ,PID controllers and continuous monitoring systems.

**UNIT V HEAT TREATMENT OF SPECIFIC ALLOYS 9**

Heat treatment of special purpose steels – tool steels, high speed steels, maraging steels, HSLA steels and die steels, heat treatment of cast irons – gray cast irons, white cast irons and S.G. irons, austempering of S.G. Iron, heat treatment of non-ferrous alloys – aluminium alloys, copper alloys, nickel alloys and titanium alloys, defects in heat treated parts – causes and remedies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Discuss the various transformation reactions associated with the changes in microstructures and properties that occur due to controlled heat treatment.
2. Explain the various heat treatment processes that can be applied for different ferrous and non-ferrous alloys.
3. Analyse the effect of various case hardening treatments on the metals and alloys.
4. Compare the various heat treatment furnaces, quenching media and furnace atmospheres.
5. Interpret the results of heat treatments on the various other non-ferrous materials, alloy steels and cast irons.

**TEXT BOOKS:**

1. Rajan, T. V., Sharma, C. P., Ashok Sharma., "Heat Treatment Principles and Techniques" Prentice-Hall of India Pvt. Ltd., New Delhi, 2011
2. Vijendra Singh, "Heat Treatment of Metals", Second edition, Standard Publishers Distributors New Delhi, 2012.
- 3.

**REFERENCES:**

1. ASM Hand book "Heat Treating", Vol.4., ASM International, 1999.
2. I. Novikov, "Theory of Heat Treatment of Metals", MIR Publishers, Moscow, 1978
3. Prabhudev. K. H. "Handbook of Heat Treatment of Steels", Tata McGraw-Hill, Publishing Co., New Delhi, 1988.
4. Sydney H. Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill, New Delhi, 1997.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2								2	3		
CO2	3	2	3	3	2		1					2	3	2	1
CO3	3	2	3	3	2		1					2	3	2	1
CO4	3	2	3	2	2	1	1					2	3	2	1
CO5	3	2	3	3	2		1					2	3	2	1
Av	3	2	2.8	2.6	2	1	1					2	3	2	1
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES:**

1. To introduce the students about properties of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

**UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10+3**

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

**UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9+3**

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

**UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 8+3**

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

**UNIT IV TURBINES 9+3**

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

**UNIT V PUMPS 9+3**

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and its variations - Work saved by fitting air vessels - Rotary pumps.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

1. Understand the properties and behaviour in static conditions. Also to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

**TEXT BOOKS:**

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2016.

**REFERENCES:**

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

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

**GE3451****ENVIRONMENTAL SCIENCES AND SUSTAINABILITY****L T P C****2 0 0 2****OBJECTIVES:**

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

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

**TOTAL : 30 PERIODS**

**OUTCOMES:**

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

**TEXT BOOKS:**

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

**REFERENCES :**

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . Edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

**CO-PO & PSO MAPPING**

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

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

<b>NCC Credit Course Level 2*</b>		
<b>NX3451</b>	<b>(ARMY WING) NCC Credit Course Level - II</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

<b>PERSONALITY DEVELOPMENT</b>	<b>9</b>
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PD 3	Group Discussion: Change your mindset, Time Management, Social Skills	6
PD 5	Public Speaking	3

<b>LEADERSHIP</b>	<b>7</b>
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L 2	Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965	7
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<b>DISASTER MANAGEMENT</b>	<b>13</b>
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DM 1	Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation	3
DM 2	Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters	9
DM 3	Fire Service & Fire Fighting	1

<b>ENVIRONMENTAL AWARENESS &amp; CONSERVATION</b>	<b>3</b>
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EA 1	Environmental Awareness and Conservation	3
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<b>GENERAL AWARENESS</b>	<b>4</b>
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GA 1	General Knowledge	4
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<b>ARMED FORCES</b>	<b>6</b>
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AF 1	Armed Forces, Army, CAPF, Police	6
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<b>ADVENTURE</b>	<b>1</b>
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AD 1	Introduction to Adventure Activities	1
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<b>BORDER &amp; COASTAL AREAS</b>	<b>2</b>
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BCA 1	History, Geography & Topography of Border/Coastal areas	2
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**TOTAL: 45 PERIODS**

<b>NCC Credit Course Level 2*</b>		
<b>NX3452</b>	<b>(NAVAL WING) NCC Credit Course Level - II</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

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

**TOTAL: 45 PERIODS**



## NCC Credit Course Level 2\*

NX3453

(AIR FORCE WING) NCC Credit Course Level - II

L T P C  
3 0 0 3

### PERSONALITY DEVELOPMENT

9

PD 3 Group Discussion: Change your mindset, Time Management, Social Skills 6

PD 5 Public Speaking 3

### LEADERSHIP

7

L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan  
Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 7

### DISASTER MANAGEMENT

13

DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services,  
Assistance, Civil Defence Organisation 3

DM 2 Initiative Training, Organising Skills, Do's & Don't's,  
Natural Disasters, Man Made Disasters 9

DM 3 Fire Service & Fire Fighting 1

### ENVIRONMENTAL AWARENESS & CONSERVATION

3

EA 1 Environmental Awareness and Conservation 3

### GENERAL AWARENESS

4

GA 1 General Knowledge 4

### GENERAL SERVICE KNOWLEDGE

6

GSK 1 Armed Forces & IAF Capsule 2

GSK 2 Modes of Entry in IAF, Civil Aviation 2

GSK 3 Aircrafts - Types, Capabilities & Role 2

### ADVENTURE

1

AD 1 Introduction to Adventure Activities 1

### BORDER & COASTAL AREAS

2

BCA 1 History, Geography & Topography of Border/Coastal areas 2

**ML3411****MATERIALS CHARACTERIZATION  
LABORATORY****L T P C  
0 0 4 2****COURSE OBJECTIVES:**

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

1. Gaining practical experience on handling sophisticated instruments.
2. Obtaining hands-on-practice for sample preparation.
3. Experiencing the procedure involved in the instrumentation methods.
4. Calibrating and standardizing the sensitive instruments.
5. Using the spectrometers, electron microscopes and thermal analysers for analysing the specimens.

**LIST OF EXPERIMENTS:**

1. Verification of Beer Lambert's law using Absorption Spectrophotometer.
2. Determination of concentration of metal ions using UV Visible spectrophotometer.
3. Determination of thermal coefficient using dilatometer.
4. Determination of conductivity using conductivity meter.
5. Identification of organic compounds using IR spectroscopy.
6. Quantitative analysis using column chromatography.
7. Qualitative identification of species using TLC.
8. Thermal degradation analysis using TGA
9. Thermal transition analysis using DSC.
10. Analysis of electron microscopic images

**COURSE OUTCOMES:**

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

1. Apply the theoretical principles and concepts of spectroscopy in characterization of materials.
2. Analyse and interpret the results obtained from the instrumental methods.
3. Demonstrate the use of suitable equipment to analyse the thermal behaviour of materials.
4. Examine the mixture of materials using chromatography technique.
5. Analyse and interpret the microstructural images obtained by electron microscopy.

**TOTAL: 60 PERIODS**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3				2	1	2	3	3	3	3
CO2	3	3	3	3	3				2	1	2	3	3	3	3
CO3	3	3	3	3	3				2	1	2	3	3	3	3
CO4	3	3	3	3	3				2	1	2	3	3	3	3
CO5	3	3	3	3	3				2	1	2	3	3	3	3
Avg	3	3	3	3	3				2	1	2	3	3	3	3

**ML3412****HEAT TREATMENT LABORATORY****L T P C  
0 0 4 2**

**COURSE OBJECTIVES:**

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

1. Performing heat treatment operations on the plain carbon steels
2. Interpreting the effect of quenching media and tempering temperature and time on the hardness of the steels
3. Enhancing the case hardness of the low carbon steels by carburizing treatment
4. Measuring the case depth of the case-hardened steels
5. Identifying the suitable heat treatment for non-ferrous materials.

**LIST OF EXPERIMENTS:**

1. Hardening and tempering of High carbon steels
2. Annealing and normalizing of hardened steels
3. Spheroidization annealing of high carbon steels
4. Effect of quenching media on hardening of steel
5. Effect of tempering temperature and time on tempering of steel
6. Effect of carbon percentage on the hardening of steel
7. Carburizing of low carbon steel
8. Case hardness depth measurements
9. Hardenability test – Jominy End Quench Test
10. Heat treatment of cast iron
11. Heat treatment of Stainless Steels and High speed steels
12. Heat treatment of non-ferrous alloys

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

1. Perform various heat treatment processes on plain carbon steels and analyze the effect of the processes on steels.
2. Execute the case hardening effect on low carbon steel and to analyze the case depth measurements.
3. Interpret the effect of quenching media and the carbon percentage on the hardening of steel
4. Exemplify the effect of Jominy end quench test on the hardenability of steel.
5. Apply heat treatment on the various non-ferrous materials and analyze the effect of heat treatment on these materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2			1		2	1	1	2	3	2	2
CO2	3	2	3	2			1		2	1	1	2	3	2	2
CO3	3	3	2				1		2	1	1	2	3	2	1
CO4	3	3	3	2	2		1		2	1	1	2	3	2	2
CO5	3	2	3	1			1		2	1	1	2	3	2	1
Avg	3	2.4	2.8	1.75	2		1		2	1	1	2	3	2	3

**ML3591**

**METAL AND POWDER FORMING TECHNIQUES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

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

- Describing types of deformations and classification of forming processes.

- Classifying and explain bulk forming processes.
- Describing sheet metal forming processes
- Distinguishing differences between conventional forming and special forming processes.
- Elaborating various stages involved in the powder forming processes.

**UNIT I INTRODUCTION 9**

Mechanical behavior of materials- Elastic and plastic deformations - Classification of forming processes - Temperature in metal working: Cold, Warm and hot working - Introduction to the theory of plastic deformation.

**UNIT II BULK FORMING 9**

Introduction - Plastic deformation in forging, rolling, extrusion, rod/wire, tube drawing and swaging processes and their applications - Effect of friction, calculation of forces, work done, process parameters, equipment's and defects - Design for manufacturing - Economics of bulk forming.

**UNIT III SHEET METAL FORMING 9**

Introduction - Sheet metal characteristics - Conventional sheet metal forming processes like shearing, bending and miscellaneous forming processes - High energy rate forming processes - Super plastic forming processes - Deep drawing process - Principles, process parameters, advantages, limitations and applications of the above - Formability of sheet metals - Equipment's - Defects - Design for manufacturing - Economics of sheet metal forming.

**UNIT IV SPECIAL FORMING 9**

Orbital forging - Isothermal forging - Hot and cold Isostatic pressing - High speed extrusion - High speed forming machines - Rubber pad forming - Water hammer forming - Fine blanking - Incremental forming and comparing the above with conventional forming.

**UNIT V POWDER FORMING 9**

Introduction - Powder production methods - Particle size characterization – Blending – Compacting - Sintering - Secondary and finishing operations - Advantages and applications of powder metallurgy - Design for manufacturing - Powder forging, rolling, extrusion, drawing - Economics of powder forging.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Illustrate deformation types and classification of forming processes.
2. Describe bulk forming processes and their applications.
3. Elaborate different sheet metal forming processes and their applications.
4. Compare and distinguish conventional and special forming processes.
5. Discuss powder forming processes and its applications

**TEXT BOOKS:**

1. Kalpakjian S. and Schmid S.R., "Manufacturing Engineering and Technology", Pearson., New Delhi, India, 2018.
2. Sadhu Singh, "Theory of plasticity and metal forming processes", Khanna Publishers, 2008

**REFERENCES:**

1. Heinz Tschätsch, "Metal Forming Practise: Processes - Machines – Tools", Springer-

- Verlag Berlin Heidelberg., Germany, 2006.
2. Juneja B.L., "Fundamentals of Metal forming Processes", New Age International Publishers Ltd., Chennai, India, 2018.
  3. Kumar Surender, "Technology of Metal Forming Processes", PHI learning Pvt. Ltd., New Delhi, India, 2008.
  4. Nagpal G.R., "Metal Forming Processes", Khanna Publishers., New Delhi, India, 2000.
  5. Mikell P. Groover, "Fundamental of Modern Manufacturing: Materials, Processes and Systems", John Wiley and Sons Ltd., United States, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1				1	1			1		3	2	1	1
2	3	2	1			1	1			1		3	2	1	1
3	3	2	1			1	1			1		3	2	1	1
4	3	1		1	2	1	1			1		3	2	2	2
5	3	1	1	1	2	1	1			1		3	2	2	2
<b>Avg</b>	3	1.4	1	1	2	1	1			1		3	2	1.4	1.4

**ML3501**

**FOUNDRY METALLURGY**

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

**COURSE OBJECTIVES:**

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

1. Getting acquainted with the various patterns, moulding materials and furnaces used in foundries.
2. Choosing moulding process for casting components.
3. Designing gating system for castings.
4. Making use of basics of ferrous casting metallurgy for casting quality ferrous castings
5. Making use of basics of non-ferrous casting metallurgy for casting quality nonferrous castings

**UNIT I PATTERN, MOULDING MATERIALS, FURNACES**

**9**

Introduction to foundry process-Pattern, types- allowances- selection of pattern materials, -Sand-Core for foundry applications – types, properties of prepared sand-Moulding and Cores additives-preparations-Types of furnaces –Crucible, Cupola, Oil fired furnaces, Electric furnaces, Arc and Induction types.

**UNIT II MOULDING PROCESSES**

**9**

Green Sand -Hand Moulding, Jolt Squeeze and High Pressure Moulding, - CO<sub>2</sub> and Nishiyama process- No Bake- Two part and Three-part Process, - Shell- Investment Casting- Permanent Moulding – Pressure Die casting processes- Ceramic- Plaster of Paris- Centrifugal- Squeeze- Electro Magnetic - Lost Foam process.

**UNIT III DESIGN OF GATING SYSTEM**

**9**

Design of Gating Systems –Types – Pressure & Un pressurized systems -Sprue- runner- gates – problems in design and manufacture of thin and unequal Sections-designing for directional solidification- Riser design-Chvorinov’s rule, Caines- Section Modulus- Naval Research Laboratory methods, feeding distances – Calculations and number of Risers required, chills and feeding aids – Exothermic And Insulating sleeves Design problems of L, T, V, X and Y junctions, Computer Applications in casting design—Software for casting design CAE –Stress, Liquid metal flow and solidification analysis.

**UNIT IV FERROUS CAST ALLOYS 9**

Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size- Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure- Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons-family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels-melting procedure and composition control for carbon steels- low alloy steels - stainless steels-composition control- slag-metal reactions-desulphurization-dephosphorisation, specifications for carbon steels- low alloy steels and stainless steels

**UNIT V NON-FERROUS CAST ALLOYS 9**

Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

1. Select a proper material for making a pattern, design patterns, and decide on the composition of sand and core and know about the different furnaces for available for melting metals.
2. Describe the various casting processes for casting a component.
3. Design suitable gating system for casting a component.
4. Use suitable casting techniques to produce sound ferrous castings.
5. Employ suitable casting techniques to produce sound nonferrous castings.

**TEXT BOOKS**

1. A.K.Chakrabarthy 'Casting Technology and Cast Alloys ,Prentice Hall of India
2. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017

**REFERENCES**

1. Manufacturing Technology - Foundry, Farming and Welding | Volume1 | 5th Edition, P N Rao, McGraw-Hill Education 2018
2. ASM Metals, Hand book "Casting", Volume 15, ASM International, 2007.
3. Beeley P, "Foundry Technology" Butterworth-Heinemann London, 2001.
4. John Campbell, "Casting", Butterworth- Heinemann, 2003.
5. The Foseco "Foundryman's Hand book", Pergamon Press, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3			1					2	1	3	3
CO2	3	2	1	1			1					2	1	1	3
CO3	3	2	1	1	3		1					2	2	3	3

<b>CO4</b>	3	3	3	3	3		1					2	2	3	3
<b>CO5</b>	3	3	3	3			1					2	3	3	3
<b>Avg</b>	2.8	2.2	1.8	2.2	3		1					2	1.8	2.6	3

**ML3502**

**NON-FERROUS METALLURGY**

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

**COURSE OBJECTIVES:**

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

1. Understanding the structure, property relations of nonferrous alloys with special emphasis on engineering applications.
2. Gaining knowledge on the important alloys used for critical applications.
3. Having an insight on the phase diagrams of industrially relevant portions of some important alloys.
4. Acquiring knowledge on the selection of suitable non-ferrous alloy for a given application.
5. Being well versed with the properties and applications of precious metals.

**UNIT I COPPER AND COPPER ALLOYS 9**

Methods of Production of Copper, Properties and applications of metallic copper. Major alloys of copper and designation- Brasses. Phase diagram of industrially relevant portion. Copper, characteristics and uses. Bronzes: Tin bronze. Composition, properties and uses. Other bronzes like Cu-Al, Cu-Si, Cu-Mn and Cu-Be alloys. Cu-Ni alloys. Typical microstructure of copper alloys.

**UNIT II ALUMINIUM AND ITS ALLOYS 9**

Methods of Production of Aluminium- Properties of Pure aluminium. Alloys of aluminium and designation, classification. Wrought and cast alloys. Heat treatable and non-heat treatable alloys. Age hardening of Al-Cu alloy. Al-Mg-Si, Al-Zn-Mg and Al-Li alloys. Typical microstructure of aluminium alloys. Applications of Al alloys in Automobile and Aircraft industries.

**UNIT III MAGNESIUM AND TITANIUM ALLOYS 9**

Methods of Production of Magnesium- properties and uses. Magnesium alloys and designation, Applications. Methods of Production of Titanium- unique characteristics of Ti metal- alpha, alpha+beta and beta titanium alloys- major types. Titanium aluminides – their properties and uses. Typical microstructure of magnesium and titanium alloys- Applications of Ti alloys in Aircraft, Chemical and Medical industries.

**UNIT IV NICKEL AND ZINC ALLOYS 9**

Methods of Production of Nickel-Properties and uses of nickel. Nickel alloys and designation– their properties and uses. Nickel aluminides. Methods of Production of Zinc-Use of zinc in corrosion protection of ferrous materials. Zinc alloys – properties and uses. Typical microstructure of nickel and zinc alloys, Applications.

**UNIT V LEAD, TIN AND PRECIOUS METALS 9**

Methods of Production of Lead and Tin-Major characteristics and applications of lead and tin and their alloys and designation. Low melting nature of solder alloys. Gold, silver and platinum – nobility of these metals. Engineering properties and applications of these metals and their alloys. Typical microstructure of solder alloys.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Correlate the structure - property relations of various copper alloys with special emphasis on engineering applications.
2. Compare the differences between various aluminium alloys with respect to their composition, properties and applications.
3. Identify suitable magnesium and titanium alloys for applications which involves magnesium and titanium alloys.

- Classify the different types of Nickel and Zinc alloys and understand the implications of these compositions on the properties and applications of the various alloys.
- Explain the importance of precious metals, their properties and applications as well as the properties and applications of Lead and Tin alloys.

### TEXT BOOKS

- K.G.Budinski and M.K.Budinski,"Engineering Materials-- Properties and Selection", PHI Learning Pvt. Ltd., New Delhi, 2010.
- Sidney H. Avner, "Introduction to Physical Metallurgy", Tata McGraw-Hill, 2nd Edition, 1997

### REFERENCES

- Ahindra Ghosh, Hem Shanker Ray, "Principles of Extractive Metallurgy", New Age International, Reprint 2001.
- Balram Gupta,"Aerospace Materials", Vol. 1, 2 and 3, S. Chand and Co., New Delhi, 1996.
- Clark and Varney,"Physical Metallurgy for Engineers", Affiliated East West Press, New Delhi, 1987.
- W.H. Dennis,"Metallurgy of the Nonferrous Metals", Sir Isaac Pitman and Sons, London,1967
- William F. Smith,"Structure and Properties of Engineering Alloys", McGraw Hill, USA, 1993

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2		1					2	3	2	2
CO2	3	2	2	1	2		1					2	3	2	2
CO3	3	2	2	1	2		1					2	3	2	2
CO4	3	2	2	1	2		1					2	3	2	2
CO5	3	2	2	1	2		1					2	3	2	2
Avg	3	2	2	1	2		1					2	3	2	2

ML3512

METAL AND POWDER FORMING LABORATORY

L T P C  
0 0 4 2

### COURSE OBJECTIVES:

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

- Acquiring knowledge on basic metal forming processes by experimental study and analysis
- Constructing formability diagrams
- Reducing thickness by sheet metal rolling
- Reducing the metal powders size and characterisation of metal powders
- Producing green compacts and sintering the compacts.

### LIST OF EXPERIMENTS:

- Formability of sheet metal by Ericsson cupping test
- Construction of Formability limit diagram
- Diameter reduction in Wire drawing
- Thickness reduction in Sheet metal rolling.
- Study of Sheet metal forming using FEA analysis software
- Powder size reduction by Ball Milling
- Measurement of Flow rate, Apparent and Tap Density of Powders
- Production of green compacts.
- Density determination of sintered product.
- Effect of Sintering temperature on the density of the sintered compact

**TOTAL: 60 PERIODS**

### COURSE OUTCOMES:

Upon completion the course, the students will be able to



1. Demonstrate the formability behaviour of the metal forming process. .
2. Use software tools for analysing the metal forming process.
3. Examine the formability of different materials
4. Characterize the powders in terms of tap density, apparent density, flow rate and particle size
5. Make a compact of desired size and shape and compare the properties of the sintered compact with that of the green compact

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2				2	1	1	1	2	1	1
CO2	3	2	1	2	2				2	1	1	1	2	1	1
CO3	3	2	1	2	2		2		2	1	1	1	1	2	1
CO4	3	2		3	2				2	1	1	1	1	2	1
CO5	3	2		2	2				2	1	1	1	1	2	1
Avg	3	2	1	2.2	2		2		2	1	1	1	1.4	1.6	1

**ML3601**

**WELDING TECHNOLOGY**

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

**COURSE OBJECTIVES:**

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

1. Acquiring knowledge on the various Metal Joining Processes.
2. Analysing the effect of heat transfer in welding.
3. Understanding the concepts involved in ferrous welding metallurgy.
4. Understanding the basics of non-ferrous welding metallurgy.
5. Knowing the causes and remedies of various welding defects ,weldability ,testing of weldments ,welding standards and codes.

**UNIT I FUNDAMENTALS OF METAL JOINING**

**9**

Welding - Principle of Gas Welding- Equipment-Technique- Principle of Arc –Arc Welding -Electrode types and classification- Gas Tungsten Arc Welding-Gas Metal Arc Welding- Submerged arc Welding-Atomic Hydrogen welding-plasma Arc Welding-Thermit Welding- Electro Slag Welding- Laser Beam Welding, Electron Beam Welding, magnetic pulse Welding- Principle - Resistance Welding - Spot Welding - Projection Welding - Upset Welding - Flash Welding - Forge Welding - Friction Welding, Friction stir welding - Diffusion Bonding - Explosion Welding, Soldering and Brazing-Adhesive Bonding.

**UNIT II WELDING METALLURGY PRINCIPLES**

**9**

Thermal cycles in welding: basic heat transfer equations, temperature distributions and cooling curves, dependence of cooling rate on heat input, joint geometry, preheat and other factors. Comparison of welding processes based on these considerations.

**UNIT III PHYSICAL METALLURGY OF WELDING**

**9**

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

**UNIT IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS 9**

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

**UNIT V DEFECTS, WELDABILITY AND STANDARDS 9**

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes

**COURSE OUTCOMES:**

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

1. Describe the various welding processes.
2. Examine the heat transfer associated with the welding process.
3. Describe the metallurgical changes in the ferrous weldments.
4. Appreciate the metallurgical changes in the alloy steels and non-ferrous weldments.
5. Identify the welding defects and provide the remedy according to the standards.

**TEXT BOOKS**

1. Baldev Raj, Shankar V, Bhaduri A K. "Welding Technology for Engineers" Narosa Publications 2009.
2. R.S.Parmar 'Welding Engineering and Technology' Khanna Publishers 2010

**REFERENCES**

1. Lancaster, J. F. "Metallurgy of Welding", 4th Londre: George Allen & Unwin.1987.
2. Linnert, G. E., "Welding Metallurgy". Vol. 1 and 2. 4th edition. A W S. USA, 1994.
3. Sindo Kuo, "Welding Metallurgy", John Wiley & Sons, 2003

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1		1	1						3	3	3
2	3	3	3	3		1	1						3	3	3
3	3	3	3	3	1	1	1					2	3	3	3
4	3	3	3	3	1	1	1					2	3	3	3
5	3	3	3	3	3	1	1					2	3	3	3
<b>Avg</b>	3	3	3	2.6	1.7	1	1					2	3	3	3

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

**TOTAL: 45 PERIODS**

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

<b>SHIP MODELLING</b>		<b>3</b>
SM	Ship Modelling Capsule	3

**TOTAL : 45 PERIODS**

**NCC Credit Course Level 3\***

<b>NX3653</b>	<b>(AIR FORCE WING) NCC Credit Course Level - III</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

<b>PERSONALITY DEVELOPMENT</b>		<b>9</b>
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PD 3	Group Discussion: Team Work	2
PD 4	Career Counselling, SSB Procedure & Interview Skills	3
PD 5	Public Speaking	4

<b>BORDER &amp; COASTAL AREAS</b>		<b>4</b>
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BCA 2	Security Setup and Border/Coastal management in the area	2
BCA 3	Security Challenges & Role of cadets in Border management	2

<b>AIRMANSHIP</b>		<b>1</b>
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A 1	Airmanship	1
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<b>BASIC FLIGHT INSTRUMENTS</b>		<b>3</b>
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FI 1	Basic Flight Instruments	3
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<b>AERO MODELLING</b>		<b>3</b>
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AM 1	Aero Modelling Capsule	3
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<b>GENERAL SERVICE KNOWLEDGE</b>		<b>2</b>
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GSK 4	Latest Trends & Acquisitions	2
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<b>AIR CAMPAIGNS</b>		<b>6</b>
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AC 1	Air Campaigns	6
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<b>PRINCIPLES OF FLIGHT</b>		<b>6</b>
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PF 1	Principles of Flight	3
PF 2	Forces acting on Aircraft	3

<b>NAVIGATION</b>		<b>5</b>
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NM 1	Navigation	2
NM 2	Introduction to Met and Atmosphere	3

<b>AERO ENGINES</b>		<b>6</b>
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E 1	Introduction and types of Aero Engine	3
E 2	Aircraft Controls	3

**TOTAL : 45 PERIODS**

**COURSE OBJECTIVES:**

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

1. Appraising the various sand testing methods.
2. Determining the effect of welding parameters on the weld bead by GTAW and GMAW processes.
3. Inspecting Carbon Steel and Stainless Steel welded specimens through microstructural analysis.
4. Examining Aluminium Alloy welded specimens through microstructural analysis.
5. Investigating Titanium Alloy welded specimens through microstructural analysis.

**LIST OF EXPERIMENTS**

1. Determination of Average Sand grain Fineness.
2. Determination of Permeability of Green sand.
3. Estimation of Active clay content in Sand
4. Loss of Ignition Test for Green sand Mould
5. Determination of Green compression and Shear Strength.
6. Determination of Dry compression Strength
7. Determination of Scratch hardness.
8. Determination of Compactability.
9. Metal casting by Green and sand and full mould process.
10. Arc striking practice.
11. Bead-on-plate welding  
Effect of welding parameters on weld bead by
  - (i) GTA welding
  - (ii) GMA Welding
  - (iii) Submerged Arc Welding
12. Microstructural Observation of Weldments
  - (i) Carbon Steel
  - (ii) Stainless Steel
  - (ii) Aluminium Alloy
  - (iv) Titanium Alloy

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

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

1. Estimate the properties of the system sand.
2. Demonstrate green and full molding process
3. To demonstrate the working of different welding process.
4. Evaluate the microstructures of weldments of ferrous materials.
5. Evaluate the microstructure of weldments of nonferrous materials

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1		1						2	2	3	3
CO2	3	3	1			1						2	1	3	3
CO3	3	3	1		2	1						2	3	3	3
CO4	3	3	3	3	3	1						2	3	3	3
CO5	3	3	3	3	3	1						2	3	3	3
Avg	3	3	1.8	2.3	2.7	1						2	2.4	3	3

**COURSE OBJECTIVES:**

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

1. Understanding the importance of NDT in quality assurance.
2. Acquiring knowledge on the basic principles of various NDT techniques, its applications, limitations, codes and standards.
3. Equipping themselves for having proper competencies to locate a flaw in various materials, products.
4. Getting ready to use NDT techniques for in-situ applications too.
5. Selecting the right NDT technique for a given application

**UNIT I INTRODUCTION & VISUAL INSPECTION METHODS 9**

NDT versus Mechanical testing, Need for NDT, Relative merits and limitations, various physical characteristics of materials and their applications in NDT.

Visual Inspection -Unaided, Aided- Borescopes -Videoscopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography, Case study.

**UNIT II LIQUID PENETRANT TESTING& MAGNETIC PARTICLE TESTING 9**

LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipments, Advantages and limitations, Inspection and Interpretation, Applications and case study.

MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation – need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting, Case study.

**UNIT III THERMOGRAPHY & EDDY CURRENT TESTING 9**

Thermography – Introduction, 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 and applications, Case study.

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations, Interpretation of Results& applications, Case study.

**UNIT IV ULTRASONIC TESTING & ACOUSTIC EMISSION TESTING 9**

Ultrasonic Testing-Principle, Basic Equipment, Transducers, couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B-Scan & C-Scan, Phased Array Ultrasound& Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results& Applications, Case study

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, Case study.

**UNIT V RADIOGRAPHY 9**

Introduction, Principle, X-ray Production, Gamma ray sources, tubing materials, X-ray tubing characteristics, Interaction of X-ray with matter, Imaging, Film techniques, Filmless techniques, Types and uses of filters and screens, Real time radiography, geometric factors, inverse square law, characteristics of film, graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography – Film Digitisation, Direct Radiography &Computed Radiography, Computed Tomography, Gamma ray Radiography, Safety in X- ray and Gamma Ray radiography, Case study.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Compare the differences between the various visual inspection techniques and apply the same to the components to be inspected.
2. Recognize the importance of Penetrant testing in NDT with the understanding of the procedures involved in the Penetration methods
3. Interpret the images and the results obtained from the Thermo graphic technique and the Eddy current testing
4. Evaluate and interpret the results obtained in the Ultrasonic inspection and Acoustic Emission technique
5. Explain the techniques involved in the Radiographic testing and the various advancements in Radiography.

**TEXT BOOKS:**

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2000, Volume-17.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd edition New Jersey, 2005

**REFERENCES:**

1. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
3. Charles, J. Hellier, "Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.
4. G. Gaussorgues, "Infrared Thermography", Chapman & Hall, University Press, Cambridge, 1994.
5. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st revised edition, 2010.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3		2	2	1		1			2	3	2	3
CO2	3	2	2		2	2	1		1			2	3	2	3
CO3	2	2	3	2	2	2	2	2	1	2		2	3	2	3
CO4	2	2	3	2	2	2	1	2	1	2		2	3	2	3
CO5	3	2	2		2	2	3	3	1	2		2	3	2	3
Avg	2.6	2	2.6	2	2	2	1.6	2.3	1	2		2	3	2	3

**COURSE OBJECTIVES**

- 1 To study the fundamentals of surface features and different types of friction associated with metals and non-metals
- 2 To study the different types of wear mechanism and its standard measurement.
- 3 To study the different types of corrosion and its preventive measures
- 4 To study the different types of surface properties and surface modification techniques
- 5 To study the various types of materials used in the friction and wear applications

**UNIT – I SURFACES AND FRICTION****9**

Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction- Laws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.

**UNIT – II WEAR****9**

Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements

**UNIT – III CORROSION****9**

Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

**UNIT – IV SURFACE TREATMENTS****9**

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

**UNIT – V ENGINEERING MATERIALS****9**

Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Describe the fundamentals of surface features and different types of friction associated with metals and non-metals
2. Analyze the different types of wear mechanism and its standard measurement.
3. Analyze the different types of corrosion and its preventive measures
4. Analyze the different types of surface properties and surface modification techniques
5. Analyze the various types of materials used in the friction and wear applications.

**TEXT BOOKS:**

1. G.W.Stachowiak and A.W.Batchelor, “Engineering Tribology”, Butterworth-Heinemann, 2005.
2. S.K.Basu, S.N.Sengupta and B.B.Ahuja ,”Fundamentals of Tribology”, Prentice Hall of India, 2005.

**REFERENCES:**

1. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.
2. Halling, J. (Editor), “Principles of Tribology “, MacMillian, 1984.
3. Rabinowicz.E., “Friction and Wear of materials”, John Willey & Sons, 1995.
4. Williams J.A., “Engineering Tribology”, Oxford University Press, 1994.
5. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000.



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

**GE3791**

**HUMAN VALUES AND ETHICS**

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

**COURSE DESCRIPTION**

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

**COURSE OBJECTIVES:**

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

**UNIT I DEMOCRATIC VALUES**

**6**

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

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

**UNIT II SECULAR VALUES**

**6**

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

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

**UNIT III SCIENTIFIC VALUES**

**6**

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

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

**UNIT IV SOCIAL ETHICS**

**6**

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

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

## **UNIT V        SCIENTIFIC ETHICS**

**6**

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

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

**TOTAL: 30 PERIODS**

### **COURSE OUTCOMES**

Students will be able to

- CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life
- CO2 : Practice democratic and scientific values in both their personal and professional life.
- CO3 : Find rational solutions to social problems.
- CO4 : Behave in an ethical manner in society
- CO5 : Practice critical thinking and the pursuit of truth.

### **REFERENCES:**

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

**COURSE OBJECTIVES:**

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

1. Appraising the various Non-Destructive testing methods.
2. Determining the discontinuities by Visual inspection process
3. Inspecting the surface cracks by Liquid penetrant testing technique
4. Examining the Eddy current and radiography results.
5. Performing ultrasonic inspection process and identifying the defects

**LIST OF EXPERIMENTS**

1. Leak testing of tubes.
2. Detection of surface defects by liquid penetrant testing
3. Analysis of size and shape of the surface discontinuities by LPT
4. Defect determination by Magnetic particle testing
5. Defect Analysis of Radiographic image
6. Flaw detection using normal beam probe in Ultrasonic testing
7. Flaw detection using angle beam probe in Ultrasonic testing
8. Determination of thickness of the component by UT technique
9. Thermal image analysis of engineering components
10. Study of Eddy current inspection technique and interpretation of EDT results.

**TOTAL: 60 PERIODS:**

**COURSE OUTCOMES:**

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

1. Detect the surface defects by Visual inspection and Liquid penetrant testing techniques.
2. Identify the defects in the components by MPT technique
3. Interpret the results obtained from Eddy current testing and Radiography testing
4. Detect the defects by ultrasonic inspection process
5. Analyse the thermal images of engineering components

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	3	1	1		1						2	2	3	3
<b>CO2</b>	3	3	1			1						2	1	3	3
<b>CO3</b>	3	3	1		2	1						2	3	3	3
<b>CO4</b>	3	3	3	3	3	1						2	3	3	3
<b>CO5</b>	3	3	3	3	3	1						2	3	3	3
<b>Avg</b>	3	3	1.8	2.3	2.7	1						2	2.4	3	3

**COURSE OBJECTIVES:**

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

1. Acquiring knowledge on the basic concepts of fracture mechanics
2. Gaining knowledge on strain energy principle and use of it for developing theories
3. Understanding and analysing the fatigue failure
4. Getting familiarized with the failure analysis on the components failing by creep, corrosion and wear failure
5. Acquiring knowledge on corrosion and wear failure of materials.

**UNIT I BASIC CONCEPTS IN FRACTURE MECHANICS 9**

Introduction to fracture- elastic deformation, plastic and elasto-plastic deformation, Brittle fracture: Griffiths theory, Ductile fracture, Inglis solution-LEFM-EPFM- Different modes of fracture- photo elastic fringes- characteristics-crack emanating from inner and outer boundaries of cylinder-

**UNIT II MECHANICS OF FRACTURE- STATIC LOADING 9**

Strain energy- strain energy in the presence of crack- energy release rate- fracture criteria- crack branching based on energy approach- Analytical solutions yielding near a crack front –Westergaard's stress function- plastic zone size – Dugdale model – J integral and its relation to crack opening displacement. Strain energy release and stress intensity factor. Evaluation of fracture Toughness of different materials: size effect & control.

**UNIT III FAILURE ANALYSIS OF FATIGUE FRACTURE 9**

Fundamental sources of failures- Deficiency in design, Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment. Micro-structural analysis of fatigue failures, some case studies in analysis of fatigue failures

**UNIT IV FAILURE ANALYSIS OF CREEP RUPTURE 9**

Fracture at elevated temperature: Time dependent mechanical behavior, stress rupture, Microstructural changes during creep, Mechanism of creep deformation and Creep deformation maps, Prediction of time to rupture, Creep-fatigue interaction. Some case studies in analysis of creep failures.

**UNIT V FAILURE ANALYSIS OF CORROSION AND WEAR 9**

Types of corrosion, Corrosion stress, corrosion cracking, Analysis of corrosion failure. Procedure for analysis of stress corrosion cracking. Effect of Environment. Analysis of corrosion characteristics of metals and alloys in different environment. Types of wear, Role of friction, Interaction of corrosion and wear. Analysis of wear failure.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

1. Design structure to prevent failure from the internal defect that unit within the structure
2. Derive the stress field solutions for fracture problems
3. Design structure to prevent fatigue and creep
4. Define different deformation and related theories
5. Analyse the corrosion and wear failure and system methods to prevent corrosion and wear

**TEXT BOOKS**

1. Hertz berg R W, "Deformation and fracture mechanics of Engineering materials" second edition John Wiley sons inc, New York 1983.
2. Knott. J.F, "Fundamentals of Fracture Mechanics" Butterworth London, 1973.



**UNIT – V ANALYSIS OF ENGINEERING FAILURES****9**

Typical defects, Microscopic surface examination, metallographic and fractographic examination, Fracture surface preservation – Cleaning and replication techniques and image interpretation, failure data retrieval, Component failure analysis : procedural steps for investigation of a failure for failure analysis, Preparation of failure analysis report.

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

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

1. Discuss the mechanisms of the role of dislocation and stacking fault on plastic deformation.
2. Assess the behavior of materials under high temperature, metallurgical factors and life prediction of high temperature materials.
3. Distinguish the characteristics, factors and method of life prediction in the stress and strain controlled fatigue.
4. Appraise the micro-mechanics and micro-structural aspects of fatigue.
5. Design and develop a procedure to perform failure analysis and generate a report.

**TEXT BOOKS:**

1. Richard. W. Hertzberg ,“ Deformation and Fracture Mechanism of Engineering Materials”, John Willey and Sons, 5th edition, 2012.
2. Thomas H Courtney,“ Mechanical Behaviour of Materials”, Waveland press, 2005.

**REFERENCES:**

1. Josef Cadek, .,“ Creep in Metallic Materials”, Elsevier,1988
2. Norman E Dowling, “Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture and Fatigue” Pearson. 2013.
3. Prashant Kumar,” Elements of Fracture Mechanics”, Tata McGraw-Hill,2009.
4. Suresh S, “ Fatigue of materials”, Cambridge University press, 1998.
5. William T Becker, Failure analysis and Prevention, ASM international, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1		1	1						1	2	1
CO2	3	3	3	3		3	1					3	3	2	3
CO3	3	3	3	3		3	1					3	3	2	3
CO4	3	3	3	3		3	1					3	3	2	3
CO5	3	3	3	3	3	3	1					3	3	2	3
Avg	3	3	2.6	2.6	3	2.6	1					3	2.6	2	2.6

**ML3003****ELECTRON MICROSCOPY****L T P C****3 0 0 3****COURSE OBJECTIVES:**

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

1. Acquiring knowledge on the basic concepts of interaction of electron beam and material interaction
2. Gaining knowledge on Scanning electron microscopy
3. Understanding and analysing the transmission electron microscopic images
4. Getting familiarised with the advanced electron microscopic techniques
5. Acquiring knowledge on the electron diffraction patterns and stereo graphic projection

**UNIT- I ELECTRON BEAM AND MATERIAL INTERACTION 9**

Electron gun – types – thermo-emission and field emission – electromagnetic and magnetic lens – aberration – corrections – electron material interaction – elastic and inelastic – signals – escape depth

**UNIT-II SCANNING ELECTRON MICROSCOPY 9**

Imaging modes – resolution – depth of field and depth of focus – contrast – number contrast – compositional contrast – Influence of process parameters on image fractography- applications

**UNIT-III TRANSMISSION ELECTRON MICROSCOPY 9**

Instrumentation - Sample preparation – Mass thickness contrast – diffraction contrast- phase contrast – High resolution TEM- Crystal defects – applications

**UNIT-IV ELECTRON DIFFRACTION 9**

Reciprocal lattice- Stereographic projection - Selected Area Electron Diffraction - Zone axis, indexing - Structure Factor - Typical patterns of BCC, FCC and HCP - Kikuchi pattern - SEM - Orientation Imaging - Electron Backscattered Diffraction (EBSD).

**UNIT-V ADVANCED ELECTRON MICROSCOPY 9**

Field ion microscopy (FIB), Low Energy Electron Diffraction (LEED), Reflection High Energy Electron Diffraction (RHEED).

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

Upon Completion of the course, the students will be able to

1. Explain the interaction between electron beam and materials
2. Interpret the images obtained from scanning electron microscopy
3. Discuss on the working principle of transmission electron microscopy
4. Identify the electron diffraction patterns and interpret them
5. Describe the different advanced electron microscopic techniques

**TEXT BOOKS**

1. Peter J. Goodhew, John Humphreys, Richard Beanland, "Electron Microscopy and Analysis", 3rd Edition, Taylor and Francis, II New Fetter Lane, London, 2001.
2. David B. Williams and C. Barry Carter, "Transmission Electron Microscopy: A Text Book for Materials Science", Publisher: Springer, USA, 2009.

**REFERENCES**

1. J. W. Edington, "Electron Diffraction in the Electron Microscope", N. V. Philips' Gloeilampenfabrieken, Eindhoven, 1975.
2. Joseph Goldstein, Dale Newbury, David Joy, et al., "Scanning Electron Microscopy and X-ray Microanalysis", Kluwer Academic / Plenum Publishers, New York, 2003.
3. Marc De Graef, "Introduction to Conventional Transmission Electron Microscopy", Cambridge University Press, UK, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	1	2	2	1							2	1	1	2
<b>CO2</b>	3	3	1	2	3							2	2	3	1
<b>CO3</b>	3	2	2	3	2							2	2	2	1
<b>CO4</b>	3	2	2	3	2							2	2	1	1
<b>CO5</b>	3	3	3	2	3							2	1	3	3
<b>Avg</b>	3	2.2	2	2.4	2.2							2	1.6	2	1.6

**COURSE OBJECTIVES:**

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

1. Acquiring knowledge on the basic concepts of production of X-rays and their interaction with matter
2. Gaining knowledge on the basics of X-ray diffraction and stereographic projection
3. Understanding and analysing XRD results to identify the phases
4. Getting familiarized with the various methods for identification of the phases in the crystals
5. Acquiring knowledge on the residual stress measurement using X-ray diffraction method

**UNIT - I X-RAY GENERATION AND INTERACTION WITH MATERIALS 9**

X-ray – generation – soft and hard x –ray – shortest wavelength – characteristic x –ray – continuous x-ray – absorption - absorption edges – elastic scattering – by an electron, electrons of an atom and atomic arrangements – x-ray fluorescence – elemental identification – collimators – detectors – precautions

**UNIT - II X-RAY DIFFRACTION (XRD): BASICS 9**

Bragg's law, Diffraction methods – Laue, rotating crystal and powder methods- Stereographic projection – texture and orientation- Intensity of diffracted beams –structure factor calculations

**UNIT - III XRD FOR PHASE IDENTIFICATION - I 9**

Crystallite size – Scherrer - Stokes and Wilson - Importance of Rietveld refinement in XRD (fundamental) Precise parameter measurement - Phase identification –ASTM catalogue of Materials identification – Grazing incidence XRD

**UNIT - IV XRD FOR PHASE QUANTIFICATION - II 9**

Internal standard – External standard – Direct comparison – single phase quantification – calibration – practical difficulties

**UNIT - V XRD RESIDUAL STRESS MEASUREMENT 9**

Warrens Method, lattice strain calculation – double exposure method – powder diffraction and diffractometer -  $\sin^2 \psi$  technique

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

1. Explain the methods of X-ray production and their interaction with the matter
2. Discuss on the basics of X-ray diffraction and the intensity of diffracted beams
3. Determine the crystal size using the results obtained from XRD
4. Identify the phases that are present in the various alloys
5. Predict the amount of residual stresses associated with the materials

**TEXT BOOKS**

1. Angelo, P.C., "Materials Characterisation", 1st Edition Cengage Publication, 2016.
2. Cullity, B. D., Stock, S.R. " Elements of X-ray diffraction", Pearson New International Edition, 3rd Edition, 2014

**REFERENCES**

1. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation ", Ninth Edition, ASM international, USA, 1986.
2. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Hong Kong University Of Science And Technology, John Wiley & Sons (Asia) Pte Ltd. 2010.



	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1							2	1	1	2
CO2	3	3	1	2	3							2	2	3	1
CO3	3	2	2	3	2							2	2	2	1
CO4	3	2	2	3	2							2	2	1	1
CO5	3	3	3	2	3							2	1	3	3
Avg	3	2.4	2	2.4	2.2							2	1.6	2	1.6

**ML3005**

**ADVANCED METALLOGRAPHIC TECHNIQUES**

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

**COURSE OBJECTIVES:**

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

1. Acquiring knowledge on the basic concepts of metallographic techniques
2. Gaining knowledge on surface preparation techniques for microscopic examination
3. Understanding and analysing the microscopic images
4. Getting familiarized with the various field metallographic techniques
5. Acquiring knowledge on colour metallography and having awareness on the safety

**UNIT – I INTRODUCTION 9**

Phase contrast microscopy- Polarized Microscopy- Differential Interference Contrast microscopy, Stereomicroscopy – Laser Scanning Confocal Microscope quantitative Near-field Scanning Optical Microscopy , solidification structure of pure metals and alloys, segregation.

**UNIT – II SURFACE PREPARATION 9**

Metallographic Sectioning and Specimen Extraction, Mounting of Specimens, Mechanical Grinding and Polishing , Chemical and Electrolytic Polishing , Contrast Enhancement and Etching , Light Microscopy

**UNIT – III QUANTITATIVE METALLOGRAPHY 9**

Digital Imaging, Quantitative Image Analysis , Quantitative Characterization and Representation of Global Microstructural Geometry , Three-Dimensional Microscopy Computer Modeling of Solidification Microstructures, Monte Carlo (MC) Models, Cellular Automaton (CA) Models.

**UNIT – IV FIELD METALLOGRAPHY TECHNIQUES 9**

Basic Equipment and Supplies, Planning for Field Metallography, Specimen Preparation, polishing, replication, Applications, Case Studies.

**UNIT - V COLOUR METALLAGRAPHY AND SAFETY 9**

Optical Methods for Producing Color, Film Formation and Interference Techniques, Anodizing, Chemical Etching, Tint Etching, Vapor Deposition Methods to Produce Color, laboratory safety, Hazard Communication Standards.

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

1. Prepare the samples for microscopic examination
2. Discuss the various methods adopted for surface preparation
3. Interpret the images obtained under microscope
4. Describe the different field metallographic techniques
5. Do colour metallography and also aware of the lab safety norms.

## TEXT BOOKS

1. ASM Handbook, Metallography and Microstructures, Volume 9, ASM international, The Materials Information Company 2004
2. George F. Vander Voort, Metallography, Principles and Practice”, ASM International, 1999.

## REFERENCES:

1. R. E. Smallman, R J Bishop, “Modern Physical Metallurgy and Materials Engineering” Sixth edition, Elsevier Science, 1999
2. R. E. Smallman, K. H. G. Ashbee, Modern Metallography - 1st Edition – Elsevier1966.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2	1								1	1	2
CO2	2	3	1	2	3								2	3	1
CO3	3	2	2	3	2								2	2	1
CO4	2	2	2	3	2								2	1	1
CO5	3	3	3	2	3								1	3	3
Avg	2.6	2.2	2	2.4	2.2								1.6	2	1.6

CPR332

FINITE ELEMENT ANALYSIS

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

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

1. Developing mathematical models for Boundary Value Problems and their numerical solution.
2. Applying concepts of Finite Element Analysis to solve one dimensional problem.
3. Determining field variables for two dimensional scalar variable problems.
4. Determining field variables for two dimensional vector variable problems.
5. Applying the need for Isoparametric transformation and the use of numerical integration.

## UNIT I INTRODUCTION

9

Historical Background – Mathematical Modeling of field problems in Engineering –Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

## UNIT II ONE-DIMENSIONAL PROBLEMS

9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of problems from solid mechanics including thermal stresses-heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Fourth Order Beam Equation – Transverse deflections and Transverse Natural frequencies of beams.

**UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts.

**UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations - Plate and shell elements.

**UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS 9**

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software- Introduction to Non Linearity.

**TOTAL = 45 PERIODS**

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

1. Develop mathematical models for Boundary Value Problems and their numerical solution
2. Apply concepts of Finite Element Analysis to solve one dimensional problems
3. Determine field variables for two dimensional scalar variable problems
4. Determine field variables for two dimensional vector variable problems
5. Apply the need for Isoparametric transformation and the use of numerical integration

**TEXT BOOKS:**

1. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann,2018.
2. Reddy,J.N. “Introduction to the Finite Element Method”, 4<sup>th</sup>Edition, Tata McGrawHill,2018.

**REFERENCES:**

1. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGrawHill, 2005
2. Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 2015.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2004.
4. Seshu.P, “Text Book of Finite Element Analysis”, PHI Learning Pvt. Ltd., NewDelhi, 2012.
5. Tirupathi R. Chandrupatla and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, International Edition, Pearson Education Limited, 2014.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	2						2		3	2	2
2	3	2	3	3	2						2		3	2	2
3	3	2	3	3							2		3	2	2
4	3	2	3	3							2		3	2	2
5	3	2	3	3	2						2			2	1
Avg	3	2	3	3	2						2		3	2	1.8

**COURSE OBJECTIVES:**

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

1. Getting introduced to the different mathematical concepts related to modeling of materials
2. Acquiring knowledge on solving one dimensional problems related to heat transfer
3. Solving two dimensional problems related to heat transfer
4. Getting introduced to the different software packages and their capabilities in solving material processing problems
5. Understanding the computer applications in physical metallurgy

**UNIT I INTRODUCTION TO MODELING AND MATHEMATICAL CONCEPTS 9**

Mathematical modeling, physical simulation, advantages and limitations - Review of differential equations, numerical methods, introduction to FEM, FDM- Governing differential equations of elastic, plastic deformation, fluid flow and heat transfer – basic steps in FEM

**UNIT II ONE DIMENSIONAL PROBLEMS 9**

Classical Techniques in FEM – Weighted residual method – Galarkin and Ritz method – Coordinates and shape functions- Potential energy approach — Assembly of stiffness matrix and load vector – Finite element equations – Quadratic shape functions – Applications to elastic deformation of bar, plane trusses and beam – steady state heat transfer

**UNIT III TWO DIMENSIONAL AND AXISYMMETRIC CONTINUUM 9**

Triangular and quadrilateral elements – Natural co-ordinates – Isoparametric formulation- 2D shape functions - Element stiffness matrix – Force vector – Solution procedure, Gaussian elimination and Cholskey decomposition techniques - Axisymmetric formulation - Boundary conditions – Applications in 2D elastic deformation and heat transfer problems.

**UNIT IV SOFTWARE PACKAGES 9**

Introduction to standard software packages – General purpose FEA packages– Special purpose packages for simulation of rolling, forging and casting simulations. - Applications of FEA in simulation of sheet metal and bulk forming, solidification of casting and weldment, Concepts of coupled analysis

**UNIT V COMPUTER APPLICATIONS IN PHYSICAL METALLURGY 9**

Use of computers for the construction of phase diagrams, Expert system for alloy design and selection of materials – computer applications in crystallography

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

Upon Completion of the course, the students will be able to

1. Apply numerical techniques to a variety of materials process including solidification, heat treatment, grain from the recovery stabilization
2. Solve one dimensional problems related to heat transfer
3. Solve two dimensional problems related to heat transfer
4. Able to evaluate the capabilities and limitation of commercial software
5. Explain the computer applications in physical metallurgy

**TEXT BOOKS**

1. AMIE, “Modeling of casting and welding process”, Volume I & II, the Metallurgical society of AMIE, 1981&1983
2. Reddy J. N., “An Introduction to Finite Element Method”, McGraw-Hill International Student Edition, 1985

## REFERENCES

1. Cerjak H., "Mathematical Modeling of Weld Phenomenon-2", The Institute of Materials, 1995
2. Cerjak H., "Mathematical Modeling of Weld Phenomenon-2", The Institute of Materials, 1995
3. Piwonka T.S., Vollen V., Katgerman I., "Modeling of Casting, Welding, and Advanced Solidification Process", 4th edition, TMS-AIME, USA, 1993
4. Stocks G.M., Turchi P.E.A., "Alloy Modeling and Design", the Metals Society, AMIE, USA, 1994
5. Trivedi R., Sekhar J.A., Majumudar J., "Principles of Solidification and Material Processing", Volume I&II, Oxford and IBH, New Delhi, 1989

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	1	2	2	1							2			2
<b>CO2</b>	2	3	1	2	3							2	2	3	
<b>CO3</b>	3	2	2	3	2							2	2	2	
<b>CO4</b>	2	2	2	3	2							2	2	1	
<b>CO5</b>	3	3	3	2	3							2		3	3
<b>Avg</b>	2.6	2.2	2	2.4	2.2							2	2	2.25	2.5

**COURSE OBJECTIVES:**

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

- Acquiring knowledge on the diffusion mechanisms and the various phase transformations that happen due to diffusion.
- Understanding the significance and importance of phase transformations and its influence on the mechanical behaviour.
- Gaining Knowledge on the diffusion less transformations that occurs in ferrous and non-ferrous materials.
- Understanding the concepts involved in the precipitation processes.
- Getting an insight on the concepts of recovery, grain growth and recrystallisation in detail.

**UNIT I DIFFUSION MECHANISMS****9**

Basics of thermodynamic & kinetics: equilibrium - configurational entropy - free energy of mixing - miscibility gap – chemical potential. Diffusion – uphill diffusion – downhill diffusion – atomic mechanisms of diffusion, Fick's 1<sup>st</sup> and 2<sup>nd</sup> law – solution to the diffusion equation – error functions – application of the non-steady state diffusion, spinodal decomposition

**UNIT II DIFFUSION CONTROLLED PHASE TRANSFORMATIONS****9**

Nucleation and growth - types of nucleation – concept of free energy during solidification – thermodynamics and kinetics of homogeneous and heterogeneous nucleation – critical nucleus size and critical free energy change – nucleation rate and growth rate – overall transformation rate, concept of activation energy – Arrhenius equation – Johnson-Mehl-Avrami equation, Pearlitic transformations.

**UNIT III DIFFUSIONLESS PHASE TRANSFORMATIONS****9**

Martensite transformation – definition – characteristic features of Martensitic transformation in steels – morphology of Martensite – lath and acicular martensite – crystallography of martensitic transformation – martensite in non-ferrous systems – thermoelastic martensite – shape memory effect – examples and applications of shape memory alloys.

**UNIT IV PRECIPITATION REACTIONS****9**

Precipitation reaction – thermodynamic considerations, structure and property during ageing – sequence of ageing – formation of G-P zones and intermediate precipitates, theories of precipitation hardening – effect of time, temperature and alloy compositions – precipitation free zones, crystallographic aspects of transformation, coarsening kinetics.

**UNIT V RECOVERY, RECRYSTALLISATION AND GRAIN GROWTH****9**

Cold working and hot working, recovery – polygonisation and dislocation movements in polygonisation, recrystallisation – effect of time, temperature, strain and other variables – Mechanism of nucleation and growth, grain growth – grain growth law, geometrical collisions, preferred orientation, secondary recrystallisation.

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

Upon Completion of the course the students will be able to:

1. Explain the various diffusion mechanisms and the thermodynamic and kinetic principles.
2. Classify the various diffusion controlled transformations and infer the effect of various parameters on the kinetics and growth of nucleation
3. Compare the differences between the diffusion controlled and diffusionless transformations and explain the diffusionless transformations in steels and non-ferrous alloys.
4. Interpret the thermal cycle on the alloys and the effect of time, temperature and composition during precipitation hardening.
5. Recall the concept of recovery, recrystallization and grain growth in cold worked and hot worked steels.

## TEXT BOOKS

1. David A. Porter, Kenneth E. Easterling, Mohamed Y. Sherif, "Phase Transformations in Metals and Alloys", CRC Press, New York, 3rd edition, 2009.
2. Jena, A.K., and Chaturvedi, M., "Phase Transformations in Materials", Prentice-Hall, 1993.

## REFERENCES

1. Anil Sinha, "Physical Metallurgy Handbook", McGraw-Hill Professional; 1st edition, 2002.
2. Reed Hill. R. E., "Physical Metallurgy Principles", Affiliated East West Press, New Delhi, 1992.
3. Romesh C. Sharma, "Phase Transformation in Materials", CBS Publishers & Distributors, New Delhi, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3								2	3	3	2
CO2	3	2	2	2								2	3	3	2
CO3	3	2	2	2								2	3	3	2
CO4	3	2	3	3								2	3	3	2
CO5	3	2	2	2								2	3	3	2
Avg	3	2.2	2.2	2.4								2	3	3	2

CML331

FUNDAMENTALS OF NANO SCIENCE

L T P C  
3 0 0 3

## COURSE OBJECTIVES :

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

1. Understanding the evolution of nanomaterials in the scientific era and different processing methods, properties of nanomaterials for the future engineering applications
2. Gaining knowledge on processing zero dimensional nanomaterials and using them in engineering applications
3. Acquiring knowledge on processing one dimensional nanomaterials and using them in engineering applications
4. Getting acquainted with processing two dimensional nanomaterials and using them in engineering applications
5. Exposing to characterization techniques used for nanomaterials.

## UNIT I INTRODUCTION TO NANOMATERIALS

9

Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials- historical development of nanomaterials – Nanomaterials classification (Gleiter's Classification) – properly changes done to size effects, Hall – Petch, inverse Hall- Petch effects - polymeric nanostructures

## UNIT II ZERO DIMENSIONAL NANOMATERIALS

9

Nanoparticles – Properties – Processing – Liquid state processing - Sol-gel process, wet chemical synthesis – Vapour state processing – PVD, CVD, Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle.

Quantum Dots – Quantum confinement – Pauli Exclusion Principle – Processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

**UNIT III ONE DIMENSIONAL NANOMATERIALS****9**

Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - growth mechanisms – Applications- Boron nanotube-Synthesis-Applications

Nanowire – processing – Laser ablation – Oxide assisted growth – carbo thermal reactions – Thermal evaporation – Temperature based synthesis – Electro spinning – Vapour–Solid growth (VS growth) - vapour – liquid – solid growth (VLS technique) – Applications.

**UNIT IV SUPER HARD COATINGS AND BULK NANOSTRUCTURED MATERIALS 9**

Superhard coating – types – characteristics – thermal stability – case studies (nc-TiN/a-Si<sub>3</sub>N<sub>4</sub> coating) – Applications.

Buck nanostructure formation – Equal Channel angular pressing(ECAP) – High pressure torsion(HPT), Accumulative roll bending – Reciprocating extrusion - compression, cyclic close die forging – Repetitive corrugation and straightening – Grain refinement mechanisms.

**UNIT V CHARACTERIZATION OF NANOMATERIALS****9**

Nano indentation – Types of nanoindenter – Force actuation-Displacement measurement- factors affecting nanoindentation- Different models for calculation of E and hardness- Atomic force microscope (AFM) cantilever dynamics–Electrostatic force mode (EFM) – Magnetic force mode (MFM)

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

Upon Completion of the course, the students will be able to

1. Explain the categories of nanomaterials and the effects due to which the properties changes
2. Describe the processes employed for processing zero dimensional nanomaterials and employ them in engineering applications
3. Select processes that can fabricate one dimensional nanomaterials
4. Prepare two dimensional nanomaterials and bulk nanostructures
5. Analyse the nanoindentation and AFM Data

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**

1. Bamberg, D., Grundman, M. and Ledentsov, N.N., “Quantum Dot Heterostructures”, Wiley, 1999.
2. Charles P. Poole Jr., Frank J. Ownes, ‘Introduction to Nanotechnology”, Wiley Interscience, 2003.
3. G Timp (ed), “Nanotechnology”, AIP press/Springer, 1999.
4. G. Wilde, “Nanostructured Materials’, Elsevier, 2008.
5. Mark Ratner and Daniel Ratner, “Nano Technology”, Pearson Education, New Delhi, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	2	1	1	1	1	1	1					1	1	2	2
<b>CO2</b>	3	2	2	2	2	1	1					2	2	2	2
<b>CO3</b>	3	2	2	2	3	1	1					2	2	2	2
<b>CO4</b>	3	2	2	2	3	1	1					2	2	2	2
<b>CO5</b>	3	3	2	2	3	1	1					2	2	2	2
<b>Avg</b>	2.8	2	1.8	1.8	2.4	1	1					1.8	1.8	2	2



**COURSE OBJECTIVES:**

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

1. Gaining knowledge on the various types of tool materials and their characteristics and applications.
2. Distinguishing the various methods of testing tool steels.
3. Understanding thoroughly the various existing manufacturing processes, heat treatment and properties of advanced tool materials.
4. Identifying suitable heat treatments that can be adopted to the tool steels and its effect on the mechanical properties.
5. Discussing the need for coating the tool materials and its implications.

**UNIT I CLASSIFICATION AND MANUFACTURE OF TOOL STEELS 9**

Classification – AISI system, selection of tool steels from the point of view of mechanical properties, Effect of alloying elements such as W, Mo, Ni, V, Ti etc., in Tool steels, Production techniques –problems in melting – powder metallurgy route, Refining methods like VAR, ESR– forming of tool steels.

**UNIT II HEAT TREATMENT OF TOOL STEELS AND DEFECTS 9**

HEAT TREATMENT AND METALLURGY OF W, S, O, A & D TYPE TOOL STEELS Water hardening tool steels, shock resistance tool steels, cold work tool steels-oil hardening, medium alloy and high carbon-high Cr(O,A&D types): Constitution, classification of principal types, heat treatment process, hardenability, distortion characteristics, properties and application.

HEAT TREATMENT AND METALLURGY OF H, T, M, SPECIAL PURPOSE TOOL STEELS-Hot work tool steels, high speed tool steels, maraging tool steels, special purpose tool steels: constitution, classification of principal types, heat treatment process, specific requirements and applications.

**UNIT III PROPERTIES, TESTING AND FAILURE OF TOOL STEELS 9**

Mechanical properties of Tool steels with respect to applications – Elevated temperature properties – Microstructures –Carbide distribution –Coating thickness, micro hardness – Adhesion and Scratch resistance. Tool failures – material heat treatment, manufacturing processes and Operational factors.

**UNIT IV ADVANCED TOOL MATERIALS 9**

Sintered Tungsten Carbide tools – ISO classification, Uses of P, M, K,H,W, S, O, A ,T grades Cermet – ceramics, mixed and reinforced grades –WC, Al<sub>2</sub>O<sub>3</sub>, SiC , CBN, PCD, TaC, TiC, Solid Carbide tools – Manufacturing techniques, heat treatment and properties, Stellites, Cemented carbides, ceramic tools, Special purpose tool steels.

**UNIT V SURFACE TREATMENTS AND COATINGS 9**

Sulphidizing of tool steels – TiN coating by PVD, coating of Carbide tools –Mono and multilayer Coatings of TiC, TiN, Alumina and DLC by PVD and CVD processes.

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

Upon completion of the course, the Students will be able to

1. Classify the various tool materials that are used for engineering applications and understand the influence of various alloying elements on the properties of tool materials
2. Select suitable heat treatment for the different tool materials in order to improve the performance of tools.
3. Test the tool materials for various properties and analyse on the various possible failures that occur in tools.
4. Explain the need for advanced tool materials and the advantages of various special tool materials over conventional tool materials.
5. Infer the effect of coating on the tool materials and are exposed to the various possible coating techniques that are available for tool materials.

## TEXT BOOKS

1. George Roberts, George Krauss, Richard Kennedy, "Tool Steels" 5th edition, ASM International, 1998.
2. Payson, Peter – "Metallurgy of Tool Steels" – John Wiley & Sons, New York 1962

## REFERENCES

1. Joseph R. Davies – "Tool Materials", ASM International, 1995
2. Robert Wilson, "Metallurgy and Heat treatment of Tool Steels, McGraw Hill New York, 1975

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1										2	3	2	2
CO2	3	2	2		2							2	3	2	2
CO3	3	2	2	2	2							2	3	3	2
CO4	3	2	2		2							2	3	2	2
CO5	3	2	2									2	3	2	2
Avg	3	1.8	2	2	2							2	3	2.2	2

ML3009

AUTOMOTIVE MATERIALS

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

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

1. Having knowledge on the overview of material properties, use of materials selection chart and considerations for material selection
2. Acquiring knowledge about the basis of materials selection
3. Getting an insight about the factors that influence materials selection for engines and transmission system
4. Selecting suitable materials for automotive structures
5. Identifying appropriate material for electronics devices in the automobile industries

### UNIT – I ENGINEERING MATERIALS AND THEIR PROPERTIES 9

Classes of engineering materials - the evolution of engineering materials, Definition of materials properties, Displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment. Selection of materials for automotive, aerospace, marine and defence applications.

### UNIT – II BASIS OF MATERIAL SELECTION 9

Selection strategy, Attribute limits and Material indices, structural index Selection procedure: Design process - types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes - Materials processing and design processes and their influence on design, Process attributes, Systematic process selection, Process selection diagrams, Process cost, Energy consumption for production, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection.

### UNIT – III MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS 9

Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.

**UNIT – IV MATERIALS FOR AUTOMOTIVE STRUCTURES 9**

Materials selection for bearings, leaf springs, chassis & frames, Bumper, shock absorbers, Damping fluid, wind screens, panels, brake shoes, Disc, wheels, differentials , damping and antifriction fluids, Tyres and tubes.

**UNIT – V ELECTRONIC MATERIALS FOR AUTOMOTIVE APPLICATIONS 9**

Materials for electronic devices meant for engine control, ABS, Steering, Suspension, Sensors, temperature sensors for climate control, anti-collision, Anti-fog, Head lamps.

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

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

1. Identify the criteria and forces that cause the changes in materials selection.
2. Investigate the influence of structural index, manufacturing process, design and functional requirements on selection strategies.
3. Recognize the temperature regime, nature of load and property requirements of materials for engines and transmission system.
4. Analyse the various stresses acting on the structural members of automobile under dynamic loading and select suitable material.
5. Adjudicate the apt material for electronic devices used in automobiles.

**TEXT BOOKS:**

1. Charles J A and Crane. F A. A., "Selection and Use of Engineering Materials", 3rd Edition, Butterworths, London UK, 1996.
2. Jason Rowe, "Advanced Materials in Automotive Engineering", Wood Head Publishing, 2012.

**REFERENCES:**

1. Ahmed E, "Advanced composite materials for Automotive applications, Wiley, 2013
2. Don H Wright, "Testing Automotive Materials and Components", SAE 1993.
3. Geoff Davis, "Materials for Automobile bodies", Butter Worth Heinemann, 2012
4. Hiroshi Yamagata, "The Science and Technology of Materials in Automotive Engines", Elsevier, 2005
5. Mstislav A M, Valentin N A, Gleb V M, "Automotive materials: a handbook for the mechanical engineer", NTIS, 1972.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	2	1							2			2
CO2	2	3	1	2	3							2	2	3	
CO3	3	2	2	3	2							2	2	2	
CO4	2	2	2	3	2							2	2	1	
CO5	3	3	3	2	3							2		3	3
Avg	2.6	2.2	2	2.4	2.2							2	2	2.25	2.5

**COURSE OBJECTIVES:**

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and direct energy deposition processes
- To be familiar with powder bed fusion and material extrusion processes.
- To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

**UNIT I INTRODUCTION****6**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing-Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

**UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM)****6**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

**UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION****6**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits -Applications.

**UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION****6**

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. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

**UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES****6**

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

**TOTAL: 30 PERIODS****ADDITIVE MANUFACTURING LABORATORY****Experiments**

1. Modelling and converting CAD models into STL file.
2. Manipulation and error fixing of STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.
6. Design and fabrication of topology optimized parts.

**TOTAL: 30 PERIODS**

**Equipment required - lab**

1. Extrusion based AM machine
2. Resin based AM machine
3. Mechanical design software
4. Open-source AM software for STL editing, manipulation and slicing.

**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 of transforming a concept into the final product in AM technology.

CO3: Elaborate the vat polymerization and direct energy deposition processes and its applications.

CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.

CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

**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.

**ML3010****CRYOGENIC TREATMENT OF MATERIALS**

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

**COURSE OBJECTIVES:**

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

1. Familiarizing with cryogenic cycles and its related fluids.
2. Gaining knowledge on cry cooler and effects of materials
3. Acquiring knowledge on cryogenic treatment
4. Understanding the characteristics of cryo treated materials
5. Having knowledge on the applications of cryoprocessing of materials

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

Insight on Cryogenics-Basics, Properties of Cryogenic fluids, Liquefaction Cycles - Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve – Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claude Cycle, Dual Cycle

**UNIT II CRYOCOOLER****9**

Cryocooler requirement- Satellite communication, Surveillance Imaging, Military applications, Impact of regenerative materials on cooler performance, Impact of material properties on cryocooler performance- Materials used, Thermal Properties, Electrical Properties, and Mechanical properties.

**UNIT III CRYOGENIC PROCESSING****9**

Historical Development of Cryogenic Treatment, Cryogenic for Ferrous Metals, Need for cryogenic treatment, Types of low temperature treatment and processors, Benefits of cryogenic treatment-Wear resistance, Stress Relieving, Hardness Precautions during cryogenic treatment.

**UNIT IV MATERIALS ENGINEERING****9**

Desirable qualities for materials used in cryogenic applications, History and applications of metallic / non-metallic materials, Understanding properties and fabrication processes of superconducting Nb<sub>3</sub>Sn wires, High temperature superconductors. Characterization of cryogenically processed materials.

**UNIT V APPLICATIONS****9**

Cryogenic processing of materials for Space applications, Superconductivity, Medical applications, Food Preservation-Individual Quick Freezing, Tool Industry, Automobiles etc

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

Upon completion of the Course, the students will be able to

1. Perform cryogenic treatment of materials
2. Specify cryocooler requirements and performance
3. Select materials for cryogenic treatment
4. Characterise the cryo-treated materials
5. Discuss the properties and application after cryogenic treatment of materials

**TEXT BOOK**

1. Randall F. Barron, "Cryogenic Systems", McGraw-Hill, 1985.

**REFERENCES**

1. Jha, A. R., "Cryogenic Technology and Applications", Butterworth-Heinemann, 2006
2. Klaus D. Timmerhaus and Richard P. Reed, "Cryogenic Engineering", Springer, 2007.
3. Scott R. B., "Cryogenic Engineering", Van Nostrand and Co., 1962.
4. William E. Bryson, "Cryogenics", Hanser Gardner Publications, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	2	2	2	3								2	1	1	
<b>CO2</b>	3	2	2	2								2	1		1
<b>CO3</b>	3	2	2	1								2	2	1	
<b>CO4</b>	3	2	2	1								2	1		2
<b>CO5</b>	3	2	2	1								2	1		1
<b>Avg</b>	2.8	2	2	1.6								2	1.2	1	1.3

**COURSE OBJECTIVES:**

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

1. Gaining knowledge about different nuclear materials
2. Understanding the principle and construction of nuclear reactors
3. Identifying the materials for nuclear reactor and fuel
4. Getting awareness of the nuclear waste and prevention techniques
5. Knowing about irradiation effects in nuclear fuels.

**UNIT I FUNDAMENTALS OF NUCLEAR ENGINEERING 9**

Atomic structure, atomic number, mass number, isotopes, nuclear energy and nuclear forces, binding energy, nuclear stability, radioactivity, nuclear reactions, nuclear fissions, nuclear fusion.

**UNIT II NUCLEAR REACTORS 9**

Types of reactors-ordinary water moderated reactors, heavy water cooled and moderated reactors-design, construction and control of nuclear reactors-moderators-coolants-reflectors and structural materials, nuclear power stations in India, comparison of nuclear power plants with thermal power plants.

**UNIT III FUELS 9**

Ores and beneficiation – Uranium and thorium ores, availability in India, solvent extraction and ore beneficiation. fuels of different types – metallic, alloy and dispersion fuels for research reactors, ceramic (oxide, carbide and nitride) fuels for thermal power reactor and fast reactors. Fabrication of oxide, mixed-oxide and mixed-carbide fuel for power reactors. Fabrication, characterization and property evaluation of advanced fuel type, processes encountered infabrication, fuel property evaluation – thermal and physical properties

**UNIT IV NUCLEAR WASTE AND RADIATION PROTECTION 9**

Introduction-unit of nuclear radiation-Types of waste –disposal –ICRP recommendations-radiation hazards and prevention –radiation dose units

**UNIT V IRRADIATION EFFECTS IN NUCLEAR FUELS 9**

Irradiation Examination of Fuels, Irradiation behaviour of metallic uranium – irradiation growth, thermal cycling, swelling, adjusted uranium, blistering in uranium rods. Irradiation effects in ceramic oxide and mixed oxide fuels, definition and units of burnup, main causes of fuel element failure in power reactors and remedies to avoid failures. Behaviour of fuel under off normal and accident condition, criteria for fuel failure during LOCA: oxidation, deformation, stored energy.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the Course, the students will be able to

1. Select the right fuel to be used in Nuclear reactor
2. Discuss the Nuclear radiation and the controlling methods.
3. Describe the construction and working principle of nuclear reactors
4. Express the safety aspects required in the nuclear plants.
5. Explain the waste in the and its disposal methods.

**TEXT BOOKS:**

1. Arora and Domkundwar, "Power plant Engineering", Dhanpati Rai &Co (P) Limited; Eighth edition (1 January 2016)
2. P.K.Nag, "Power Plant Engineering" Tata Mcgraw Hill, 2007

**REFERENCES:**

1. Frost, "Nuclear Fuel Elements: Design Fabrication and Performance", pergamon publications, 1982.
2. Gupta C K "Materials in Nuclear Applications" vol.1, CRC publications, 1989.
3. Kaufman A R, John Wiley, "Nuclear Reactor Fuel Elements, Metallurgy and Fabrication", 1962
4. Olander D R., "Fundamental Aspects of Nuclear Reactor Fuel Elements" NTIS publication, 1976
5. 1976
6. Benedict M and Pigter T.A. "Nuclear Chemical Engineering" Mcgraw Hill 1981
7. Combined power plants by J.H.Horlocks by Pergamon press,1992
8. L.C. Merrite, "Basic principles of Nuclear science and Reactors" Wiley Eastern 1977.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3		3	3					2	1	1	
CO2	3	2	2	2		3	3					2	1		1
CO3	3	2	2	1		3	3					2	2	1	
CO4	3	2	2	1		3	3					2	1	3	2
CO5	3	2	2	1		3	3					2	1	3	1
Avg	3	2	2	1.6		3	3					2	1.2	2	1.3

**ML3012**

**COMPOSITE MATERIALS**

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

**COURSE OBJECTIVES:**

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

1. Gaining knowledge on different matrix and reinforcement materials and selection of them for making different composites.
2. Familiarizing with different manufacturing methods for making different polymer matrix composites components
3. Acquiring knowledge on various in-situ and ex-situ techniques for processing metal matrix composites and interface properties
4. Summarizing different techniques used to produce ceramic matrix composites and carbon-carbon composites
5. Developing constitutive equations for different laminates to evaluate the stress and strain in each lamina

**UNIT I INTRODUCTION TO COMPOSITES**

**9**

Fundamentals of composites - need for composites – enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers

**UNIT II POLYMER MATRIX COMPOSITES**

**9**

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. PMC processes - hand lay up processes – spray up processes – compression moulding – reinforced reaction injection moulding - resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), glass fibre reinforced plastics (GRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates.-applications of PMC in aerospace, automotive industries



**UNIT III METAL MATRIX COMPOSITES****9**

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement - volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process - diffusion bonding – stir casting – squeeze casting, In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries

**UNIT IV CERAMIC MATRIX COMPOSITES AND SPECIAL COMPOSITES****9**

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fiber perform. Sol-gel technique

**UNIT V MECHANICS OF COMPOSITES****9**

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix ( $Q_{ij}$ ), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

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

Upon completion of this course, the students can able to

1. Identify suitable matrix and reinforcement materials, to develop different composite components.
2. Select suitable process to fabricate PMC structures/component.
3. Design and select suitable processes to develop MMCs.
4. Suggest suitable techniques to fabricate CMCs and C-C composites.
5. Develop and use the constitutive equation for the design of composite components.

**TEXT BOOKS**

1. Chawla K. K., "Composite materials", Springer – Verlag, Second Edition, 1998.
2. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", Chapman and Hall, London, England, 1st edition, 1994.

**REFERENCES**

1. Broutman, L.J. and Krock, R.M., "Modern Composite Materials", Addison-Wesley, 1967
2. Clyne, T. W. and Withers, P. J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1993.
3. Sharma, S.C., "Composite materials", Narosa Publications, 2000.
4. Strong, A.B., "Fundamentals of Composite Manufacturing", SME, 1989.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	2	1					2	3	2	1
CO2	2	1	2	1	1	1	1					2	3	3	2
CO3	2	1	2	1	1	1	1					2	3	3	2
CO4	2	1	2	1	1	1	1					2	3	3	2
CO5	2	1	2	1	1	1						2	3	3	3
Avg	2	1	1.8	1	1	1.2	1					2	3	2.8	2

**COURSE OBJECTIVES:**

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

1. acquiring knowledge on raw materials for ceramic, natural ceramic and engineering ceramic
2. Understanding the characteristics and processing application of glass, refractories and engineering ceramics
3. Gaining knowledge on the advanced ceramics and their applications.
4. Identifying the proper refractory material for a given application
5. Getting acquainted with the various applications of ceramic materials

**UNIT I FUNDAMENTALS 9**

Ceramic crystal structures. Phase diagram  $Al_2O_3-SiO_2$ . Ceramic raw materials, Silicate and non silicate ceramics. Composition, properties, Mineralogy, Phase analysis.

**UNIT II GLASS AND ITS PROCESSING 9**

Introduction, classification, preparation-raw materials, mixing, charging, melting, processing. Manufacture of glass products- flat ware, hollow ware. Culletts, optical glass, optical fibers.

**UNIT III REFRACTORIES AND ITS PROCESSING 9**

Importance and requirements, classification-fire clay, alumino silicate, silica, magnesite, forsterite, dolomite, chromite, chrome magnesite, zirconia, carbon and graphite-refractory failures.

**UNIT IV CERAMIC PROCESS 9**

Ceramic fabrication processes-slip forming process, plastic forming process, dry forming process, drying and finishing, firing.

**UNIT V ADVANCED CERAMICS 9**

Oxides, carbides, nitrides, borides, silicides, sialon carbon fibres and Carbon composites. Applications in structural, electrical and bioceramics. Ceramic coatings (thermal barriers), nuclear(cermets), process (filter, catalyst).

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

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

1. Understand the basic of ceramic materials and their characteristics.
2. Describe the processing route and techniques of ceramics
3. Discuss on the various refractory materials and compare them
4. Select the suitable ceramic material for a given application
5. Discuss about the different advanced ceramics and its applications.

**TEXT BOOKS:**

1. James S.Reed, "Principles of Ceramic processing" John Wiley and Sons NY 1988
2. Nandi D.N.Handbook on Refractories Tata Mc Graw –Hill publishing Co New Delhi 1991
3. W.D.Kingery, H.K.Bowen and D.R. Uhlmann, "Introduction to Ceramics", 2nd Edition, by John Wiley and Sons, New York,1976

**REFERENCES:**

1. David W. Richerson, "Modern Ceramic Engineering", 3rd Edition, Taylor & Francis, 2005.
2. Singer, F and Singer, S.S, "Industrial Ceramics", Oxford & IBH Publishing Co., 1991
3. Tooley F.V, "Handbook of Glass Manufacture", Vol I&II, Ogden Publishing Co., NY, 1960.
4. W.Ryan, "Properties of Ceramic Raw Materials", 2nd Edition, Pergamon Press, 1978

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	2	1					2	3	2	1
CO2	3	1	2	1	1	1	1					2	3	3	2
CO3	3	1	2	1	1	1	1					2	3	1	2
CO4	3	1	1	1	1	1	1					2	3	1	2
CO5	3	1	1	1	1	1	3					2	3	1	3
Avg	3	1	1.4	1	1	1.2	1.4					2	3	1.6	2

**ML3014**

**SMART MATERIALS**

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

**COURSE OBJECTIVES:**

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

1. Knowing the different concepts in selecting smart materials
2. Comparing the different electro-rheological materials
3. Discuss on the various and piezoelectric materials
4. Distinguishing the different shape memory materials and their applications
5. Identifying suitable materials for various applications such as actuators, sensors, etc.

**UNIT I INTRODUCTION**

**9**

Intelligent / Smart materials – Functional materials – Polyfunctional materials – Structural materials, Electrical materials, bio-compatible materials. – Intelligent biological materials – Biomimetics – Wolff's Law – Biocompatibility – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis – in vitro and in vivo evaluation of biomaterials.

**UNIT II ELECTRO-RHEOLOGICAL AND PIEZOELECTRIC MATERIALS**

**9**

The principal ingredients of smart materials –microsensors- hybrid smart materials – an algorithm for synthesizing smart materials – active, passive reactive actuator based smart structures- suspensions and electro-rheological fluids – Bingham body model – principal characteristics of electro-rheological fluids – charge migration mechanism for the dispersed phase – electro- rheological fluid domain – fluid actuators- design parameter – application of Electro-rheological fluids –

**UNIT III MAGNETO-RHEOLOGICAL AND PIEZOELECTRIC MATERIALS**

**9**

Basics, Principles and instrumentation and application of Magnetorheological fluids – Piezoelectric materials: polymers and ceramics, mechanism, properties and application. Introduction to electro-restrictive and magneto-restrictive materials

**UNIT III SHAPE MEMORY MATERIALS**

**9**

Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – martensitic transformations – austenitic transformations – thermoelastic martensitic transformations– classification of SMA alloys- mechanism of magnetic SMA

**UNIT III APPLICATIONS OF SHAPE MEMORY ALLOYS**

**9**

Continuum applications of SMA fasteners – SMA fibers – reaction vessels, nuclear reactors, chemical plant, etc. – micro robot actuated by SMA – SMA memorization process (Satellite Antenna Applications) SMA blood clot filter – Impediments to applications of SMA – Shape memory polymers– mechanism of shape memory-Primary moulding – secondary moulding– types and applications.

**TOTAL:45 PERIODS**

## COURSE OUTCOMES:

Upon Completion of the Course, the students will be able to

1. Discuss the different Smart materials.
2. Describe the functions of Electro-Rheological Materials and their suitability for various applications.
3. Discuss the functions of Piezoelectric Materials and their suitability for various applications.
4. Explain the principle of shape memory effect and the transformations that occur in smart materials.
5. Select a suitable smart material for a given application

## TEXT BOOKS

1. M. V. Gandhi and B. S. Thompson, "Smart Materials and Structures", Chapman and Hall, London, First Edition, 1992
2. Mohsen Shahinpoor and Hans-Joerg Schneider "Intelligent Materials", RSC Publishing, 2008

## REFERENCES

1. Duerig, T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects of Shape memory Alloys", Butterworth – Heinemann, 1990
2. Mel Schwartz (Ed), Encyclopaedia of Smart Materials" Volume –I and II, John Wiley & Sons, Inc. 2002
3. Rogers, C. A., Smart Materials, "Structures and Mathematical issues", Technomic Publishing Co., U.S.A, 1989

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	2	2	1		2						2	2	2	3
CO2	3	2	2	1		2						2	2	2	3
CO3	3	2	2	1		2						2	2	2	3
CO4	3	2	3	3		2	2					2	3	3	3
CO5	3	2	3	3		2	2					2	3	3	3
Avg	3	2	2.4	1.8		2	2					2	2.4	2.4	3

**CME364**

**ENERGY STORAGE DEVICES**

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

## COURSE OBJECTIVES

- 1 To study the various types of energy storage devices and technologies and their comparison.
- 2 To learn the techniques of various energy storage devices and their performances.
- 3 To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
- 4 To learn about the renewable energy storage systems and management systems.
- 5 To have an insight into other energy storage devices, hydrogen, and fuel cells.

## UNIT – I INTRODUCTION TO ENERGY STORAGE

**9**

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical– Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies –Efficiency and Comparison.

## UNIT – II ENERGY STORAGE SYSTEMS

**9**

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types- Charging and Discharging – Battery testing and performance.

**UNIT – III MOBILE AND HYBRID ENERGY STORAGE SYSTEMS 9**

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

**UNIT – IV RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT 9**

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid– Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management

**UNIT – V OTHER ENERGY DEVICES 9**

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC, MCFC and Biofuel Cells – Biogas Storage.

**TOTAL:45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

**TEXT BOOKS:**

1. Rober Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2 nd Edition, Springer, 2015.
2. Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001

**REFERENCES:**

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, 2016.
2. Ibrahim Dincer and Mark A Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & amp; Sons, 2002.
3. Lindon David, “Handbook of Batteries”, McGraw Hill, 2002.
4. Aulice Scibioh M. and Viswanathan B, “Fuel Cells – principles and applications’, University Press(India), 2006
5. Ru-Shiliu, Leizhang, Sueliang Sun, “Electrochemical Technologies for Energy Storage and Conversion”, Wiley Publications, 2012.

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	-	-	-	-	-	1	2	3
2	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
3	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
4	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
5	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
Low (1) ; Medium (2) ; High (3)															

**COURSE OBJECTIVES:**

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

1. Learning the basics of hydrogen and its production and storage methods.
2. Gaining knowledge about the basics of fuel cells and their scope for energy related applications.
3. Understanding the different types of fuel cells and their working.
4. Acquiring knowledge on the thermodynamics and kinetics of fuel cell process.
5. Getting an insight into fuel cell applications and its economics.

**UNIT – I                    HYDROGEN – PROPERTIES, PRODUCTION AND STORAGE                    9**

Hydrogen as a source of energy, physical and chemical properties, salient characteristics, relevant issues and concerns – Production – Steam Reforming – Water Electrolysis – Photo-dissociation and Catalytic methods – Storage options – Compressed gas – liquid – hydrides and other chemical forms – Safety issues.

**UNIT – II                    FUEL CELLS – BASICS                    9**

Fundamentals of Fuel Cells – Brief History - Attractive Features – Comparison of Battery and Fuel Cells - Working Principle – Components of Fuel Cells - Importance and Scope for Applications.

**UNIT – III                    FUEL CELLS - CLASSIFICATION                    9**

Types of fuel cells – Construction and Working of PEMFC, DMFC, AFC, PAFC, SOFC, MCFC, BFC– relative merits and demerits – Applications.

**UNIT – IV                    FUEL CELLS – KINETICS AND THERMODYNAMICS                    9**

Thermodynamics and kinetics of fuel cell process – Butler Volmer Equation – Losses and types - Performance Evaluation of Fuel Cells – Efficiency.

**UNIT – V                    FUEL CELLS – APPLICATIONS AND ECONOMICS                    9**

Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the Course, the students will be able to

1. Understand the hydrogen properties and know the Hydrogen generation and storage methods.
2. Recognize the principle operations of fuel cells and their components.
3. Comprehend the different types of fuel cells and their uses.
4. Understand the thermodynamics and kinetics behind the fuel cell processes.
5. Apply the fuel cells for domestic, automotive, space craft power generations and evaluate the techno-economics of fuel cells.

**TEXT BOOKS:**

1. Viswanathan B. and Aulice Scibioh.M, “Fuel Cells – Principles and Applications”, Universities Press, 2006.
2. Hart A.B. and G.J.Womack, “Fuel Cells: Theory and Application”, Prentice Hall, New York Ltd., London 1989.

**REFERENCES:**

1. Rebecca L. and Busby, “Hydrogen and Fuel Cells: A Comprehensive Guide”, Penn Well Corporation, Oklahoma, 2005.
2. Bent Sørensen, “Hydrogen and Fuel Cells: Emerging Technologies and Applications”, Elsevier, UK 2005.
3. Kordesch K. and G.Simader, “Fuel Cell and Their Applications”, Wiley-Vch, Germany 1996.
4. Andrew L Dicks, David A J Rand, “Fuel Cell Systems Explained”, 3<sup>rd</sup> Edition, John Wiley & Sons, 2018.
5. Jeremy Rifkin, “The Hydrogen Economy”, Penguin Group, USA 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	2	3	1	1							1		1	1
CO2	3	2	3	2	1							1		1	1
CO3	3	2	3	3	3							1		1	1
CO4	3	2	3	3	3							1		1	1
CO5	3	2	3	1								1		1	1
Avg	3	2	3	2	2							1		1	1

**ML3015 SEMICONDUCTORS AND OPTOELECTRONIC MATERIALS AND DEVICES L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

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

1. Gaining knowledge on semiconductor materials, mechanisms and processing techniques
2. Understanding the concepts and working principles of optoelectronic devices
3. Getting acquainted with the basics of semiconductor understanding of fundamentals of optoelectronics
4. Acquiring knowledge on the Quantum effects and relevant properties due to their effect
5. Comparing the different processing techniques
6. Designing suitable optoelectronic devices for any given application

**UNIT I BASICS OF SEMICONDUCTORS 9**

Energy bands and Charge carriers in Semiconductors: Direct and Indirect semiconductors, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts.

**UNIT II FUNDAMENTS OF OPTOELECTRONICS 9**

Elements Of Light – Wave nature of light, Polarization, Interference, Diffraction, Light Source. Excess carriers in Semiconductors: optical absorption; photo, electro and cathode – luminescence. Relevance of III-V and IV-VI material-system in optoelectronic devices. Lasers – Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers.

**UNIT III QUANTUM EFFECT 9**

Quantum confinement, Engineering classifications of nanostructures (1D, 2D, 3D confinement) -nano particles- quantum dots, nanowires-ultra-thin films multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, optical, Magnetic and Thermal properties. Semiconducting Hetrostructures.

**UNIT IV ADVANCED PROCESSING TECHNIQUES 9**

Optoelectronic materials fabrication - Mechanical Milling, Colloidal routes, Self-assembly, CVD, MOCVD, Sputtering, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE and Lithography. Processing Environment - clean room technology: specifications and design, air and water purity, requirements for particular processes.

**UNIT V MODERN OPTOELECTRONIC DEVICES 9**

Optoelectronic Integrated Circuits: Introduction, hybrid and Monolithic Integration, Application of Opto Electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices. Quantum dot, quantum well lasers, LED, Photovoltaic, Photo-transistors, opto-electronic switches.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

Upon Completion of the Course, the students will be able to

1. Relate the impacts of semiconductor material properties and the optical properties of semiconductor devices.
2. Discuss the fundamental properties of optoelectronic devices
3. Explain the quantum effect and the length scales of materials
4. Describe the various advanced processing techniques adopted for fabrication of optoelectronic materials.
5. Identify suitable material for any given application.

## TEXT BOOKS:

1. Jasprit Singh, "Opto Electronics – As Introduction to materials and devices", McGraw-Hill International Edition, 1998.
2. Pallab Bhattacharya "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 2006.

## REFERENCES:

1. B. E. A. Saleh and M. C. Teich, "Fundamentals of Photonics", John Wiley, 2nd ed. 2007.
2. Timp. G, "Nanotechnology", AIP press/Springer, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	2	3	1	1							1	2	1	1
CO2	3	2	3	2	1							1	2	1	1
CO3	3	1	3	3	3							1	2	1	1
CO4	3	2	3	3	3							1	2	1	1
CO5	3	2	3	1								1	2	1	1
Avg	3	1.8	3	2	2							1	2	1	1

ML3016

ADVANCED MATERIALS CHARACTERISATION

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

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

1. Learning the basics of microscopic techniques and their working principle
2. Gaining knowledge about the various methods determining the surface composition
3. Understanding the surface analysis techniques by various ways
4. Acquiring knowledge on the mechanical characterisation techniques
5. Getting an insight into the electrical and magnetic characterisation methods

### UNIT - I MICROSCOPY

9

Phase contrast microscopy- Polarized Microscopy- Differential Interference Contrast microscopy, Stereomicroscopy – Laser Scanning Confocal Microscope quantitative Near-field Scanning Optical Microscopy

### UNIT - II SURFACE CHEMICAL ANALYSIS

9

Electron spectroscopy for chemical analysis (ESCA), Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Electron Energy Analysers, Secondary ion mass spectrometry



**UNIT - III SURFACE ANALYSIS****9**

Unit meshes of five types of surface nets - diffraction from diperiodic structures using electron, Low Energy Electron Diffraction (LEED), Reflection High Energy Electron Diffraction (RHEED) – Brunauer-Emmett-Teller (BET) surface area analysis- Atomic Force Microscopy – Scanning tunnelling microscopy.

**UNIT - IV MECHANICAL CHARACTERIZATION TECHNIQUES****9**

Elastic and plastic deformation-mechanical properties of materials, models for interpretation of nanoindentation load-displacement curves, Nanoindentation data analysis methods-Hardness testing of thin films and coatings, Mechanical properties evaluation by universal testing machine (UTM), Dynamic mechanical analysis.

**UNIT - V ELECTRICAL AND MAGNETIC CHARACTERIZATION TECHNIQUES****9**

Measurement of resistivity by 4-probe method, Hall measurement, Measurement of magnetic of properties of nanomaterial (Magnetic hysteresis and dielectric properties by LCR meter), Vibrating sample magnetometer.

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

Upon Completion of the course, the students will be able to

1. Describe the various advanced microscopic techniques
2. Identify the surface chemical composition by interpreting the results from spectroscopic methods
3. Discuss on the different methods used to analyse the surface area and composition
4. Explain the various advanced mechanical characterization techniques
5. Enumerate and explain the various electrical and magnetic characterization methods

**TEXT BOOKS**

1. Angelo, P.C., "Materials Characterisation", 1st Edition Cengage Publication, 2016.
2. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

**Reference Books:**

1. ASM Handbook: Materials Characterization, ASM International, 2008.
2. Yang Leng: Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008.
3. Robert F. Speyer: Thermal Analysis of Materials, Marcel Dekker Inc., New York, 1994.
4. Nanotechnology-Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannangra Geoff Smith, Michelle Simons and Burkhard Raguse, Overseas Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
<b>CO1</b>	3	2	2	1	1							1	2	1	1
<b>CO2</b>	3	2	2	2	1							1	2	1	1
<b>CO3</b>	3	2	2	3	3							1	2	1	1
<b>CO4</b>	3	2	2	3	3							1	2	1	1
<b>CO5</b>	3	2	2	1								1	2	1	1
<b>Avg</b>	3	1.8	3	2	2							1	2	1	1

**COURSE OBJECTIVES:**

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

- Acquiring a comprehensive knowledge on the basics involved in thin films and development of thin films.
- Getting acquainted with the various methods of preparation of thin films.
- Explaining the methods of deposition monitoring and control and its importance.
- Gaining knowledge on the surface modification technologies of deposition of thin film for different application like optical emission, abrasion resistance, dielectric, electronic applications, energy conversion, etc.
- Knowing the applications of thin films in various fields.

**UNIT I BASICS OF THIN FILMS****9**

Cosine law of emission. Emission from a point source. Mass of material condensing on the substrate. Chemical methods: Qualitative study of preparation of thin films by Electroplating, vapour phase growth and anodization. Physical methods: Vacuum evaporation

**UNIT II PREPARATION OF THIN FILMS****9**

Study of thin film vacuum coating unit - Construction and uses of vapour sources-wire, sublimation, crucible and electron bombardment heated sources. Arc and Laser evaporation. Sputtering - Study of glow Discharge - Physical nature of sputtering - Sputtering yield- Experimental set up for DC sputtering, AC sputtering and RF sputtering. Nucleation and growth of thin films (qualitative study only): Four stages of film growth.

**UNIT III DEPOSITION MONITORING AND CONTROL****9**

Microbalance, Crystal oscillator thickness monitor, optical monitor, Resistance Monitor. Thickness measurement: Multiple Beam Interferometer, Fizeau (Tolansky) technique - Fringes of equal chromatic order (FECO) method - Ellipsometry (qualitative only).

**UNIT IV PROPERTIES OF THIN FILM****9**

Sheet resistance - size effect - Electrical conduction in thin metallic films. Effect of Ageing and Annealing - Oxidation - agglomeration. Dielectric properties: DC conduction mechanism - Low field and high field conduction. Breakdown mechanism in dielectric films - AC conduction mechanism. Temperature dependence of conductivity. Optical properties: Optical constants and their determination - Spectrophotometer method. Anti-reflection coatings. Interference filters. Thin film Solar Cells CuInSe<sub>2</sub> solar cell.

**UNIT V APPLICATION OF THIN FILMS****9**

Thin film resistors: Materials and Design of thin film resistors (Choice of resistor and shape and area) - Trimming of thin film resistors - sheet resistance control - Individual resistor trimming. Thin film capacitors: Materials - Capacitor structures - Capacitor yield and capacitor stability. Thin film field effect transistors: Fabrication and characteristics - Thin film diodes.

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

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

- Explain the fundamental principles of Thin film technology.
- Compare the various techniques of preparation of thin films with respect to the processes, advantages, limitations and applications.
- Interpret the results obtained from Microbalance, Crystal oscillator thickness monitor, optical monitor, Resistance Monitor and Thickness measurements.
- Interpret the effect of size of thin films and ageing and annealing on the optical and conductive properties of thin films.

- Identify suitable surface modification technologies of deposition of thin film for different application like optical emission, abrasion resistance, dielectric, electronic applications, energy conversion, etc.

### TEXT BOOKS

1. Goswami A, "Thin Film Fundamentals", New Age International (P) Ltd., 1996.
2. K.L. Chopra, "Thin Film Phenomena", McGraw-Hill, 1983

### REFERENCES

1. AichaElshabini-Riadaud Fred D Barlow III, "Thin Film Technology Hand book", McGraw Hill Company, 1997.
2. Anders H, "Thin Films in Optics", Focal press, 1967.
3. Guthrie A, "Vacuum Technology", John Wiley and Sons, 1963.
4. Maissel L.I and Glang R, "Hand Book of Thin Film Technology", McGraw Hill, 1970.
5. Rao V V, Ghosh, T.B., Chopra, K.L., "Vacuum Science and Technology", Allied Publications, 1998
6. Schwartz B and Schwartz N, "Measurement Techniques for Thin Films", John Wiley & Sons, 1967.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
CO1	3	2	1	2								2	2	3	1
CO2	3	1	2	1	1							2	2	2	1
CO3	3	2	1	2								2	3	2	1
CO4	3	1	1	2								2	2	2	1
CO5	3	2	1	2								3	3	2	1
Avg	3	1.6	1.2	1.8	1							2.2	2.4	2.2	1

ML3018

MEMS AND NANOTECHNOLOGY

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

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

1. Acquiring knowledge about the materials used in MEMS.
2. Understanding the basics of nanoelectromechanical systems (NEMS)
3. Developing the skills to utilize MEMS devices in the real-time applications.
4. Familiarizing with microdevices.
5. Identifying suitable micro and nano electromechanical systems for a given application.

### UNIT – I MATERIAL ASPECTS OF MEMS AND NEMS

9

Overview of MEMS and NEMS. Material Aspects – Silicon and its compounds – Thin metal films – semiconductor – optical properties – Polymers – Smart materials.

### UNIT – II SENSORS

9

MEMS Sensors– Mechanical Sensors– Thermal Sensors– Magnetic Sensors – Micro-opto electromechanical Systems – Radio Frequency (RF) MEMS. Microfluidic Systems; Chemical and Biomedical Microsystems.

### UNIT – III ACTUATORS

9

MEMS Actuators – Mechanical Actuators – Thermal Actuators – Magnetic Actuators – Micro-opto electromechanical Systems – Radio Frequency (RF) MEMS. Microfluidic Systems; Chemical and Biomedical Microsystems.

**UNIT – IV MEMS AND NEMS APPLICATIONS - I** **9**  
 Applications in Computer industry – Making of ICs and Microprocessors – Data storage devices.  
 Automobile – Safety and Stability Control. Health care

**UNIT – V MEMS AND NEMS APPLICATIONS - II** **9**  
 Lab-on-a-Chip. Consumer Products; Micro reactor; Micro-bots; MOEMS; Molecular machines.  
 Applications of NEMS

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Select suitable material for MEMS and Microsystems,
2. Explain the scaling laws involved in miniaturization.
3. Apply the working principle of electrostatic based MEMS sensors and actuators in the design of MEMS devices.
4. Apply the working principle of thermal based MEMS sensors and actuators in the design of MEMS devices.
5. Design the elements of Micro-fluidic systems, and select suitable MEMS devices for Industrial applications.

**TEXT BOOKS:**

1. Mark A. Ratner and Daniel Ratner, “Nanotechnology: A Gentle Introduction to the Next Big Idea, Pearson, 2003.
2. Tai-Ran Hsu, “MEMS and Micro systems Design and Manufacture”, McGraw Hill Education, 2015.

**REFERENCES:**

1. Bharat Bhushan, “Handbook of Nanotechnology”, Springer, 2006.
2. Marc Madou, “Fundamentals of Microfabrication”, CRC Press, 2002.
3. Stephen D Senturia, “Microsystem Design”, Kluwer Academic Publishers, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	1	2	1								2	2	1	1
<b>CO2</b>	3	1	2	1								2	2	1	1
<b>CO3</b>	3	1	3	1								2	2	1	1
<b>CO4</b>	3	2	1	1								2	3	1	1
<b>CO5</b>	3	1	3	1					2			2	3	1	3
<b>Avg</b>	3	1.2	2.2	1					2			2	2.4	1	1.4

**ML3019**

**MICRO AND NANO FABRICATION**

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

**COURSE OBJECTIVES:**

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

1. Getting acquainted with the developments in microfabrication process engineering
2. Getting an insight about the microfabrication technologies.
3. Gaining a comprehensive knowledge on micromanufacturing methods.
4. Understanding the basics of the thin film deposition processes
5. Discuss on the scaling laws and their influences on process and design selection

**UNIT – I INTRODUCTION**

**9**

Review of early developments in Microfabrication Process Engineering, Introduction to Material Science for device fabrication

**UNIT – II MANUFACTURING PROCESSES 9**

Hot Processing and Ion implantation - Diffusion, Thermal Oxidation, Ion implantation, Rapid Thermal Processing. Pattern Transfer

**UNIT – III LITHOGRAPHY 9**

Photolithography, Extreme UV lithography, X-ray Lithography, Electron Beam lithography Focused ion beam Lithography, nanoimprint.

**UNIT – IV THIN FILM DEPOSITION TECHNIQUES 9**

Thin film deposition – Physical deposition: Evaporation and sputtering – Chemical Vapour Deposition – Epitaxial growth. Surface Micromachining of silicon

**UNIT – V MICROMANUFACTURING PROCESSES 9**

Etching – Isotropic etching – Anisotropic etching – Deep Reactive ion etching (DRIE). Surface micromachining, Bulk Micro-manufacturing, LIGA Process. Scaling laws and their influences on process and design selection

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

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

1. Select suitable material for MEMS and Microsystems, and explain the scaling laws involved in miniaturization.
2. Explain the various micro-manufacturing processes.
3. Discuss on the various lithography techniques
4. Describe the working principles of various thin film deposition techniques
5. Explain the method of etching, surface and bulk micro manufacturing methods

**TEXT BOOKS:**

1. Stephen A.Campbell, "Fabrication Engineering at the micro and nano scale", Oxford University Press, 4<sup>th</sup> edition, 2013.
2. Maria Stepanova and Stephen Dew, "Nanofabrication: Techniques and Principles", Springer, 2011

**REFERENCES:**

1. Bharat Bhushan, "Handbook of Nanotechnology", Springer, 2006.
2. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 2002
3. Stephen D Senturia, "Microsystem Design", Kluwer Academic Publishers, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	1	2	1								2	2	1	1
<b>CO2</b>	3	1	2	1								2	2	1	1
<b>CO3</b>	3	1	3	1								2	2	1	1
<b>CO4</b>	3	2	1	1								2	3	1	1
<b>CO5</b>	3	1	3	1					2			2	3	1	3
<b>Avg</b>	3	1.2	2.2	1					2			2	2.4	1	1.4

**COURSE OBJECTIVES:**

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

1. Acquiring knowledge on fluid mechanics specific to materials processing
2. Outlining the different flow in pipes
3. Using heat transfer equations in solving casting related problems
4. Comparing different modes of heat transfer and their applications in materials processing.
5. Familiarizing with the concepts of radiation, mass transfer and diffusion.

**UNIT I FLUID MECHANICS 9**

Properties of fluids such as density, viscosity and specific weight. Fluid statics - Pressure at a point - Pressure variations in horizontal and vertical directions - Concept of gauge and absolute pressure. Use of manometer for pressure measurements. Introduction to Hydrostatic Forces.

Energy Balance in Fluid Flow: Types of flow - continuity equation - Application to one dimensional problems. Derivation of Bernoulli's equation and Euler's equation - Examples illustrating the use of energy equation in metallurgical processes.

**UNIT II INTERNAL AND EXTERNAL FLOW 9**

Classification of flow - Reynolds number - Laminar flow between parallel plates and circular pipes - Simple problems.

Pressure in Fluid Flow: Head loss due to friction -Darcy - Weisbach equation - flow through pipes - use of Moody diagram - Minor losses - Simple problems.

**UNIT III CONDUCTION HEAT TRANSFER 9**

Steady state heat conduction - simple examples. Transient heat conduction - Systems with negligible internal resistance - Lumped heat analysis - Response time of a temperature measuring instrument - System with negligible surface resistance- heat flow in an infinitely thin plate (Semi infinite body) - System with finite surface and internal resistance - Chart solutions of transient heat conduction problems – Examples on Heat Treatment

**UNIT IV CONVECTIVE HEAT TRANSFER 9**

Forced and free convection - Boundary layer concept -velocity and thermal boundary layers (no derivation) - Simple problems - Flow over flat plate - laminar and turbulent boundary layers (no derivation) - Simple problems – Boundary layer development in a circular duct (no derivation) - Flow over cylinders and spheres-Simple problem- applications in metallurgical processes.

**UNIT V RADIATION HEAT TRANSFER 9**

Nature of thermal radiation, Concept of Black body, Emissive power – Gray body - Shape factor - Simple problems on Radiation heat transfer between surfaces. Introduction to Gas radiation.

Mass Transfer: Diffusion mass transfer. Simple problems using Fick's law of diffusion. Introduction to convective mass transfer-Introduction to computational fluid dynamics- software.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course the students will be able to

1. Apply the concepts of fluid mechanics, mass transport for minerals processing, solidifications etc.
2. Discuss the flow behaviour in pipes and use of this knowledge in casting
3. Use the conductive heat principles in materials processing
4. Utilise the convective heat transfer in materials processing
5. Illustrate the mass transfer principle in materials processing

## TEXT BOOKS

1. Kothandaraman C.P. and Rudramoorthy, R., "Basic Fluid Mechanics", New Age International Publishers, Chennai 1998
2. Sachdeva, R C," Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1996.

## REFERENCES

1. Byron Bird R, W E Shawart, "Transport Phenomena", John-Wiley & Sons Inc, 1994.
2. Irving H Shames," Mechanics of Fluids", third edition, McGraw Hill Publishing Co., New York, 1992.
3. Kothandaraman C P , "Fundamentals of heat and Mass Transfer", second edition, New Age International Publishers, Chennai, 1997.
4. Robert, W Fox, "Introduction to Fluid Mechanics", John Wiley & Sons, New York, USA, 1994

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2	1							2			2
CO2	2	1	1	2	3							2	2	3	
CO3	3	2	2	3	2							2	2	2	
CO4	2	2	2	3	2							2	2	1	
CO5	3	3	3	2	3							2		3	3
Avg	2.6	1.8	2	2.4	2.2							2	2	2.25	2.5

ML3021

MATERIALS SELECTION AND DESIGN

L T P C

3 0 0 3

### COURSE OBJECTIVES:

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

1. Having an overview of criteria, use of property chart and economics of materials selection.
2. Gaining knowledge about the manufacturing system, process selection and DFM.
3. Getting an insight to the manufacturing considerations in design.
4. Understanding the influence of the nature of load and material properties in design
5. Acquiring knowledge on the framework in materials design for various kinds of failures.

### UNIT – I MATERIAL SELECTION IN DESIGN

9

Introduction, relation of materials selection to design, general criteria for selection, performance characteristics of materials, materials selection process, design process and materials selection, Types of design, material property chart, material performance indices, materials selection procedure, Structural index, economics of materials, recycling and materials selection

### UNIT – II MATERIALS PROCESSING AND DESIGN

9

Role of Processing in Designing, classification of manufacturing processes, types of manufacturing systems, influence of material on process selection. Design for manufacturability, DFM guidelines, Design for assembly, DFA guidelines, computer methods for DFMA, Design for machining, casting, forging, welding and heat treatment and its DFM guidelines

**UNIT – III MANUFACTURING CONSIDERATIONS IN DESIGN 9**

Surface finish, texture, Standardization, Interchangeable manufacturing, Selective assembly, selection of materials based on mechanical properties -- Preferred numbers, Limits, fits and tolerances, Types of fits and tolerances. Geometric tolerance, types of form and position tolerances, tolerance and manufacturing methods, selection of fits.

**UNIT – IV MATERIALS PROPERTIES AND DESIGN 9**

Stress - Strain diagram, design for strength, rigidity, design under static loading, stress due to torsion and bending, variable loading, stress concentration, fluctuating stress, eccentric loading – stress concentration. Design examples with shaft design and spring design.

**UNIT – V SAFETY CRITERIA IN DESIGN 9**

Design for brittle fracture, plane strain fracture toughness, fatigue failure, Design criteria, fatigue parameters, infinite, safe life and damage tolerance design, fatigue life prediction, corrosion resistance, forms of corrosion, corrosion prevention, Design against wear, types of wear, wear prevention, Designing with plastics, design for stiffness, Time dependent part performance.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Identify suitable procedure for selection of material using material property chart.
2. Recognize the suitable manufacturing process with due considerations of design features of the component.
3. Elucidate the manufacturing considerations in design.
4. Analyse the influence of material properties and the nature of loading on design.
5. Develop a design procedure for safe design against various types of failures.

**TEXT BOOKS:**

1. Dieter George E, Engineering Design, Tata McGraw-Hill education, 1991.
2. Michael F Ashby, Materials selection in Machine Design , Butterworth and Heinemann,2010

**REFERENCES:**

1. Bhandari V B, Design of Machine Elements, 3<sup>rd</sup> edition, Tata McGraw-Hill Education, 2010
2. Charles J A & Crane F A A, Selection and Use of Engineering Materials, Elsevier, 2013
3. Mangonan P L, The Principles of Materials Selection for Engineering Design, Prentice Hall, 1999
4. ASM Handbook : Materials Selection and Design, Volume 20, Taylor & Francis,1997
5. Mahmoud M Farag, Materials and Process Selection for Engineering Design, CRC Press, 2013

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2						2	3	3	3
CO2	3	3	3	3	2	2	2					2	3	3	3
CO3	3	3	3	3	2	2	2					2	3	3	3
CO4	3	3	3	3	2	2						2	3	3	3
CO5	3	3	3	3	2	2						2	3	3	3
Avg	3	3	3	3	2	2	2					2	3	3	3



**COURSE OBJECTIVES:**

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

1. Acquiring knowledge on green energy technology.
2. Getting knowledge on different sources of renewable energies.
3. Getting introduced nanotechnology in green energy.
4. Obtaining knowledge on different green energy materials.
5. Having an overview about the green management concept and its applications.

**UNIT I GREEN ENERGY AND SUSTAINABLE DEVELOPMENT 9**

Global warming; greenhouse gas emissions, impacts, mitigation and adaptation; future energy Systems- clean/green energy technologies. Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/ environmental aspects.

**UNIT II RENEWABLE ENERGY RESOURCES 9**

Current energy requirements - Review of conventional energy resources. Solar Energy and its conversion methods, solar thermal collectors – photovoltaic; Wind energy – Ocean, Wave and Tidal energy. Smart batteries – Fuel Cells and Types – Materials. Other Sources: Hydropower, Nuclear fission and fusion-Geothermal energy.

**UNIT III GREEN NANOTECHNOLOGY 9**

Nanoparticles preparation techniques, Greener Nanosynthesis: Greener Synthetic Methods for Functionalized Metal Nanoparticles, Greener Preparations of Semiconductor and Inorganic Oxide Nanoparticles, green synthesis of Metal nanoparticles, Nanomaterials for Alternative Energy: Nanomaterials for Fuel Cells and Hydrogen Generation and storage, Nanostructures for efficient solar hydrogen production, Metal Nanoclusters in Hydrogen Storage Applications, Metal Nanoparticles as Electrocatalysts in Fuel Cells, Nanowires as Hydrogen Sensors, Nanomaterials in Energy Storage Devices: MWNT for Li Ion Batteries, Nanomaterials in Electrodes, Hybrid Nanotubes: Anode Material, Supercapacitor, Battery Electrodes

**UNIT IV PROCESSING OF GREEN ENERGY MATERIALS 9**

Silicon processing methods - Fabrication methods: physical and chemical vapour deposition techniques, photolithography, electroless and electrochemical deposition, etching, mask plating. Newer Energy Materials: Carbon nano-tubes (CNTs) and multiwall carbon nanotubes (MWCNTs) - methods of production, properties and its utility in energy devices.

**UNIT V GREEN MANAGEMENT 9**

Concept of green management; evolution; nature, scope, importance and types; developing a theory; green management in India; relevance in twenty first century.

**COURSE OUTCOMES:**

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

1. Discuss on the green energy technology.
2. Explain the different sources of renewable energies.
3. Elaborate technological and economical aspects of conversion of renewable energies into useful forms.
4. Explain the energy sciences, its importance and utility.
5. Elaborate the green management concept and its applications.

**REFERENCES:**

1. A. Johansson, Clean Technology”, Lewis 1992.
2. Ed K. Mulder, Sustainable Development for Engineering, Greenleaf Publishing, 2006.
3. Green Management and Green Technologies: Exploring the Causal Relationship by Jazmin SeijasNogarida, 2008.
4. J Fiksel, Design for Environment, Mcgraw Hill, 1996.
5. M. Charter and U. Tischner, Sustainable Solutions, Greenleaf Publishing, 2001.
6. M. Graziani and P. Fornasiero, Renewable resources and renewable energy- A global challenge, CRC-Taylor and Francis, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2								2	3	3	1
CO2	3	1	2	1	1							2	3	2	1
CO3	3	2	1	2								2	3	2	1
CO4	3	1	1	2								2	2	2	1
CO5	3	2	1	2								1	3	2	1
Avg	3	1.6	1.2	1.8	1							1.8	2.8	2.2	1

**CMF339**

**UNCONVENTIONAL MACHINING PROCESSES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- Understand the need and importance of non-traditional machining methods and process selection.
- Gain the knowledge to remove material by thermal evaporation, mechanical energy process.
- Apply the knowledge to remove material by chemical and electro chemical methods.
- Analyze various material removal applications by unconventional machining process.

**UNIT I**

**INTRODUCTION**

**9**

Need for non-traditional machining methods, classifications of modern machining processes, considerations in process selection, materials application, Ultrasonic machining: Elements of the process, mechanics of metal removal, process parameters, economic considerations, application and limitations, recent developments.

**UNIT II**

**ABRASIVE JET MACHINING**

**9**

Abrasive jet machining, water jet machining and abrasive water jet machining: basic principles, equipment’s process variables, mechanics of metal removal, MRR, applications and limitations; Electro chemical processes: Fundamentals of electro chemical machining, electro chemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, tool design, surface finish and accuracy, economic aspect of ECM, simple problem for estimation of metal removal rate

**UNIT III**

**THERMAL METAL REMOVAL PROCESSES**

**9**

General principle and applications of Electric discharge machining, electric discharge grinding, electric discharge wire cutting processes, power circuits in EDM, mechanism of metal removal in EDM, process parameters. Selection of tool electrodes and dielectric fluids, surface finish and accuracy.

**UNIT IV ELECTRON BEAM MACHINING 9**

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non thermal processes, general principle and applications of laser beam machining, thermal features, cutting speed and accuracy of cut.

**UNIT V PLASMA MACHINING 9**

Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries; Chemical machining principle, maskants, etchants, applications.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

- Compare non-traditional machining, classification, material applications in material removal process
- Summarize the principle and processes of abrasive jet machining.
- Understand the principles, processes and applications of thermal metal removal processes.
- Identify the principles, processes and applications of EBM.
- Understand the principles, processes and applications of Plasma Machining.

**TEXT BOOKS:**

1. K. Jain, "Advanced Machining Processes", Allied Publishers, 1st Edition, 2013.
2. Pandey P. C., Shah H.S., "Modern Machining Processes", Tata McGraw-Hill, 1st Edition, 2013.

**REFERENCES:**

1. Bhattacharya A, "New Technology", The Institute for Engineers, 1st Edition, 1973.
2. C. Elanchezian, B. Vijaya Ramnath, M. Vijayan, "Unconventional Machining processes", Anuradha Publication, 1st Edition, 2005.
3. M. K. Singh, "Unconventional Machining processes", New Age International Publishers, 1st Edition, 2010.

<b>ML3023</b>	<b>LASER PROCESSING OF MATERIALS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

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

1. Obtaining an overview of principle and types of laser
2. Acquiring knowledge about the fundamentals of heat and fluid flow during laser processing.
3. Getting an insight to the metallurgical aspects involved during laser processing.
4. Gaining on the methodology, parameters and imperfections laser welding and surface modification.
5. Getting an exposure to laser instrumentation, parameters and material considerations in laser cutting and drilling process.

**UNIT – I PRINCIPLES OF INDUSTRIAL LASERS 9**

Principle of laser generation, Stimulated and spontaneous emissions, Einstein's coefficients, Population inversion, optical resonators, laser modes- mode selection, laser pumping, Rate equation, line- broadening mechanisms, laser beam modifications, types of industrial lasers, Solid state lasers, Gas lasers and semiconductor laser.

**UNIT – II THERMAL PROCESS- HEAT AND FLUID FLOW 9**  
Heat flow in the work piece, Temperature distribution: thick plate with point heat source, thin plate with line heat source, peak temperature ,cooling rates and Gaussian heat source. Fluid flow in molten pool: continuity equation, Navier-Stokes equation and surface tension effects.

**UNIT – III LASER METALLURGY 9**  
Process microstructure- fusion zone, zone of partial melting, HAZ. discontinuities- porosity, cracking, lack of fusion, incomplete penetration and undercut.

**UNIT – IV LASER WELDING AND SURFACE MODIFICATIONS 9**  
Laser welding parameters, Laser efficiency, Process mechanisms (Key hole and Plasmas), Material considerations, imperfections and industrial applications. Recent developments Laser surface modifications: Laser surface heat treatment, Laser surface melting- Glazing, Laser direct Metal deposition– Laser surface alloying, Laser surface cladding and Hard coatings, Laser physical vapour deposition and Laser shock peening.

**UNIT – V LASER MACHINING 9**  
Laser instrumentation for cutting and drilling, cut quality and process characteristics methods of cutting material consideration, practical performance, process variations , industrial applications of Laser cutting and drilling. New developments- Micromachining.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Identify suitable laser source required during laser processing.
2. Explain the heat and fluid flow during laser processing.
3. Analyze the microstructure and discontinuities in the materials subjected to laser processing.
4. Appraise the appropriate methodology, parameters and remedy for imperfections during laser surface modifications
5. Devise the instrumentation for laser cutting and drilling based on the nature of material.

**TEXT BOOKS:**

1. Elijah kannatey-Asibu, Jr., “Principles of Laser Materials processing “, John Wiley & Sons, 2009
2. John Ion,” Laser Processing of Engineering Materials: Principles, Procedure and Industrial Application”, Elsevier, 2005

**REFERENCES:**

1. Jacques Perriere, Eric Millon, Eric Fogarassy, “Recent Advances in Laser Processing of Materials”, Elsevier Science, 2006
2. Jonathan R. Lawrence,” Advances in Laser Materials Processing: Technology, Research and Application”, Elsevier Science, 2010
3. Kamleshwar Upadhyay, “Plasma and Laser Processing of Material”, TMS, 1991.
4. Peter Schaaf, “Laser Processing of Materials: Fundamentals, Applications and Developments”, Springer Science & Business Media,2010
5. Walter W Duley,” Laser Processing and Analysis of Materials”, Springer Science & Business Media, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
<b>CO1</b>	3	2	1	2	1							2	2	3	1
<b>CO2</b>	3	1	2	1	2							2	2	2	1
<b>CO3</b>	3	2	1	2	1							2	3	2	1
<b>CO4</b>	3	1	1	2	1							2	2	2	1
<b>CO5</b>	3	2	1	2	1							1	3	2	1
<b>Avg</b>	3	1.6	1.2	1.8	1.2							1.8	2.4	2.2	1

**COURSE OBJECTIVES:**

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

1. Gaining a comprehensive knowledge on various aspects of Stainless steel making, metallurgy, Properties and its applications.
2. Acquiring knowledge on the classification of stainless steels and their properties.
3. Knowing the importance of use of stainless steels in various fields of technology.
4. Discussing the effect of how the composition and heat treatments affect the characteristics and corrosion behaviour of stainless steels.
5. Having a thorough knowledge on the numerous applications and importance of stainless steels.

**UNIT I HISTORY AND EVOLUTION OF STAINLESS STEEL 9**

Essential elements, evolution, development of alloys, selection of Stainless steels, Recent processing enhancements. Some Metallurgical Principles.

**UNIT II CLASSIFICATION OF STAINLESS STEELS 9**

Wrought and Cast Stainless steels – Ferritic, Martensitic, Austenitic, Cr-Ni-Mo Stainless steels, Precipitation Hardened, Duplex, Heat Resistant, Abrasive and Wear resistant steels-Composition, Metallurgy, Properties, Phase Diagrams, Fretting and Galling, Welding and Weldability of Stainless steels.

**UNIT III MELTING AND SECONDARY REFINING OF STAINLESS STEELS 9**

Raw Materials selection, Melting Furnaces (EAF, EIF), melt treatment, Continuous casting, secondary refining –AOD, VOD, IOC converters processing, advantages and limitations.

**UNIT IV CORROSION BEHAVIOUR OF STAINLESS STEELS 9**

Atmospheric, aqueous, stress corrosion, cracking and Hydrogen Embrittlement, High Temperature corrosion, Corrosion of Cast stainless steels, PREN Index, Corrosion rate estimations- ASTM Practices.

**UNIT V APPLICATIONS OF STAINLESS STEELS 9**

Architecture and construction, Automotive and Marine systems, Petroleum, Chemical, Pulp and Paper Industries applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the Students will be able to:

1. Recall the essential elements responsible for the unique properties of stainless steels and basic metallurgical principles involved.
2. Classify the various types of stainless steels based on the microstructure and the effect of microstructure on the properties of stainless steels.
3. Explain the production methodology of stainless steel making and the influence of the process on the quality of the stainless steel.
4. Interpret the results of corrosion testing and PREN index and understand the influence of the various environmental factors on the corrosion of stainless steels.
5. Identify the suitable stainless steel material for a given application.

**TEXT BOOKS**

1. John C. Lippold, Damien J. Kotecki, "Welding Metallurgy and Weldability of Stainless steels", Wiley and Sons, Edition 2005
2. Jonathan Beddoes, J. Gordon Parr, "Introduction to Stainless Steels", ASM International, 2000
3. Joseph R. Davis, "STAINLESS STEELS", ASM International, 3rd print,--1999

**REFERENCES**

1. Donald Peckner, Irving Melvis Bernstein, "Hand Book of Stainless steels", McGraw Hill, 1977.
2. Joseph R. Davis, "Alloy Digest Source Book: Stainless Steels", ASM International, 2000.

3. Michael F. McGuire , “Stainless steels for Design Engineers”, ASM International,2008
4. R.A. Lula, James Gordon Parr , “Stainless steels”, American Society for Metals, 1996.
5. Source book on Stainless steels, American Society for Metals, 1976.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2									2	3	3	2
CO2	3	2	3	2								2	3	3	2
CO3	3	2	3	2	2		2					2	3	3	2
CO4	3	3	3	2	2		2					2	3	3	2
CO5	3	3	3	2	2							2	3	3	2
Avg	3	2.2	2.2	2	1.6		2					1.8	2.8	2.6	1.6

**ML3025**

**FUELS, FURNACES AND REFRACTORIES**

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

**COURSE OBJECTIVES:**

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

1. Obtaining knowledge on the different modes of heat transfer.
2. Acquiring knowledge on different types of fuels
3. Getting an insight to the different furnaces.
4. Familiarizing with the different refractories
5. Knowing the environmental aspects while handling furnaces.

**UNIT I FUNDAMENTALS**

**9**

Thermal Energy, conversion. Heat Transfer, conduction, radiation, convection. Thermoelectric effect. Thermocouples, Peltier effect. Temperature measurement.

**UNIT II FUELS**

**9**

Thermal Energy conversion. Fossil fuels, availability, deposits, calorific content. Nuclear Fuels, Solar and geothermal heating.

**UNIT III FURNACES**

**9**

Firing, electric Resistance, Radiation, Induction. Temperature control - PID. Multi zone furnaces. Batch and tunnel furnaces.

**UNIT IV REFRACTORIES**

**9**

Heat resistant materials in steel making and non-ferrous production plants. Applications in the power, energy conversion, petroleum and chemical industries.

**UNIT V ADVANCED ISSUES**

**9**

Energy and Environment, Environmental optimization, recycling of thermal energy. Emissions control.

**COURSE OUTCOMES**

Upon Completion of the course, the students will be able to

1. Distinguish the fundamental aspects of heat transfer in furnaces.
2. Select different fuels for energy generation system.
3. Illustrate the different furnaces and its temperature control
4. Outline the use of Refractories in furnace and its application
5. Identify the environmental issues in using furnaces.

**TEXT BOOKS:**

1. Gupta. O. P., "Elements of Fuels, Furnaces and Refractories", 4th edition, Khanna Publishers, New Delhi, 2000.
2. Gupta. O. P., "Elements of Fuels, Furnaces and Refractories", 4th edition, Khanna Publishers, New Delhi, 2000.

**REFERENCES:**

1. Gilchrist, J. D., "Fuels, Furnaces and Refractories", Pergamon Press, 1977.
2. Yeshvant V. Deshmukh, "Industrial Heating: Principles, Techniques, Materials, Applications, and Design", CRC Press, 2005

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2			2	3					2	3	2	
CO2	3	2	2	1		2	3					2	3	2	1
CO3	3	1	1	1		2	3					2	3	2	1
CO4	3	1		1	2	2	3					2	3	2	2
CO5	3					2	3					2	3	2	
Avg	3	1.5	1.7	1	2	2	3					2	3	2	1.3

**CAS331****HIGH TEMPERATURE MATERIALS****L T P C****3 0 0 3****OBJECTIVES**

- To learn the concepts of damage mechanism.
- To acquire knowledge in of components at elevated temperatures
- To understand the concept of creep
- To design material for creep resistance
- To introduce to the theory of super alloys and other advanced materials

**UNIT I CREEP****9**

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperatures and strain rate.

**UNIT II DESIGN FOR CREEP RESISTANCE****9**

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

**UNIT III FRACTURE****9**

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture due to micro void coalescence – diffusion controlled void growth; fracture maps for different alloys and oxides.

**UNIT IV OXIDATION AND HOT CORROSION****9**

Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation – defect structure and control of Oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.

**UNIT V SUPER ALLOYS AND OTHER MATERIALS****9**

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallics, high temperature ceramics.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Apply the concepts of damage mechanism.
- Describe the knowledge of components at elevated temperatures
- Explain the concept of creep
- Design materials to able to have creep resistance
- Explain the theory of super alloys and other advanced materials

**TEXT BOOKS**

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.
2. Hertzberg R.W., "Deformation and Fracture Mechanics of Engineering materials", 4<sup>th</sup> Edition, John Wiley, USA, 1996.
3. Courtney T .H, "Mechanical Behaviour of Materials", McGraw-Hill, USA, 1990.

**REFERENCES**

1. Boyle J.T, Spencer J, "Stress Analysis for Creep" ,Butterworths, UK, 1983.
2. Bressers.J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
3. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I.	2	3	3	2	2	3	-	-	-	-	1	1	2	1	2
II.	3	2	3	2	2	3	-	-	-	-	1	1	2	1	2
III.	2	3	3	2	2	3	1	2	2	1	1	2	2	1	2
IV.	3	2	3	2	2	3	1	2	2	1	1	1	2	1	2
V.	2	2	3	3	2	3	1	2	1	1	1	1	2	2	3
<b>Average</b>	2.4	2.4	3	2.1	2	3	0.6	1.5	1	0.6	1	1.4	2	1.2	2.1

**GE3751****PRINCIPLES OF MANAGEMENT**

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

**COURSE OBJECTIVES:**

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

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS****9**

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



**UNIT II PLANNING****9**

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

**UNIT III ORGANISING****9**

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

**UNIT IV DIRECTING****9**

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

**UNIT V CONTROLLING****9**

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

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

CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.

CO2: Have same basic knowledge on international aspect of management.

CO3: Ability to understand management concept of organizing.

CO4: Ability to understand management concept of directing.

CO5: Ability to understand management concept of controlling.

**TEXT BOOKS:**

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

**REFERENCES:**

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		-	-	-	1	-	-	-	-	-	-	2	1	1
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1
<b>Avg.</b>	1.66	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

**COURSE OBJECTIVES:**

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

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

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

**UNIT II TQM PRINCIPLES****9**

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

**UNIT III TQM TOOLS & TECHNIQUES I****9**

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

**UNIT IV TQM TOOLS & TECHNIQUES II****9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM****9**

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

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

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

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

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

#### TEXT BOOK:

1. Dale H. Besterfield, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwarese and Rashmi Urdhwarese, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

#### REFERENCES:

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

**GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING**

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

#### COURSE OBJECTIVES:

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

#### UNIT I DEMAND & SUPPLY ANALYSIS

**9**

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

#### UNIT II PRODUCTION AND COST ANALYSIS

**9**

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

#### UNIT III PRICING

**9**

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

**UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9**  
 Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

**UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9**  
 Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES: Students able to**

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

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

**CO3:** Understand the market structures and integration concepts

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

**CO5:** Apply the concepts of financial management for project appraisal

**TEXT BOOKS:**

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

**REFERENCES:**

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

**MAPPING OF COS AND POS:**

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

**GE3754**

**HUMAN RESOURCE MANAGEMENT**

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

**OBJECTIVE:**

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

<b>UNIT I</b>	<b>INTRODUCTION TO HUMAN RESOURCE MANAGEMENT</b>	<b>9</b>
The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.		
<b>UNIT II</b>	<b>HUMAN RESOURCE PLANNING</b>	<b>9</b>
Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.		
<b>UNIT III</b>	<b>TRAINING AND EXECUTIVE DEVELOPMENT</b>	<b>9</b>
Types of training and Executive development methods – purpose – benefits.		
<b>UNIT IV</b>	<b>EMPLOYEE COMPENSATION</b>	<b>9</b>
Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.		
<b>UNIT V</b>	<b>PERFORMANCE EVALUATION AND CONTROL</b>	<b>9</b>
Performance evaluation – Feedback - The control process – Importance – Methods – grievances –Causes – Redressal methods.		

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

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

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

**COURSE OBJECTIVES:**

The student should be made to:

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

**UNIT I INTRODUCTION**

9

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

**UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING**

9

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

**UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS**

9

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

**UNIT IV KNOWLEDGE MANAGEMENT APPLICATION**

9

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

**UNIT V FUTURE TRENDS AND CASE STUDIES**

9

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

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

- CO1: Understand the process of acquiring knowledge from experts
- CO2: Understand the learning organization.
- CO3: Use the knowledge management tools.
- CO4: Develop knowledge management Applications.
- CO5: Design and develop enterprise applications.

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

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

**TEXT BOOK:**

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

**REFERENCE:**

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

**GE3792****INDUSTRIAL MANAGEMENT****L T P C****3 0 0 3****COURSE OBJECTIVES**

- 1 To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- 2 To study the planning; organizing and staffing functions of management in professional organization.
- 3 professional organization.
- 4 To study the leading; controlling and decision making functions of management in professional organization.
- 5 To learn the organizational theory in professional organization.
- 6 To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT – I INTRODUCTION TO MANAGEMENT****9**

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

**UNIT – II FUNCTIONS OF MANAGEMENT – I****9**

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

**UNIT – III FUNCTIONS OF MANAGEMENT – II****9**

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

**UNIT – IV ORGANIZATION THEORY****9**

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

**UNIT – V PRODUCTIVITY AND MODERN TOPICS****9**

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

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

**MAPPING OF COS AND POS:**

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



## 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>
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### **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>
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### **OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

### **1. COURSE CONTENTS**

Introduction to Elements of Literature

#### **1. Relevance of literature**

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

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

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

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

- a) Emotions and imaginations.

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

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

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

### **3. READINGS:**

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

#### 3.1 Textbook:

- 1.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

### **4. OTHER SESSION:**

4.1\*Tutorials:

4.2\*Laboratory:

4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

### **5.\*ASSESSMENT:**

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL: 45 PERIODS**

### **OUTCOME OF THE COURSE:**

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

### Theme - A: The Component of Films

- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making... structure of a film

### Theme - B: Evolution of Film Language

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

### Theme - C: Film Theories and Criticism/Appreciation

- C-1: Realist theory; Auteurists
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

### Theme – D: Development of Films

- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

### Theme - E: Indian Films

- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

### READING:

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

### COURSE OBJECTIVE

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

### UNIT I HAZARDS, VULNERABILITY AND DISASTER RISKS

9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - , Inter relations between Disasters and Sustainable development Goals



## CO's – PO's & PSO's MAPPING

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

### MANDATORY COURSES II

**MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA L T P C**  
**SIDDHA 3 0 0 0**

#### **COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

#### **UNIT I HEALTH AND ITS IMPORTANCE**

**2+4**

**Health: Definition - Importance of maintaining health** - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

#### **UNIT II DIET**

**4+6**

**Role of diet in maintaining health** - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components** - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

**Definition of BMI and maintaining it with diet**

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

**Common cooking mistakes**

Different cooking methods, merits and demerits of each method

**UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 4+4**

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory -

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
2. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England  
The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
2. **Simple lifestyle modifications to maintain health**  
<https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20c>ook.
3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>  
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>  
<https://yogamedicine.com/guide-types-yoga-styles/>  
**Ayurveda** : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
9. **Siddha** : [http://www.tkdil.res.in/tkdil/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdil.res.in/tkdil/langdefault/Siddha/Sid_Siddha_Concepts.asp)
10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
11. **Preventive** herbs : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

## COURSE OUTCOMES:

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

**MX3086**

**HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA**

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

## UNIT- I CONCEPTS AND PERSPECTIVES

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history  
Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation  
verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology &  
society, Sources of history on science and technology in India.

## UNIT- II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA

Introduction to the works of D.D. Kosambi, Dharmapal, Debiprasad Chattopadhyay, Rehman, S. Irfan  
Habib, Deepak Kumar, Dhruv Raina, and others.

### **UNIT- III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1<sup>st</sup> century AD to C-1200.

### **UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**

Legacy of technology in Medieval India, Interactions with Arabs

Development in medical knowledge, interaction between Unani and Ayurveda and alchemy

Astronomy and Mathematics: interaction with Arabic Sciences

Science and Technology on the eve of British conquest

### **UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**

Science and the Empire

Indian response to Western Science

Growth of techno-scientific institutions

### **UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**

Science, Technology and Development discourse

Shaping of the Science and Technology Policy

Developments in the field of Science and Technology

Science and technology in globalizing India

Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

**MX3087 POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY L T P C  
3 0 0 0**

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

#### **OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

#### **COURSE TOPICS:**

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam Smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**



Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

**GRADING:**

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**MX3088**

**STATE, NATION BUILDING AND POLITICS IN INDIA**

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

**OBJECTIVE:**

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary, The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.

Goals, objective and philosophy.

Why a federal system?

National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)

New social movements.

The changing nature of Indian Political System, the future scenario. What can we do?

### **OUTCOME OF THE COURSE:**

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

### **SUGGESTED READING:**

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
- vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

**TOTAL : 45 PERIODS**

**MX3089**

**INDUSTRIAL SAFETY**

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

### **OBJECTIVES**

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

### **UNIT I SAFETY TERMINOLOGIES**

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold 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.

## **TEXTBOOKS**

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

## **REFERENCES**

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall,England
5. Society of Safety Engineers, USA

## **ONLINE RESOURCES**

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>

Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

Course Outcomes	Statement	Program Outcome														
		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

### OPEN ELECTIVE I AND II

#### **OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS L T P C 2 0 2 3**

#### **OBJECTIVES:**

The main objectives of this course are to:

1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

#### **UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH**

**6**

**Introduction** - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

#### **UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES**

**6**

**Informed Search** - Greedy Best First - A\* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

### UNIT III LEARNING

6

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

### UNIT IV SUPERVISED LEARNING

6

**Neural Network**: Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree**: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines** (SVM)

### UNIT V UNSUPERVISED LEARNING

6

**Unsupervised Learning** – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

**TOTAL : 30 PERIODS**

### PRACTICAL EXERCISES: 30 PERIODS

#### Programs for Problem solving with Search

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A\* algorithms.

#### Supervised learning

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

#### Unsupervised learning

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (<https://archive.ics.uci.edu/ml/datasets.html>) or constructed by the students.

### OUTCOMES:

- CO1: Understand the foundations of AI and the structure of Intelligent Agents  
CO2: Use appropriate search algorithms for any AI problem  
CO3: Study of learning methods  
CO4: Solving problem using Supervised learning  
CO5: Solving problem using Unsupervised learning

**TOTAL: 60 PERIODS**

### TEXT BOOKS:

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

## REFERENCES

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352**

**IOT CONCEPTS AND APPLICATIONS**

**L T P C**

**2 0 2 3**

### OBJECTIVES:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

### **UNIT I INTRODUCTION TO INTERNET OF THINGS 5**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

### **UNIT II COMPONENTS IN INTERNET OF THINGS 5**

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

### **UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 6**

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

### **UNIT IV OPEN PLATFORMS AND PROGRAMMING 7**

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

### **UNIT V IOT APPLICATIONS 7**

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

**30 PERIODS**

### **PRACTICAL EXERCISES: 30 PERIODS**

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5. Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10. Design an IOT based system

**OUTCOMES:****CO 1:** Explain the concept of IoT.**CO 2:** Understand the communication models and various protocols for IoT.**CO 3:** Design portable IoT using Arduino/Raspberry Pi /open platform**CO 4:** Apply data analytics and use cloud offerings related to IoT.**CO 5:** Analyze applications of IoT in real time scenario.**TOTAL:60 PERIODS****TEXTBOOKS**

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

**REFERENCES**

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. ArshdeepBahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015
6. <https://www.arduino.cc/>  
[https://www.ibm.com/smarterplanet/us/en/?ca=v\\_smarterplanet](https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet)

**OCS353****DATA SCIENCE FUNDAMENTALS****L T P C  
2 0 2 3****COURSE OBJECTIVES:**

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

**UNIT I INTRODUCTION****6**

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

**UNIT II DATA MANIPULATION****9**

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

**UNIT III MACHINE LEARNING****5**

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

#### **UNIT IV DATA VISUALIZATION**

**5**

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

#### **UNIT V HANDLING LARGE DATA**

**5**

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS**

#### **PRACTICAL EXERCISES:**

**30 PERIODS**

#### **LAB EXERCISES**

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
  - a) Frequency distributions
  - b) Mean, Mode, Standard Deviation
  - c) Variability
  - d) Normal curves
  - e) Correlation and scatter plots
  - f) Correlation coefficient
  - g) Regression
6. Use the standard benchmark data set for performing the following:
  - a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
  - b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

**Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.**

#### **COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

- CO1:** Gain knowledge on data science process.
- CO2:** Perform data manipulation functions using Numpy and Pandas.
- CO3:** Understand different types of machine learning approaches.
- CO4:** Perform data visualization using tools.
- CO5:** Handle large volumes of data in practical scenarios.

**TOTAL:60 PERIODS**

#### **TEXT BOOKS**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

#### **REFERENCES**

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.



**OBJECTIVES:**

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I INTRODUCTION****7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

**UNIT II VR MODELING****6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**UNIT III VR PROGRAMMING****6**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS****6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY****5**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL:60 PERIODS**

## OUTCOMES:

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

**CO1:** Understand the basic concepts of AR and VR

**CO2:** Understand the tools and technologies related to AR/VR

**CO3:** Know the working principle of AR/VR related Sensor devices

**CO4:** Design of various models using modeling techniques

**CO5:** Develop AR/VR applications in different domains

## TEXTBOOKS:

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003

## OPEN ELCTIVE III

**OHS351**

**ENGLISH FOR COMPETITIVE EXAMINATIONS**

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

### **COURSE DESCRIPTION:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

### **Objectives:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

### **UNIT I**

**9**

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

### **UNIT II**

**9**

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

### **UNIT III**

**9**

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

**UNIT IV****9**

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

**UNIT V****9**

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

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

At the end of the course, learners will be able

- Expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- Identify errors with precision and write with clarity and coherence
- Understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- Communicate effectively in group discussions, presentations and interviews
- Write topic based essays with precision and accuracy

**CO-PO & PSO MAPPING**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
<b>AVg.</b>	<b>2</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>	<b>3</b>	<b>2.4</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.

**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/>

**OMG352**

**NGOS AND SUSTAINABLE DEVELOPMENT**

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

## COURSE OBJECTIVES

- To understand the importance of sustainable development
- To acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- To comprehend the role of NGOs in attaining sustainable development

### **UNIT I ENVIRONMENTAL CONCERNS**

**9**

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

### **UNIT II ROLE OF NGOS**

**9**

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

### **UNIT III SUSTAINABLE DEVELOPMENT**

**9**

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

### **UNIT IV NGO'S FOR SUSTAINABILITY**

**9**

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

### **UNIT V LEGAL FRAMEWORKS**

**9**

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

**TOTAL 45 : PERIODS**

## OUTCOMES

Upon completion of this course, the student will :

- CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development
- CO2 Have a knowledge on the role of NGOs towards sustainable development
- CO 3 Present strategies for NGOs in attaining sustainable development
- CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO 5 understand the environmental legislations

## REFERENCE BOOKS

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

**OMG353**

## DEMOCRACY AND GOOD GOVERNANCE

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

### UNIT-I

**(9)**

Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

### UNIT-II

**(9)**

Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

### UNIT-III

**(9)**

Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

### UNIT- IV

**(9)**

Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

### UNIT-V

**(9)**

Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.

**TOTAL 45 : PERIODS**

## REFERENCES:

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

**COURSE OBJECTIVES**

- 1 To know the Indian and global energy scenario
- 2 To learn the various solar energy technologies and its applications.
- 3 To educate the various wind energy technologies.
- 4 To explore the various bio-energy technologies.
- 5 To study the ocean and geothermal technologies.

**UNIT – I ENERGY SCENARIO 9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status- Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

**UNIT – II SOLAR ENERGY 9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

**UNIT – III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

**UNIT – IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion- mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration — Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

**UNIT – V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

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

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

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

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

**OME354**

**APPLIED DESIGN THINKING**

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

**OBJECTIVES:**

The course aims to

- Introduce tools & techniques of design thinking for innovative product
- development Illustrate customer-centric product innovation using on simple
- use cases Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

**UNIT I DESIGN THINKING PRINCIPLES**

**9**

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

**UNIT II ENDUSER-CENTRIC INNOVATION**

**9**

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

**UNIT III APPLIED DESIGN THINKING TOOLS**

**9**

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

**UNIT IV CONCEPT GENERATION**

**9**

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

## UNIT V SYSTEM THINKING

9

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES

**At the end of the course, learners will be able to:**

- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

### TEXT BOOKS

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadacos, (2014), Value Proposition Design: How to Create Products and Services Customers Want, Wiley
3. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
4. 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-7812cdf9b85>

**MF3003**

**REVERSE ENGINEERING**

**LT P C**

**3 0 0 3**

### COURSE OBJECTIVES:

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

## UNIT I INTRODUCTION & GEOMETRIC FORM

**9 Hours**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.



**UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9 Hours**

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

**UNIT III DATA PROCESSING 9 Hours**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT IV 3D SCANNING AND MODELLING 9 Hours**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

**UNIT V INDUSTRIAL APPLICATIONS 9 Hours**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

**TEXT BOOKS:**

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

**REFERENCES:**

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluwer Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer-Verlag London Limited 2008.

**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, Eµper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

Mapping of COs with POs and PSOs															
COs/Pos & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

**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

1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles.
4. Explain the role of power electronics in hybrid and electric vehicles
5. 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”, CRC Press,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	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1		3	2					2		1	3
2	1	1	2	1		3	2					2		1	3
3	1	1	2	1		3	2					2		1	3
4	1	1	2	1		3	2					2		1	3
5	1	1	2	1		3	2					2		1	3
Avg.	1	1	2	1		3	2					2		1	3

**OAS352**

**SPACE ENGINEERING**

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

**OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young’s modulus, Poisson’s ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE**

**6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS****10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION****9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY****10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V SPACE APPLICATIONS****10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

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

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, &quot; Introduction to Aeronautics: A design perspective &quot; 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 GROUPODYNAMICS****9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS****9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

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

- CO1: Understand the basic concepts of industrial management  
 CO2: Identify the group conflicts and its causes.  
 CO3: Perform swot analysis  
 CO4 : Analyze the learning curves  
 CO5 : Understand the placement and performance appraisal

**REFERENCES:**

1. Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
<b>AVg.</b>	2	2.2	2.3	3									1.8	2	2.6

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION**

9

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROL CHARTS**

9

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables-  $\bar{X}$ , R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES**

9

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICAL PROCESS CONTROL**

9

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

**UNIT V ACCEPTANCE SAMPLING**

9

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to:

- CO1:** Control the quality of processes using control charts for variables in manufacturing industries.
- CO2:** Control the occurrence of defective product and the defects in manufacturing companies.
- CO3:** Control the occurrence of defects in services.
- CO4:** Analyzing and understanding the process capability study.
- CO5:** Developing the acceptance sampling procedures for incoming raw material.

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
<b>AVg.</b>	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1





## TEXT BOOKS

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

## REFERENCES:

1. Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A, 1979.
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.
3. Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010.
4. Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition, 1999
4. Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-
Avg.	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-

OMR351

MECHATRONICS

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

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

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

### UNIT – I INTRODUCTION AND SENSORS

9

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors.

### UNIT – II 8085 MICROPROCESSOR

9

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

### UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE

9

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

CO1: Select sensors to develop mechatronics systems.

CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

CO 4: Apply PLC as a controller in mechatronics system.

CO 5: Design and develop the apt mechatronics system for an application.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

**TEXT BOOKS:**

1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES:**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.



CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

Mapping of COs with POs and PSOs															
COs/POs& PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

**TEXT BOOKS:**

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2<sup>ND</sup> edition 2012.

**REFERENCES:**

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**OAE352**

**FUNDAMENTALS OF AERONAUTICAL ENGINEERING**

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

**OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT**

**8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS**

**10**

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

**UNIT III BASICS OF AERODYNAMICS**

**9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

**UNIT IV BASICS OF AIRCRAFT STRUCTURES 9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams-elastic constants-Factor of Safety.

**UNIT V BASICS OF PROPULSION 9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production-Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS**

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

**REFERENCE**

1. SADHU SINGH, "Internal Combustion Engines and Gas Turbine"-, SS Kataria & sons, 2015
2. KERMODE , "Flight Without Formulae", -, Pitman; 4th Revised edition 1989

**OGI351**

**REMOTE SENSING CONCEPTS**

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

**OBJECTIVES:**

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

**UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

**UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

**UNIT III ORBITS AND PLATFORMS 9**

Motions of planets and satellites – Newton’s law of gravitation - Gravitational field and potential - Escape velocity - Kepler’s law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

**UNIT IV SENSING TECHNIQUES 9**

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

**UNIT V DATA PRODUCTS AND INTERPRETATION 9**

Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

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

On completion of the course, the student is expected to

- CO 1** Understand the concepts and laws related to remote sensing
- CO 2** Understand the interaction of electromagnetic radiation with atmosphere and earth material
- CO 3** Acquire knowledge about satellite orbits and different types of satellites
- CO 4** Understand the different types of remote sensors
- CO 5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

**REFERENCES:**

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

**CO-PO MAPPING**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						

PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

**OAI351**

**URBAN AGRICULTURE**

**L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

**UNIT I INTRODUCTION**

**9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

**UNIT II VERTICAL FARMING**

**9**

**Vertical farming- types**, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: **The house plants/ indoor plants**

**UNIT III SOIL LESS CULTIVATION**

**9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, **backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping**

**UNIT IV MODERN CONCEPTS**

**9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

**UNIT V WASTE MANAGEMENT**

**9**

Concept, scope and maintenance of waste management- **recycle of organic waste, garden wastes- solid waste management-scope**, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops
5. Explain the concept of waste management on roof tops

**TEXT BOOKS:**

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.

2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

**REFERENCES:**

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. <https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24>.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

**CO-PO MAPPING**

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

**OEN351**

**DRINKING WATER SUPPLY AND TREATMENT**

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

**OBJECTIVE:**

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER**

**9**

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization –



Significance – Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE 9**

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT 9**

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – sand filters - Disinfection -- Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT 9**

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

**UNIT V WATER DISTRIBUTION AND SUPPLY 9**

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS**

**OUTCOMES**

- CO1: An understanding of water quality criteria and standards, and their relation to public health
- CO2: The ability to design the water conveyance system
- CO3: The knowledge in various unit operations and processes in water treatment
- CO4: An ability to understand the various systems for advanced water treatment
- CO5: An insight into the structure of drinking water distribution system

**TEXT BOOKS :**

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

**REFERENCES :**

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbitt.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.

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

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

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

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

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

OEE352

ELECTRIC VEHICLE TECHNOLOGY

L T P C

3 0 0 3

### COURSE OBJECTIVES

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

#### UNIT I ROTATING POWER CONVERTERS

9

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

#### UNIT II STATIC POWER CONVERTERS

9

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

#### UNIT III CONTROL OF DC AND AC MOTOR DRIVES

9

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

#### UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS

9

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

#### UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES

9

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

- CO1: Able to understand the principles of conventional and special electrical machines.  
CO2: Acquired the concepts of power devices and power converters  
CO3: Able to understand the control for DC and AC drive systems.

CO4: Learned the electric vehicle architecture and power train components.

CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2			3								3	3	3
CO2	3	2	2			3			3				3	3	3
CO3	3			3		2	2						3	3	3
CO4	3	2	2		3								3	3	3
CO5	3		2								2		3	3	3
Avg	3	2	2	3	3	1	2		3		2		3	3	3

#### REFERENCES:

- 1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 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

**OEI353**

#### **INTRODUCTION TO PLC PROGRAMMING**

**L T P C**

**3 0 0 3**

#### **COURSE OBJECTIVES:**

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.
5. Exposures about communication architecture of PLC/SCADA.

#### **UNIT I INTRODUCTION TO PLC**

**9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

#### **UNIT II PLC INSTRUCTIONS**

**9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

#### **UNIT III PLC PROGRAMMING**

**9**

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

#### **UNIT IV COMMUNICATION OF PLC AND SCADA**

**9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

**UNIT V CASE STUDIES**

9

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

**TOTAL:45 PERIODS****SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

5

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

- CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)  
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)  
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)  
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles and Applications, Pearson publication

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/108105063>
2. <https://www.electrical4u.com/industrial-automation/>
3. <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
4. <https://www.electrical4u.com/industrial-automation/>

**MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES**

PO, PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
<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	2.25	2.6	1.6			1		1			3	3	2.9

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

General definition and size effects—important nano structured materials and nano particles-importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT II SYNTHESIS OF NANOMATERIALS****8**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT III NANO COMPOSITES****10**

Definition- importance of nanocomposites- nano composite materials-classification of composites-metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based-influence of size, shape and role of interface in composites applications.

**UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES****10**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

**UNIT V APPLICATIONS OF NANO MATERIALS****9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots-Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

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

- CO1 Understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.  
 CO2 Able to acquire knowledge about the different types of nano material synthesis  
 CO3 Describes about the shape, size,structure of composite nano materials and their interference  
 CO4 Understand the different characterization techniques for nanomaterials  
 CO5 Develop a deeper knowledge in the application of nanomaterials in different fields.

**TEXT BOOKS**

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, “ Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press
2. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties &Applications” Imperial College Press, 2004
3. William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 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 Gbtl & Co
3. Ivor Brodie and Julius J.Murray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

## COURSE ARTICULATION MATRIX

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	acquire knowledge about the different types of nano material synthesis	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	describes about the shape, size, structure of composite nano materials and their interference	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	understand the different characterization techniques for nanomaterials	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	develop a deeper knowledge in the application of nanomaterials in different fields	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
Overall CO		3	2	2	1	3	3	1	1	1	1	1	1	3	2	1

**OCH352**

**FUNCTIONAL MATERIALS**

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

**OBJECTIVE:**

- The course emphasis on the molecular self assembly and materials for polymer electronics

**UNIT I INTRODUCTION**

**9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY**

**9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS**

**9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS**

**9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS**

**9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays,

Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohan K. Pillai and Meera Parthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**OFD352**

**TRADITIONAL INDIAN FOODS**

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

**OBJECTIVE:**

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

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES**

**9**

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

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING**

**9**

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

**UNIT III TRADITIONAL FOOD PATTERNS**

**9**

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

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS**

**9**

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

**UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS**

**9**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1 To understand the historical and traditional perspective of foods and food habits

CO2 To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor "Food Culture in India" Greenwood Press, 2005.

2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353****INTRODUCTION TO FOOD PROCESSING****L T P C**  
**3 0 0 3****OBJECTIVE:**

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

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

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

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

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

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

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

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

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

**UNIT V FOOD HYGIENE****9**

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

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

On completion of the course the students are expected to

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



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

**TEXT BOOKS/REFERENCES:**

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

**OPY352**

**IPR FOR PHARMA INDUSTRY**

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

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.

- B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

#### REFERENCES:

- Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
- Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
- S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

#### COURSE OUTCOME

The student will be able to

- C1** Understand and differentiate the categories of intellectual property rights.
- C2** Describe about patents and procedure for obtaining patents.
- C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
- C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
- C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
- C6** Understand the interrelationships between different Intellectual Property Rights on International Society

CO – PO MAPPING												
IPR FOR PHARMA INDUSTRY												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<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**

#### OBJECTIVE:

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

#### UNIT I RESIN FINISHING

**9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

#### UNIT II FLAME PROOF & WATERPROOF

**9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES 9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES 9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING 9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

CO: 1 Basics of Resin Finishing Process.

CO:2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

### TEXT BOOKS:

1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

### REFERENCES:

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

### OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY

L T P C  
3 0 0 3

#### OBJECTIVES:

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

#### UNIT I INTRODUCTION

9

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures. Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

#### UNIT II WORK STUDY

9

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

#### UNIT III METHOD STUDY

9

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

#### UNIT IV WORK MEASUREMENT

9

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

#### UNIT V WORK STUDY APPLICATION

9

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

## **OUTCOMES:**

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity

CO2: Method study

CO3: Motion analysis

CO4: Work measurement and SAM

CO5: Ergonomics and its application to garment industry

## **TEXTBOOKS:**

1. George Kanway, "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. David M. Levine., Timothy C. Krehbiel., and Mark L. Berenson., "Business Statistics: A First Course", 7th Edition, Pearson Education Asia, New Delhi, 2015, ISBN: 032197901X | ISBN-13: 9780321979018
4. Chase., Aquilano., and Jacobs., "Production and Operations Management", Tata McGraw-Hill, New Delhi, 8th Edition, 1999, ISBN: 0256225567 | ISBN-13: 9780256225563
5. Gavriel Salvendy., "Industrial Engineering – Technology and operations management", WileyInterscience Publications, USA, 2001, ISBN: 0471330574 | ISBN-13: 9780471330578
6. Gordana Colovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221

## **REFERENCES**

1. Johnson Maurice "Introduction of Work Study", International Labour Organization, Geneva, 2005.
2. V.Ramesh Babu "Industrial Engineering in Apparel Production" Woodhead publishing India PVT ltd, 2012
3. Kiell B.Zandin, " Mayanard's " Industrial Engineering Hand Book", Fifth edition, Mc Graw Hill, NewYork, 2001.
4. Sharma (S K) ;Sharma (Savita "Work Study And Ergonomics "S. K. Kataria & Sons (publishers) ISBN: 818845834, 2010
5. Khanna.O.P., "Industrial Engineering and Management", Danpat Rai and Sons,1987.
6. Ralph M. Barnes, "Motion and Time Study Design and Measurement of Work", 7th Edition, John Wiley and Sons, New York, 1980.
7. Khan.M.I., "Industrial Ergonomics", PHI LTD. Eastern Economy Edition, 2010.
8. Kantilla Ila, "Apparel Industry In India", Prentice Hall, 1990.
9. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

**Course Articulation Matrix:**

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
<b>Overall CO</b>		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

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

**OTT353**

**BASICS OF TEXTILE MANUFACTURE**

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

**OBJECTIVES:**

To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES**

**9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES**

**9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING**

**9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING****9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

**UNIT V BASICS OF KNITTING AND NONWOVEN****9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

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

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres

CO2: Regenerated and synthetic fibres

CO3: Yarn spinning

CO4: Weaving

CO5: Knitting and nonwoven

**TEXTBOOKS**

1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

**REFERENCES:**

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

**COURSE ARTICULATION MATRIX:**

COURSE OUTCOMES	STATEMENT	PROGRAM OUTCOME														
		P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	P S O 1	P S O 2	PS O 3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

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

**OPE351 INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS**

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

**OBJECTIVE:**

The course is aimed to  
Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**

Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**

Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**

Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS**

**OUTCOMES:**



On the completion of the course students are expected to

**CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

**CO2:** Understand the insights of primary treatment processes to produce the precursors.

**CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

**CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

**CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.

**CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS:**

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition. McGraw Hill, New York, 1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons, 1986.

**REFERENCES:**

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

**CPE334**

**ENERGY CONSERVATION AND MANAGEMENT**

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

**OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

**UNIT I INTRODUCTION**

**9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS**

**9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS**

**9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES**

**9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

**UNIT V ECONOMICS**

**9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com). a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
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, bambooning. 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**

- Ability to find out the correlation between various processing techniques with product properties.
- Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- Acquire knowledge on additives for plastic compounding and methods employed for the same
- Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- Select an appropriate processing technique for the production of a plastic product

## REFERENCES:

1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

**OEC351**

**SIGNALS AND SYSTEMS**

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

## COURSE OBJECTIVES:

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

### **UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals -Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

### **UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

### **UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

### **UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

### **UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9**

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:****At the end of the course, the student will be able to:**

CO1:Determine if a given system is linear/causal/stable

CO2: Determine the frequency components present in a deterministic signal

CO3:Characterize continuous LTI systems in the time domain and frequency domain

CO4:Characterize discrete LTI systems in the time domain and frequency domain

CO5:Compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

**REFERENCES:**

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2<sup>nd</sup> Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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>3</b>	<b>2</b>	<b>3</b>	<b>1</b>

**OEC352****FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS****L T P C  
3 0 0 3****COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES****9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS****9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER****9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9**

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

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

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

CO1: Explain the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Analyze frequency response of BJT and MOSFET amplifiers

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Design and analyze power amplifiers and supply circuits

**TEXT BOOKS:**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

**REFERENCES:**

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

**OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia – The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

**TEXT BOOKS:**

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

**REFERENCES:**

1. Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

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

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

**CBM333****ASSISTIVE TECHNOLOGY****L T P C  
3 0 0 3****OBJECTIVES:****The student should be made to:**

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

**UNIT I            CARDIAC ASSIST DEVICES****9**

Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

**UNIT II            HEMODIALYSERS****9**

Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

**UNIT III           HEARING AIDS****9**

Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

**UNIT IV           PROSTHETIC AND ORTHODIC DEVICES****9**

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.



**UNIT V RECENT TRENDS**

9

Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

**TOTAL:45 PERIODS****OUTCOMES:****On successful completion of this course, the student will be able to**

CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.

CO2: Describe the underlying principles of hemodialyzer machine.

CO3: Indicate the methodologies to assess the hearing loss.

CO4: Evaluate the types of assistive devices for mobilization.

CO5: Explain about TENS and biofeedback system.

**TEXT BOOKS:**

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

**REFERENCES:**

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

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

OMA352

OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

**OBJECTIVES:**

This course will help the students to

- Determine the optimum solution for Linear programming problems.
- Study the Transportation and assignment models and various techniques to solve them.
- Acquire the knowledge of optimality, formulation and computation of integer programming problems.
- Acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- Determine the optimum solution for non-linear programming problems.

<b>UNIT I</b>	<b>LINEAR PROGRAMMING</b>	<b>9</b>
Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.		
<b>UNIT II</b>	<b>TRANSPORTATION AND ASSIGNMENT PROBLEMS</b>	<b>9</b>
Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .		
<b>UNIT III</b>	<b>INTEGER PROGRAMMING</b>	<b>9</b>
Introduction – All and mixed I.P.P – Gomory’s method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.		
<b>UNIT IV</b>	<b>DYNAMIC PROGRAMMING PROBLEMS</b>	<b>9</b>
Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .		
<b>UNIT V</b>	<b>NON - LINEAR PROGRAMMING PROBLEMS</b>	<b>9</b>
Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.		

**TOTAL:45 PERIODS**

**OUTCOMES:**

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

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- Solve the integer programming problems using various methods.
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- Determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

**REFERENCES :**

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum’s Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.L.td, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS
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	01	02	03	04	05	06	07	08	09	10	11	12	O1	O2	O3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

OMA353

ALGEBRA AND NUMBER THEORY

L T P C  
3 0 0 3

**OBJECTIVES:**

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

**UNIT I GROUPS AND RINGS**

9

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

**UNIT II FINITE FIELDS AND POLYNOMIALS**

9

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

**UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS**

9

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

**UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES**

9

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

**UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS**

9

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

**TOTAL: 45 PERIODS**

**OUTCOMES :**

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5<sup>th</sup> Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.

**REFERENCES:**

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2<sup>nd</sup> Edition , 2006.

1.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
<b>CO2</b>	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
<b>CO3</b>	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
<b>CO4</b>	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
<b>CO5</b>	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
<b>Avg</b>	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

**OMA354****LINEAR ALGEBRA****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I            MATRICES AND SYSTEM OF LINEAR EQUATIONS****9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II            VECTOR SPACES****9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III            LINEAR TRANSFORMATION****9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV            INNER PRODUCT SPACES****9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V            EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION****9**

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES:

After the completion of the course the student will be able to

1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

## TEXT BOOKS

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5<sup>th</sup> Edition, 2019.

## REFERENCES

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8<sup>th</sup> Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7<sup>th</sup> Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4<sup>th</sup> Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

**OBT352**

**BASICS OF MICROBIAL TECHNOLOGY**

**L T P C**

**3 0 0 3**

## COURSE OBJECTIVE:

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

### UNIT I BASICS OF MICROBES AND ITS TYPES

**9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

### UNIT II MICROBIAL TECHNIQUES

**9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

### UNIT III PATHOGENIC MICROBES

**9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES 9**  
Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES 9**  
Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Microbes and their types
2. Cultivation of microbes
3. Pathogens and control measures for safety
4. Microbes in different industry for economy.

**TEXT BOOKS**

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**OBT353 BASICS OF BIOMOLECULES L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES 9**  
Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS 9**  
Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN. 9**  
Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein.

**UNIT IV NUCLEIC ACIDS 9**  
Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & RNA; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature. DNA double helix (Watson and crick) model, types of DNA, RNA.

## **UNIT V VITAMINS AND HORMONES**

**9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin. Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses of vitamins and hormones.

### **OUTCOMES:**

- Students will learn about various kinds of biomolecules and their physiological role.
- Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TOTAL: 45 PERIODS**

### **TEXT BOOKS**

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

### **REFERENCES**

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al. "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

## **OBT354 FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY**

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

### **OBJECTIVES:**

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

## **UNIT-I INTRODUCTION TO CELL**

**9**

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria, mycoplasma and prions.

## **UNIT II CELL ORGANELLES**

**9**

Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.





## OPEN ELECTIVE IV

OHS352

### PROJECT REPORT WRITING

L T P C  
3 0 0 3

#### COURSE OBJECTIVE

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

#### UNIT I

9

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

#### UNIT II

9

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

#### UNIT III

9

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

#### UNIT IV

9

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

#### UNIT V

9

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

#### OUTCOMES

By the end of the course, learners will be able to

- Write effective project reports.
- Use statistical tools with confidence.
- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

#### CO-PO & PSO MAPPING

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
1		2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2		2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3		2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4		3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5		3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.		2.1	2.2	2.4	2.1	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

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

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

#### REFERENCES:

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)  
Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

**OMA355**

**ADVANCED NUMERICAL METHODS**

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

**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**

**TEXT BOOKS:**

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

**REFERENCES:**

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers",4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
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**

**OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I RANDOM VARIABLES**

**9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II RANDOM PROCESSES**

**9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III SPECIAL RANDOM PROCESSES**

**9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV CORRELATION AND SPECTRAL DENSITIES**

**9**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS**

**9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

**TOTAL: 45 PERIODS**

**OUTCOMES**

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

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

**TEXT BOOKS**

1. Ibe, O.C., " Fundamentals of Applied Probability and Random Processes ", 1<sup>st</sup> Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.

## REFERENCES

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3<sup>rd</sup> Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
Avg	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

**OMA357**

**QUEUEING AND RELIABILITY MODELLING**

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

### OBJECTIVES:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

#### UNIT I RANDOM PROCESSES

**9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

#### UNIT II MARKOVIAN QUEUEING MODELS

**9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

#### UNIT III ADVANCED QUEUEING MODELS

**9**

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E<sub>k</sub>/1 as special cases – Series queues – Open Jackson networks.

#### UNIT IV SYSTEM RELIABILITY

**9**

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

#### UNIT V MAINTAINABILITY AND AVAILABILITY

**9**

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS**

## OUTCOMES

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

- Enable the students to apply the concept of random processes in engineering disciplines.
- Students acquire skills in analyzing various queueing models.
- Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- Students can analyze reliability of the systems for various probability distributions.
- Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

## TEXT BOOKS

1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., "Fundamentals of Queueing Theory", John Wiley and Sons, New York,2018.
2. Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

## REFERENCES

1. Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> Edition, John Wiley and Sons, 2002.
4. Govil A.K., "Reliability Engineering", Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

## OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

L T P C  
3 0 0 3

### OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

### UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

### UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

**UNIT III PRODUCTION & OPERATIONS PLANNING 9**

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase-Action phase- Control phase - Aggregate production planning

**UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9**

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

**UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9**

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45 : PERIODS**

**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 know 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.

**OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT L T P C  
3 0 0 3**

**OBJECTIVES**

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

**UNIT I OVERVIEW OF IWRM 9**

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

**UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION 9**

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

**UNIT III WATER ECONOMICS 9**  
Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

**UNIT IV RECENT TREANDS IN WATER MANAGEMENT 9**  
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

**UNIT V IMPLEMENTATION OF IWRM 9**  
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

**TOTAL: 45 PERIODS**

### **OUTCOMES**

On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

- CO1** Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
- CO2** Discuss on the different water uses; how it is impacted and ways to tackle these impacts.
- CO3** Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
- CO4** Illustrate the recent trends in water management.
- CO5** Understand the implementation hitches and the institutional frameworks.

### **TEXT BOOKS**

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* "Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

### **REFERENCES**

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET.  
[http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial\\_text.pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial_text.pdf)
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

**OMG355 MULTIVARIATE DATA ANALYSIS L T P C**  
**3 0 0 3**

### **OBJECTIVE:**

- To know various multivariate data analysis techniques for business research.

**UNIT I INTRODUCTION 9**  
Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

<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.		
		<b>TOTAL: 45 PERIODS</b>

**OUTCOMES:**

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

**REFERENCES :**

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002



**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****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:**

- Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
- Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
- Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
- Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
- Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

**COURSE OBJECTIVES:**

To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.

To be acquainted with vat polymerization and material extrusion processes

To be familiar with powder bed fusion and binder jetting processes.

To gain knowledge on applications of direct energy deposition, and material jetting processes.

To impart knowledge on sheet lamination and direct write technologies.

**UNIT I INTRODUCTION 9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

**UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION 9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

**UNIT III POWDER BED FUSION AND BINDER JETTING 9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

**UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION 9**

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery -Materials -Benefits -Applications.

**UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY 9**

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.

Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course students shall be able to:

CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

CO3: Elaborate the process and applications of powder bed fusion and binder jetting.

CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

CO5: Acquire knowledge on sheet lamination and direct write technology.

**TEXT BOOKS:**

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3<sup>rd</sup> edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

**REFERENCES:**

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

**OME356****NEW PRODUCT DEVELOPMENT**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES**

- 1 To introduce the fundamental concepts of the new product development
- 2 To develop material specifications, analysis and process.
- 3 To Learn the Feasibility Studies & reporting of new product development.
- 4 To study the New product qualification and Market Survey on similar products of new product development  
To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT – I FUNDAMENTALS OF NPD****9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS****9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT – III ESSENTIALS OF NPD****9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM 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**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar

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

**OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX****9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT****9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN****9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING****9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING****9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

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

**At the end of the course, learners will be able to:**

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS**

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

## REFERENCES

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. [https://help.prusa3d.com/en/category/prusaslicer\\_204](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010**

**MICRO AND PRECISION ENGINEERING**

**LT P C**

**3 0 0 3**

### COURSE OBJECTIVES:

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

### UNIT I INTRODUCTION TO MICROSYSTEMS

**9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

### UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS

**9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

### UNIT III INTRODUCTION TO PRECISION ENGINEERING

**9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

### UNIT IV PRECISION MACHINING PROCESSES

**9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

### UNIT V METROLOGY FOR MICRO SYSTEMS

**9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES:

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

- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system

**TEXT BOOKS:**

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

**REFERENCES:**

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in Manufacturingll, New Age International, New Delhi, 2005

**OMF354****COST MANAGEMENT OF ENGINEERING PROJECTS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

**UNIT – I INTRODUCTION TO COSTING CONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT – II INTRODUCTION TO PROJECT MANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT – III PROJECT EXECUTION AND COSTING CONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT – IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT – V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

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

CO1: Understand the costing concepts and their role in decision making.

CO2: Understand the project management concepts and their various aspects in selection.

CO3: Interpret costing concepts with project execution.

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

CO5: Become familiar with quantitative techniques in cost management.

## TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

## REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

**AU3002**

**BATTERIES AND MANAGEMENT SYSTEM**

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

## COURSE OBJECTIVES:

The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

### **UNIT I            ADVANCED BATTERIES**

**9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

### **UNIT II            BATTERY PACK**

**9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

### **UNIT III           BATTERY MODELLING**

**9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks



**UNIT IV BATTERY STATE ESTIMATION 9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

**UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9**

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

**TOTAL =45 PERIODS**

**COURSE OUTCOMES:**

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

1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a BatteryModel or Simulation.
4. Estimate State-of-Charges in a Battery Pack.
5. Approach different BMS architectures during real world usage.

**TEXT BOOKS**

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea ,"Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

**REFERENCE BOOKS**

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

**AU3008 SENSORS AND ACTUATORS L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

**UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

**UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

**UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

**UNIT IV AUTOMOTIVE ACTUATORS****9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS****9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

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

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

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment's for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application
4. Understand the operation of the sensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

**TEXT BOOKS:**

1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin Dhanesh N. Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001
3. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

**REFERENCES:**

1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

**OAS353****SPACE VEHICLES**

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

**OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS****9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**OIM352**

**MANAGEMENT SCIENCE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental concepts of management and organization to students.
2. To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y- Herzberg Two Factor Theory of Motivation- Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

**UNIT II OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout- Methods of Production (Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement – Business Process Reengineering (BPR)- Statistical Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on Product Life Cycle.

**UNIT III HUMAN RESOURCES MANAGEMENT 9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating –Capability Maturity Model (CMM)Levels.

**UNIT IV PROJECT MANAGEMENT 9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

**UNITV 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.

**REFERECES:**

1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. KoontzandWeihrich: 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	
<b>AVg.</b>	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

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

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNIT II WORK STUDY****9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNIT III PRODUCT PLANNING AND PROCESS PLANNING****9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

**UNIT IV PRODUCTION SCHEDULING****9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC****9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

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

Upon completion of this course,

- CO1:The students can able to prepare production planning and control act work study,
- CO2:The students can able to prepare product planning,
- CO3:The students can able to prepare production scheduling,
- CO4:The students can able to prepare Inventory Control.
- CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" McGraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

## REFERENCES

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
8. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			3		1				1		3		
2	3	2			3									2	
3		2			3									2	
4		2	2												
5	3	3	2											1	
<b>AVg.</b>	3	2.6	2		3		1				1		3	1.8	

OIE353

OPERATIONS MANAGEMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVE:

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

### UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT

9

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

### UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN

9

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.
- CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
- CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
- CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
- CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**CO’s- PO’s & PSO’s MAPPING**

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
<b>AVg.</b>	3	2.6	3	2.6								2	2	3	3

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12<sup>th</sup> Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**

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

**COURSE OBJECTIVES:**

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

**UNIT I INTRODUCTION AND SCOPE 9**

Occupational Health and Environmental Safety Management - Principles practices. 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**

Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL: 45 PERIODS**



**COURSE OUTCOMES:**

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

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

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

**OSF353****CHEMICAL PROCESS SAFETY****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

## **UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

## **UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

## **UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

## **UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

## **UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

#### **Students able to**

**CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.

**CO2** Develop thorough knowledge about safety in the operation of chemical plants.

**CO3** Apply the principles of safety in the storage and handling of gases.

**CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.

**CO5** Develop thorough knowledge about

### **TEXT BOOK**

- 1 David A Crowl& Joseph F Louvar,"Chemical Process safety", Pearson publication, 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	-	-	-	-
<b>AVg.</b>	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

OMR352

**HYDRAULICS AND PNEUMATICS**

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

**COURSE OBJECTIVES:**

1. To knowledge on fluid power principles and working of hydraulic pumps
2. To obtain the knowledge in hydraulic actuators and control components
3. To understand the basics in hydraulic circuits and systems
4. To obtain the knowledge in pneumatic and electro pneumatic systems
5. To apply the concepts to solve the trouble shooting

**UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal’s Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps

CO 2: Recognize the concepts in hydraulic actuators and control components

CO 3: Obtain the knowledge in basics of hydraulic circuits and systems

CO 4: Know about the basics concept in pneumatic and electro pneumatic systems

CO 5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1		2	2						1	2	2	1
CO2	3	2	1		2	2						1	2	2	1
CO3	3	2	1		2	2						1	2	2	1
CO4	3	2	1		2	2						1	2	2	1
CO5	3	2	1		2	2						1	2	2	1
CO/PO & PSO Average	3	2	1		2	2						1	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

### TEXT BOOKS

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

### REFERENCES

1. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McG Raw Hill, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987
5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, "Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

**OMR353**

**SENSORS**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

### UNIT I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

### UNIT II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT III FORCE, MAGNETIC AND HEADING SENSORS 9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS 9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT V SIGNAL CONDITIONING 9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

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

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

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

**TEXT BOOKS**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES:**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histan, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

**COURSE OBJECTIVES**

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**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.

**TEXT BOOKS**

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

**REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujiita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

**COURSE OBJECTIVES:**

1. To impart knowledge on basics of propulsion system and ship dynamic movements
2. To educate them on basic layout and propulsion equipment's
3. To impart basic knowledge on performance of the ship
4. To impart basic knowledge on Ship propeller and its types
5. To impart knowledge on ship rudder and its types

**UNIT I                      BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS                      9**

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

**UNIT II                      SHIPS MOVEMENTS AND SHIP STABILIZATION                      9**

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

**UNIT III                      SHIPS SPEED AND ITS PERFORMANCE                      9**

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

**UNIT IV                      BASICS OF PROPELLER                      9**

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

**UNIT V                      BASICS OF RUDDER                      9**

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Explain the basics of propulsion system and ship dynamic movements

CO2: Familiarize with various components assisting ship stabilization.

CO3: Demonstrate the performance of the ship.

CO4: Classify the Propeller and its types, Materials etc.

CO5: Categories the Rudder and its types, design criteria of rudder.

**TEXT BOOKS:**

1. GP. Ghose, “Basic Ship propulsion”, 2015
2. E.A. Stokoe “Reeds Ship construction for marine engineers”, Vol. 5, 2010
3. E.A. Stokoe, “Reeds Naval architecture for the marine engineers”, 4<sup>th</sup> Edition, 2009



**REFERENCES BOOKS:**

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

**MAPPING OF COS AND POS:**

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
<b>Avg</b>	5/5=1	2/2=1	4/4=1	4/4=1	2/2=1				1/1=1	1/1=1	2/2=1	1/1=1	1/1=1	5/5=1		5/5=1

**OMV351****MARINE MERCHANT VESSELS****L T P C  
3 0 0 3****OBJECTIVES:**

At the end of the course, students are expected to acquire

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

**UNIT I INTRODUCTION TO HYDROSTATICS****9**

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

**UNIT II TYPES OF SHIP****10**

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

**UNIT III SHIPBUILDING MATERIALS****9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV MARINE PROPELLER AND RUDDER****8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY****9**

Role of IMO (International Maritime Organization), SOLAS (International Convention for the Safety of Life at Sea), MARPOL (International Convention for the Prevention of Pollution from Ships) , MLC (Maritime Labour Convention), STCW 2010 (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

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

Upon completion of this course, students would

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

**TEXT BOOKS:**

1. D.J.Eyres, "Ship Constructions", Seventh Edition, Butter Worth Heinemann Publishing, USA,2015
2. Dr.DA Taylor, "Merchant Ship Naval Architecture" I. Mar EST publications, 2006
3. EA Stokoe, E.A, "Naval Architecture for Marine Engineers", Vol.4, Reeds Publications,2000

**REFERENCES:**

1. Kemp & Young "Ship Construction Sketches & Notes", Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

**OMV352****ELEMENTS OF MARINE ENGINEERING****L T P C**  
**3 0 0 3****OBJECTIVES:****At the end of the course, students are expected to**

1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. Be aware of ship propellers and steering system

**UNIT I                    ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS                    9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II                    MARINE PROPULSION MACHINERY SYSTEM                    9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III                    MARINE AUXILIARY MACHINERY SYSTEM                    9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV                    MARINE BOILER SYSTEM                    9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V                    SHIP PROPELLERS AND STEERING MECHANISM                    9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS****OUTCOMES:****At the end of the course, students should able to,**

1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system

4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellers and steering system

**TEXT BOOKS:**

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

**REFERENCES:**

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

**CRA332**

**DRONE TECHNOLOGIES**

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

**COURSE OBJECTIVES:**

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

**UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

**UNIT IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

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

CO1: Know about a various type of drone technology, drone fabrication and programming.

CO2: Execute the suitable operating procedures for functioning a drone

CO3: Select appropriate sensors and actuators for Drones

CO4: Develop a drone mechanism for specific applications

CO4: Create the programs for various drones

## CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/Pos&P SOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3
CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

## TEXT BOOKS

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones", Maker Media, Inc, 2016

## REFERENCES

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

**OGI352**

**GEOGRAPHICAL INFORMATION SYSTEM**

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

## OBJECTIVES:

To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

### UNIT I FUNDAMENTALS OF GIS

**9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

### UNIT II SPATIAL DATA MODELS

**9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

### UNIT III DATA INPUT AND TOPOLOGY

**9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input –

Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS 9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT 9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS-distributed GIS.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

- CO1** Have basic idea about the fundamentals of GIS.
- CO2** Understand the types of data models.
- CO3** Get knowledge about data input and topology
- CO4** Gain knowledge on data quality and standards
- CO5** Understand data management functions and data output

**TEXT BOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCES:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006.

**CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

**OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT 9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmes (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIBUSINESS IN GLOBAL ARENA: LEGAL PERSPECTIVE 9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing- Directing-Motivation-ordering-leading-supervision- communication and control-Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

**UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE 9**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

**UNIT V ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT 9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract farming (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

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

1. Judge about agricultural finance, banking and cooperation
2. Evaluate basic concepts, principles and functions of financial management
3. Improve the skills on basic banking and insurance schemes available to customers
4. Analyze various financial data for efficient farm management
5. Identify the financial institutions

**TEXT BOOKS:**

1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

**REFERENCES:**

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO-PO MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation 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

**OBJECTIVE:**

The identification of different aspects of biological diversity and conservation techniques.

**UNIT I INTRODUCTION 9**

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

**UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY 9**

Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

**UNIT III MICROBIAL DIVERSITY 9**

Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

**UNIT IV MEGA DIVERSITY 9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

**UNIT V CONSERVATIONS OF BIODIVERSITY 9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

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

1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 13<sup>th</sup> Edition 2019.

**REFERENCES:**

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.

**OUTCOMES:**

Upon successful completion of this course, students will:

CO1: An insight into the structure and function of diversity for ecosystem stability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: An understanding of biodiversity in community resource management.

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.



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

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

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

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

OEE353

INTRODUCTION TO CONTROL SYSTEMS

L T P C  
3 0 0 3

### OBJECTIVES

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

### UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS 9

Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

### UNIT II TIME RESPONSE ANALYSIS & ROOT LOCUS TECHNIQUE 9

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

### UNIT III FREQUENCY RESPONSE ANALYSIS 9

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

### UNIT IV STABILITY CONCEPTS & ANALYSIS 9

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response.

### UNIT V STATE VARIABLE ANALYSIS 9

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

**TOTAL: 45 PERIODS**

### OUTCOMES:

Ability to

CO1: Design the basic mathematical model of physical System.

CO2: Analyze the time response analysis and techniques.

CO3: Analyze the transfer function from different plots.

CO4: Apply the stability concept in various criterion.

CO5: Assess the state models for linear and continuous Systems.

**TEXT BOOKS:**

1. Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5<sup>th</sup> Edition 2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

**REFERENCES:**

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5<sup>th</sup> Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2							2	3	3	3
CO2	3	3	2	3	1								3	3	3
CO3	3	3	3	2	2								3	3	3
CO4	3	3	3	2	2							2	3	3	3
CO5	3	3	3	1	1							1	3	3	3
													3	3	3

**OEI354****INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS****LT P C  
3 0 0 3****COURSE OBJECTIVES:**

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

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

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

**UNIT II AUTOMATION COMPONENTS****9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS****9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS****9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V DISTRIBUTED CONTROL SYSTEM****9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**TOTAL:45 PERIODS****SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)****5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:****Students able to**

- CO1** Design a signal conditioning circuits for various application (L3).  
**CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).  
**CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).  
**CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)  
**CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

**REFERENCES:**

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3 rd Edition,2005.

**List of Open Source Software/ Learning website:**

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>CO1</b>	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
<b>CO2</b>	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO3</b>	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
<b>CO4</b>	3	3	3	3	1			1		1			1		1
<b>CO5</b>	3	3	3	3	1	1		1		1			1		1
<b>AVg.</b>	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

**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****OUTCOMES:**

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

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

**TEXT BOOKS:**

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

**REFERENCES**

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

**Course articulation matrix**

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PS O2	PS O3
<b>CO1</b>	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
<b>CO2</b>	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
<b>CO3</b>	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
<b>CO4</b>	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
<b>CO5</b>	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
<b>OVERALL CO</b>		<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>

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

**OCH354**

**SURFACE SCIENCE**

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

**OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

**OBJECTIVES:**

The course aims to

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

**UNIT I****9**

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

**UNIT II****9**

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

**UNIT III****9**

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

**UNIT IV****9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for 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.

**UNIT V****9**

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

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

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

CO1 understand the importance of food polymers

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

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

**TEXT BOOKS:**

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 REGULATIONS**

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

**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**

**OBJECTIVES:**

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

**UNIT I INTRODUCTION AND SIGNIFICANCE 6**  
Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

**UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS 11**  
Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

**UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 11**  
In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

**UNIT IV ROLE IN HEALTH AND DISEASE 11**  
The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

**UNIT V SAFETY ISSUES 6**  
Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael "Natural Products: A Laboratory Guide", 2nd Edition, Academic Press / Elsevier, 2005.

**REFERENCES:**

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

**COURSE OUTCOME - NUTRACEUTICALS**

<b>CO 1</b>	Acquire knowledge about the nutraceuticals and functional foods, their classification and benefits.
<b>CO 2</b>	Acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
<b>CO 3</b>	Attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
<b>CO 4</b>	Distinguish the various <i>in vitro</i> and <i>in vivo</i> assessment of antioxidant activity of compounds from plant sources.
<b>CO 5</b>	Gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
<b>CO 6</b>	Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

<b>CO – PO MAPPING</b>												
<b>NUTRACEUTICALS</b>												
<b>COURSE OUTCOME</b>	<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>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****OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

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

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT****9**

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING 9**

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING 9**

Definition of printing – Difference between printing and 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****OUTCOMES:**

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

CO1: Basics of grey fabric

CO2: Basics of pre treatment

CO3: Concept of Dyeing

CO4: Concept of Printing

CO5: Machinery in processing industry

**TEXT BOOKS:**

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

**REFERENCES:**

1. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018
3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

**COURSE ARTICULATION MATRIX:**

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

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	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	-

<b>CO4</b>	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>CO5</b>	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall I CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

**FT3201**

**FIBRE SCIENCE**

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

**COURSE OBJECTIVES**

- To enable the students to learn about the types of fibre and its properties

**UNIT I INTRODUCTION TO TEXTILE FIBRES 9**

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

**UNIT II REGENERATED FIBRES 9**

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

**UNIT III SYNTHETIC FIBRES 9**

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

**UNIT IV SPECIALITY FIBRES 9**

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

**UNIT V FUNCTIONAL SPECIALITY FIBRES 9**

**Properties and end uses :** Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

**TEXT BOOKS:**

- Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
- Meredith R., and Hearle J. W. S., "Physical Methods of Investigation of Textiles", Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
- Mukhopadhyay S. K., "Advances in Fibre Science", The Textile Institute,1992, ISBN: 1870812379



**REFERENCES:**

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

CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
<b>Avg</b>	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

**OPE353****INDUSTRIAL SAFETY****L T P C  
3 0 0 3****OBJECTIVES:**

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

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

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE****9**

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS****9**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

**UNIT IV HAZARDS AND RISK MANAGEMENT****9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

## **UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT**

**9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS**

### **OUTCOMES:**

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

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354**

## **UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES**

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

### **OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

### **UNIT I FLUID MECHANICS CONCEPTS**

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**

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**

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**

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**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

### **TEXTBOOKS:**

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchero, J.T., Tata McGraw Hill New York 1997

### **REFERENCE BOOKS**

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352**

**PLASTIC MATERIALS FOR ENGINEERS**

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

### **COURSE OBJECTIVES**

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

## **UNIT I        INTRODUCTION TO PLASTIC MATERIALS**

**9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

## **UNIT II        ENGINEERING THERMOPLASTICS AND APPLICATIONS**

**9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)



**UNIT III THERMOSETTING PLASTICS****9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

**UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS****9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS****9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

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

- To study the importance, advantages and classification of plastic materials
- Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
- To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
- Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
- To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

**REFERENCES**

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A. Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> Edn., CRC press (2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

**OPT353****PROPERTIES AND TESTING OF PLASTICS****L T P C  
3 0 0 3****COURSE OBJECTIVES**

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

**UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9**

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

**UNIT II MECHANICAL PROPERTIES 9**

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

**UNIT III THERMAL RHEOLOGICAL PROPERTIES 9**

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

**UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9**

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.
- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

**REFERENCES:**

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2<sup>nd</sup> Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

**OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

**UNIT I      MOS TRANSISTOR PRINCIPLES      9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

**UNIT II      COMBINATIONAL LOGIC CIRCUITS      9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

**UNIT III      SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES      9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

**UNIT IV      INTERCONNECT, MEMORY ARCHITECTURE      9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

**UNIT V      DESIGN OF ARITHMETIC BUILDING BLOCKS      9**

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1:** Understand the working principle and characteristics of MOSFET

**CO2:** Design Combinational Logic Circuits

**CO3:** Design Sequential Logic Circuits and Clocking systems

**CO4:** Understand Memory architecture and interconnects

**CO5:** Design of arithmetic building blocks.

**TEXT BOOKS:**

1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.( Units - I).

**REFERENCES:**

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

C O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
<b>C</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**

**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.

**OUTCOMES:**

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

CO1: Describe the concepts of wearable system.

CO2: Explain the energy harvestings in wearable device.

CO3: Use the concepts of BAN in health care.

CO4: Illustrate the concept of smart textile

CO5: Compare the various wearable devices in healthcare system

**TOTAL: 45 PERIODS**

## 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 inclinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS****9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:****Upon completion of the course, students will be able to:**

1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill, 2005

**REFERENCES:**

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3<sup>rd</sup> Edition, Springer, 2006.

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

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

**OBT355****BIOTECHNOLOGY FOR WASTE MANAGEMENT****L T P C****3 0 0 3****UNIT I BIOLOGICAL TREATMENT PROCESS****9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continuous fermentation

**UNIT II WASTE BIOMASS AND ITS VALUE ADDITION****9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

**UNIT III BIOCONVERSION OF WASTES TO ENERGY****9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

**UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES 9**  
Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases  
- Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

**UNIT V BIOCOMPOSTING OF ORGANIC WASTES 9**  
Overview of composting process - Benefits of composting, Role of microorganisms in composting -  
Factors affecting the composting process - Waste Materials for Composting, Fundamentals of  
composting process - Composting technologies, Composting systems – Nonreactor Composting,  
Reactor composting - Compost Quality

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

After completion of this course, the students should be able

1. To learn the various methods biological treatment
2. To know the details of waste biomass and its value addition
3. To develop the bioconversion processes to convert wastes to energy
4. To synthesize the chemicals and enzyme from wastes
5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

### **TEXT BOOKS**

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press
2. Joseph C A., (2019) "Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press,

### **REFERENCE BOOKS**

1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products', The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014) 'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014

**OBT356**

**LIFESTYLE DISEASES**

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

**UNIT I INTRODUCTION 9**  
Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

**UNIT II CANCER 9**  
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

**UNIT III CARDIOVASCULAR DISEASES 9**  
Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse – Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation





2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al. Editor(s): Barry R. Bloom, Paul Henri Lambert, Academic Press, 2016, Pages xxi-xxiv.

#### REFERENCES:

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

### VERTICAL 1: FINTECH AND BLOCK CHAIN

**CMG331**

**FINANCIAL MANAGEMENT**

**LT P C**

**3 0 0 3**

#### LEARNING OBJECTIVES

1. To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

#### **UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9**

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

#### **UNIT II . SOURCES OF FINANCE 9**

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

#### **UNIT III INVESTMENT DECISIONS 9**

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting – Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

#### **UNIT IV FINANCING AND DIVIDEND DECISION 9**

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure. Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

#### **UNIT V WORKING CAPITAL DECISION 9**

Working Capital Management: Working Capital Management - concepts - importance -Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS**

## TEXT BOOKS

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

## REFERENCES .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

**CMG332**

**FUNDAMENTALS OF INVESTMENT**

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

## OBJECTIVES:

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

## UNIT I THE INVESTMENT ENVIRONMENT

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

## UNIT II FIXED INCOME SECURITIES

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

## UNIT III APPROACHES TO EQUITY ANALYSIS

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

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

## UNIT V INVESTOR PROTECTION

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism

**TOTAL: 45 PERIODS**

## REFERENCES:

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

**OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

**UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM 9**

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

**UNIT II MANAGING BANK FUNDS/ PRODUCTS 9**

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

**UNIT III DEVELOPMENT IN BANKING TECHNOLOGY 9**

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money – forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

**UNIT IV FINANCIAL SERVICES 9**

Introduction – Need for Financial Services – Financial Services Market in India – NBFC — Leasing and Hire Purchase — mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

**UNIT V INSURANCE 9**

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

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

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

**CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS****UNIT I INTRODUCTION TO BLOCKCHAIN 9**

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY 9**  
 Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

**UNIT III ETHEREUM 9**  
 Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

**UNIT IV WEB3 AND HYPERLEDGE ` 9**  
 Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**UNIT V EMERGING TRENDS 9**  
 Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

**TOTAL: 45 PERIODS**

**REFERENCE**

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2<sup>nd</sup> Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.

**CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS L T P C 3 0 0 3**

**UNIT I CURRENCY EXCHANGE AND PAYMENT 9**  
 Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

**UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9**  
 A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

**UNIT III INSURETECH 9**  
 InsurTech Introduction , Business model disruption AI/ML in InsurTech IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

**UNIT IV PEER TO PEER LENDING 9**  
 P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES 9**

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

**CMG336**

**INTRODUCTION TO FINTECH**

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

**OBJECTIVES:**

1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

**UNIT I INTRODUCTION 9**

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY 9**

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY 9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE 9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT IV 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., Barberis J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

**VERTICAL 2: ENTREPRENEURSHIP****CMG337****FOUNDATIONS OF ENTREPRENEURSHIP****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

**UNIT I INTRODUCTION TO ENTREPRENEURSHIP****9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

**UNIT II BUSINESS OWNERSHIP & ENVIRONMENT****9**

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

**UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP****9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

**UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -- Success Stories of Technopreneurs - Case Studies

**UNIT 5 EMERGING TRENDS IN ENTREPRENERUSHIP 9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrprernerual Develoments - Local – National – Global perspectives.

**TOTAL45 : PERIODS**

**OUTCOMES:**

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

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship

CO 4 Learn about applications of tehnopreneurship and successful technopreneurs

CO 5 Acquaint with the recent and emerging trends in entrepreneuruship

**TEXT BOOKS:**

1. S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
2. Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning.

**REFERENCES :**

1. Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
2. Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
3. Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
4. David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
5. HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>
6. JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
7. Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
8. Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businessess.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

**UNIT I INTRODUCTION TO MANAGING TEAMS****9**

Introduction to Team - Team Dynamics - Team Formation – Stages of Team 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:

- CO 1 Learn the basics of managing teams for business.
- CO 2 Understand developing effective teams for business management.
- CO 3 Understand the fundamentals of leadership for running a business.
- CO 4 Learn about the importance of leadership for business development.
- CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

**REFERENCES :**

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).



**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

**UNIT I CREATIVITY 9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE 9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training- -Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION 9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP 9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS 9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

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

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

CO 1 Learn the basics of creativity for developing Entrepreneurship

CO 2 Understand the importance of creative intelligence for business growth

CO 3 Understand the advances through Innovation in Industries

CO 4 Learn about applications of innovation in building successful ventures

CO 5 Acquaint with developing innovative business models to run the business efficiently and effectively

**SUGGESTED READINGS:**

1. Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand
2. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
3. Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
4. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.
5. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
6. Dale Timpe, Creativity, Jaico Publishing House, 2003.
7. Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
8. Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**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
- CO 2 Understand the marketing environment
- CO 3 Acquaint about product and pricing strategies
- CO 4 Knowledge of promotion and distribution in marketing management.
- CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

**REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

**OBJECTIVES:**

1. To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
2. To create an awareness of the roles, functions and functioning of human resource department.
3. To understand the methods and techniques followed by Human Resource Management practitioners.

**UNIT I INTRODUCTION TO HRM 9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles-Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

**UNIT II HUMAN RESOURCE PLANNING 9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

**UNIT III RECRUITMENT AND SELECTION 9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

**UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9**

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

**UNIT V CONTROLLING HUMAN RESOURCES 9**

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

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

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To know about the methods of Training and Employee Development.

CO 5 To comprehend the techniques of controlling human resources in organisations.

**REFERENCES:**

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**COURSE OBJECTIVES:**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINESS VENTURE 9**

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

**UNIT II INTRODUCTION TO VENTURE FINANCING 9**

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.

**UNIT III SOURCES OF DEBT FINANCING 9**

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

**UNIT IV SOURCES OF EQUITY FINANCING 9**

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

**UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9**

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

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

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

- CO 1 Learn the basics of starting a new business venture.
- CO 2 Understand the basics of venture financing.
- CO 3 Understand the sources of debt financing.
- CO 4 Understand the sources of equity financing.
- CO 5 Acquaint with the methods of fund raising for new business ventures.

**REFERENCES :**

- 1) Principles of Corporate Finance by Brealey and Myers et al., 12<sup>TH</sup> ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis, Selection ,Financing, Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.
- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. McGraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.



**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**

**UNIT-I**

**(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT-II**

**(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT-III**

**(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

- UNIT-IV** (9)
1. All India Services
  2. Service Conditions
  3. State Public Service Commission

- UNIT-V** (9)
1. Employer Employee Relations
  2. Wage and Salary Administration
  3. Allowances and Benefits

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations

**CMG346 ADMINISTRATIVE THEORIES L T P C**  
**3 0 0 3**

**UNIT I** (9)  
Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II** (9)  
Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory

**UNIT III** (9)  
Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

**UNIT IV** (9)  
Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V** (9)  
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Crozier M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347**

**INDIAN ADMINISTRATIVE SYSTEM**

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

**UNIT I**

**(9)**

Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II**

**(9)**

Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III**

**(9)**

Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV**

**(9)**

Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V**

**(9)**

Corruption – Ombudsman, Lok Pal & Lok Ayuktha

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348**

**PUBLIC POLICY ADMINISTRATION**

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

**UNIT-I**

**(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT-II**

**(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT-III**

**(9)**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT-IV**

**(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT-V**

**(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS**



## REFERENCES:

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

## VERTICAL 4: BUSINESS DATA ANALYTICS

CMG349

STATISTICS FOR MANAGEMENT

L T P C  
3 0 0 3

### OBJECTIVE:

- To learn the applications of statistics in business decision making.

### UNIT I INTRODUCTION 9

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

### UNIT II SAMPLING DISTRIBUTION AND ESTIMATION 9

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

### UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS 9

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

### UNIT IV NON-PARAMETRIC TESTS 9

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

### UNIT V CORRELATION AND REGRESSION 9

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS**

### OUTCOMES:

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

## REFERENCES:

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James
6. Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
7. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**OBJECTIVES:**

- To know how to derive meaning from huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Data mining, Text mining, Web mining, Data ware house.		
<b>UNIT II</b>	<b>DATA MINING PROCESS</b>	<b>9</b>
Datamining process – KDD, CRISP-DM, SEMMA Prediction performance measures		
<b>UNIT III</b>	<b>PREDICTION TECHNIQUES</b>	<b>9</b>
Data visualization, Time series – ARIMA, Winter Holts,		
<b>UNIT IV</b>	<b>CLASSIFICATION AND CLUSTERING TECHNIQUES</b>	<b>9</b>
Classification, Association, Clustering.		
<b>UNIT V</b>	<b>MACHINE LEARNING AND AI</b>	<b>9</b>
Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization		

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

1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

**REFERENCES:**

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition, 2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriack C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. Galit Shmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**OBJECTIVES:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I INTRODUCTION TO HR ANALYTICS 9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

**UNIT II HR ANALYTICS I: RECRUITMENT 9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III HR ANALYTICS - TRAINING AND DEVELOPMENT 9**

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

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

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

**REFERENCES:**

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrices, HBR, 2001.

**OBJECTIVE:**

To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I            MARKETING ANALYTICS****9**

Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

**UNIT II            COMMUNITY BUILDING AND MANAGEMENT****9**

History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.

**UNIT III            SOCIAL MEDIA POLICIES AND MEASUREMENTS****9**

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

**UNIT IV            WEB ANALYTICS****9**

Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

**UNIT V            SEARCH ANALYTICS****9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

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

- The Learners will understand social media, web and social media analytics and their potential impact.

**REFERENCES:**

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

**OBJECTIVE:**

To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

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

Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

<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>

**OUTCOME:**

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

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

<b>CMG354</b>	<b>FINANCIAL ANALYTICS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVE:**

- This course introduces a core set of modern analytical tools that specifically target finance applications.

<b>UNIT I</b>	<b>CORPORATE FINANCE ANALYSIS</b>	<b>9</b>
Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.		
<b>UNIT II</b>	<b>FINANCIAL MARKET ANALYSIS</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>PORTFOLIO ANALYSIS</b>	<b>9</b>
Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.		

**UNIT IV TECHNICAL ANALYSIS 9**  
Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS 9**  
Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

**TOTAL: 45 PERIODS**

### **OUTCOME**

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

### **REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

## **VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

**CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT L T P C**  
**3 0 0**

### **OBJECTIVE:**

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

**UNIT I SUSTAINABLE DEVELOPMENT GOALS 9**  
Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

**UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9**  
Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement & Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

### **UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9**

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

### **UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9**

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

### **UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

#### **OUTCOME:**

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

**CO1** Understand the environment sustainability goals at global and Indian scenario.

**CO2** Understand risks in development of projects and suggest mitigation measures.

**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.

**CO5** Explain the new technologies for maintenance of infrastructure projects.

#### **REFERENCES:**

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.

9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

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

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

### CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT

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

#### OBJECTIVES:

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

#### UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9

Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

#### UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

#### UNIT III WATER MANAGEMENT 9

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

#### UNIT IV ENERGY AND WASTE MANAGEMENT 9

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

#### UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9



Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- CO1** Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture
- CO2** Discuss the sustainable ways in managing soil health, nutrients, pests and diseases
- CO3** Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources
- CO4** Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas
- CO5** Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

**REFERENCES:**

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

**CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES**

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

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

**CES333**

**SUSTAINABLE BIOMATERIALS**

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

**OBJECTIVES**

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

## **UNIT I INTRODUCTION TO BIOMATERIALS 9**

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

## **UNIT II BIO POLYMERS 9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

## **UNIT III BIO CERAMICS AND BIOCOMPOSITES 9**

General properties- Bio ceramics -Silicate glass - Alumina ( $Al_2O_3$ ) -Zirconia ( $ZrO_2$ )-Carbon- Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites- Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)– glass ceramics - Orthopedic implants-Tissue engineering scaffolds

## **UNIT IV METALS AS BIOMATERIALS 9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

## **UNIT V NANOBIMATERIALS 9**

Meatlicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor- Bioimaging/Molecular Imaging- challenges and future perspective.

**TOTAL : 45 PERIODS**

### **OUTCOMES**

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

### **REFERENCES**

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopoldo Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.

8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad "Functional Bionanomaterials" Springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**CES334**

**MATERIALS FOR ENERGY SUSTAINABILITY**

**L T P C**

**3 0 0 3**

**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**

### OUTCOMES

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

### REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

**CES335**

**GREEN TECHNOLOGY**

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

### COURSE OBJECTIVE:

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

## UNIT I PRINCIPLES OF GREEN CHEMISTRY

9

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

**UNIT II POLLUTION TYPES 9**  
Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

**UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9**  
Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

**UNIT IV DESIGNING GREEN PROCESSES 9**  
Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

**UNIT V GREEN NANOTECHNOLOGY 9**  
Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

- CO1: To understand the principles of green engineering and technology  
CO2: To learn about pollution using hazardous chemicals and solvents  
CO3: To modify processes and products to make them green and safe.  
CO4: To design processes and products using green technology  
CO5 – To understand advanced technology in green synthesis

### **TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications,2008

### **REFERENCE BOOKS**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

**CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS L T P C  
3 0 0 3**

### **OBJECTIVES:**

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

**UNIT I ENVIRONMENTAL MONITORING AND STANDARDS 9**  
Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

**UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS 9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

**UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING 9**

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

**UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT 9**

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

**UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING 9**

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**OTAL: 45 PERIODS****COURSE OUTCOMES**

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability of the environment.
CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

**TEXTBOOKS**

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and solid wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

**REFERENCES**

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

## COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

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

#### COURSE OBJECTIVES:

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

#### UNIT I ENERGY SCENARIO 9

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

#### UNIT II ENERGY AND ENVIRONMENT 9

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

#### UNIT III SUSTAINABLE DEVELOPMENT 9

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

#### UNIT IV RENEWABLE ENERGY TECHNOLOGY 9

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

#### UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

**TOTAL : 45 PERIODS**

#### COURSE OUTCOMES:

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

1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

#### REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, "Energy and the environment", Willey, 2005.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C**  
**3 0 0 3**

#### COURSE OBJECTIVES:

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

#### **UNIT I ENERGY AND ENVIRONMENT 9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

#### **UNIT II ENERGY AUDITING 9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

#### **UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

#### **UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES 9**



Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

## **UNIT V      SUSTAINABLE DEVELOPMENT**

**9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

**TOTAL:45 PERIODS**

### **COURSE OUTCOMES:**

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

1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

### **REFERENCES:**

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