



**ANNA UNIVERSITY, CHENNAI**

**AFFILIATED INSTITUTIONS**

**REGULATIONS 2021**

**CHOICE BASED CREDIT SYSTEM**

**B. TECH. BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING**

**VISION OF THE DEPARTMENT**

To become a Centre of excellence in technical education, promoting research and bringing out professionals with social commitment capable of contributing to individual and national prosperity.

**MISSION OF THE DEPARTMENT**

1. To impart sound basic knowledge of Biotechnology and Biochemical Engineering concepts to achieve career fulfilment.
2. To inculcate passion and motivation for lifelong learning and learning in premier National and International institutions.
3. To excel students to identify, analyze and solve problems related to the field and also skillful in emerging areas of Biotechnology and Biochemical Engineering.

**1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

1. Be able to design, develop and provide solutions for products and processes in Biotechnology and Biochemical Engineering and allied fields through quality education
2. Be able to address challenges in industrial and research areas with socio-ethical responsibilities
3. Our graduates will excel in biotech and related industries as good process and design engineers capable of handling production related activities including quality control.
4. Our graduates will serve as good entrepreneurs with strong ethical values and communication skills.

**2. PROGRAMME OUTCOMES (POs):**

The Biotechnology and Biochemical Engineering Graduates will have the ability to

<b>PO#</b>	<b>Graduate Attribute</b>
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 analyze 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 modeling 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.

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

1. Acquire sound basic knowledge of bioscience, biotechnology and engineering concepts to emerge as good process engineers in industries.
2. Impart expertise on various bioprocess techniques for sustainable design and development
3. As bioprocess engineer, function as member or leader for managing projects, recognize the need for technological change and communicate with the society effectively.
4. Design and develop solutions to environmental and biochemical industrial problems

### 4. PEOs/ POs Mapping:

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

**MAPPING – UG- Biotechnology & Biochemical Engineering**

Year	Semester	Course Title	PO												PSO				
			PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
YEAR I	SEMESTER 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												
			2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-		
		English Laboratory	3	3	3	3	1	3	3	3	3	3	3	3	3	-	-	-	
Professional English - II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	3	-	-	-			
SEMESTER II	Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-			
	Engineering Graphics	3	1	2		2					3		2	2	2				
	Materials Science for Biotechnologists																		
	Basic Electrical, Electronics and Instrumentation Engineering	2	1	1					1					-	-	-			
	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology																		
	Engineering Practices Laboratory	3	2			1	1	1					2	2	1	1			
	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	1.6	1.4	0.8	1.6					1.2	1.6								
	Communication Laboratory / Foreign Language	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-			

Year	Semester	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PS O4	
YEAR II	SEMESTER III	Transforms and Partial Differential Equations	3	3	1	1	0	0	0	0	2	0	0	3	-	-	-			
		Cell Biology	3	2	3	2	2	2	2	2	2	3	3	2	2	3	3	2	1	
		Fluid Mechanics For Chemical Engineers	3	3	3	3	3	3	3	2	3	2	1	1	2	3	3	3		
		Chemical Process Calculations	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
		Microbiology	3	3	3	3	3	2	3	2	2	2	2	2	2	3	2	3	2	
		Biochemistry Laboratory	2	3	2	2	2	1	2	3	1	1	2	2	2	2	2	2	1	
		Cell Biology and Microbiology Laboratory	3	3	3	3	3	2	1	1	3	2	3	3	3	3	3	3	2	
		Professional Development																		
SEMESTER IV	Probability and Statistics	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-				
	Basic Industrial Biotechnology	3	2	3	2	2	2	2	2	3	3	2	2	3	3	2	1			
	Environmental Science and Engineering	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-				
	Chemical Engineering Laboratory-1 (Fluid Mechanics & Heat Transfer)	2		2	2	2		2	3			2	2	2	2	2				
	Bioprocess Principles	3	3	3	2	2	3	3	3	2	2	3	3	3	3	3	3	3		
	Immunology	3	2	3	2	3	2	3	2	3	1	2	2	2	2	3	3	2		
	Immunology Laboratory	3	3	3	3	3	2	1	1	2	3	3	3	3	3	3	2	3		
SEMESTER VI	COURSE TITLE		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PS O4	
	Bioprocess Engineering		3	3	3	3	2	1	3	-	3	1	3	3	3	3	3	3	2	

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



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**NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES**  
**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**  
**B. TECH. BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING**  
**CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII**

**SEMESTER I**

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
<b>THEORY</b>								
2.	HS3152	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
<b>PRACTICALS</b>								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory §	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>16</b>	<b>1</b>	<b>10</b>	<b>27</b>	<b>22</b>

§ Skill Based Course

**SEMESTER II**

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	HS3252	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3252	Materials Science for Biotechnologists	PCC	3	0	0	3	3
4.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
7.		NCC Credit Course Level 1 <sup>#</sup>	-	2	0	0	2	2
<b>PRACTICALS</b>								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language §	EEC	0	0	4	4	2
<b>TOTAL</b>				<b>17</b>	<b>1</b>	<b>16</b>	<b>31</b>	<b>23</b>

<sup>#</sup> NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

§ 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.	BT3392	Biochemistry	PCC	3	0	0	3	3
3.	BT3351	Cell Biology	PCC	3	0	0	3	3
4.	BT3352	Microbiology	PCC	3	0	0	3	3
5.	CH3352	Fluid Mechanics for Chemical Engineers	PCC	3	0	0	3	3
6.	BT3491	Chemical Process Calculations in Biotechnology	PCC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	BT3361	Biochemistry Laboratory	PCC	0	0	3	3	1.5
8.	BT3362	Cell and Microbiology Laboratory	PCC	0	0	3	3	1.5
9.	GE3361	Professional Development <sup>§</sup>	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>18</b>	<b>1</b>	<b>8</b>	<b>27</b>	<b>23</b>

§ Skill Based Course

### SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA3391	Probability and Statistics	PCC	3	1	0	4	4
2.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
3.	BI3401	Chemical Thermodynamics and Bio-Thermodynamics	ESC	4	0	0	4	4
4.	BT3451	Analytical Techniques In Biotechnology	PCC	3	0	0	3	3
5.	BT3391	Basic Industrial Biotechnology	PCC	3	0	0	3	3
6.	BT3452	Industrial Enzymology	PCC	3	0	0	3	3
7.		NCC Credit Course Level 2 <sup>#</sup>		3	0	0	3	3 <sup>#</sup>
<b>PRACTICALS</b>								
8.	BI3411	Chemical Engineering Laboratory-1 (Fluid Mechanics & Heat Transfer)	PCC	0	0	3	3	1.5
9.	BT3461	Analytical Instrumentation Laboratory	PCC	0	0	3	3	1.5
10.	BI3511	Industrial Training/Internship I <sup>*</sup>	EEC	-	-	-	-	-
<b>TOTAL</b>				<b>18</b>	<b>1</b>	<b>6</b>	<b>25</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.

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

**SEMESTER V**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	BT3551	Bioprocess Principles	PCC	3	0	0	3	3
2.	BT3552	Immunology	PCC	3	0	0	3	3
3.	BI3501	Heat and Mass Transfer	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
7.		Mandatory Course- I <sup>&amp;</sup>	MC	3	0	0	3	0
<b>PRACTICALS</b>								
8.	BT3561	Immunology Laboratory	PCC	0	0	3	3	1.5
9.	BI3511	Industrial Training/Internship I <sup>*</sup>	EEC	0	0	0	0	2
<b>TOTAL</b>				<b>21</b>	<b>0</b>	<b>3</b>	<b>24</b>	<b>21.5</b>

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

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

**SEMESTER VI**

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	BI3601	Chemical Reaction Engineering	PCC	3	0	0	3	3
2.	BT3651	Bioprocess Engineering	PCC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Professional Elective VI	PEC	3	0	0	3	3
6.		Open Elective – I <sup>*</sup>	OEC	3	0	0	3	3
7.		Mandatory Course-II <sup>&amp;</sup>	MC	3	0	0	3	0
8.		NCC Credit Course Level 3 <sup>#</sup>		3	0	0	3	3 #
<b>PRACTICALS</b>								
9.	BI3611	Chemical Engineering Lab-2 (Mass Transfer & Chemical Reaction Engineering)	PCC	0	0	3	3	1.5
10.	BT3661	Bioprocess Laboratory	PCC	0	0	3	3	1.5
11.	BI3711	Industrial Training/Internship II <sup>##</sup>	EEC	-	-	-	-	-
<b>TOTAL</b>				<b>21</b>	<b>0</b>	<b>6</b>	<b>27</b>	<b>21</b>

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

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

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

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

**SEMESTER VII/VIII\***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	BT3751	Downstream Processing	PCC	3	0	0	3	3
2.	GE3791	Human values and Ethics	HSMC	2	0	0	2	2
3.		Management Elective <sup>#</sup>	HSMC	3	0	0	3	3
4.		Open Elective – II <sup>**</sup>	OEC	3	0	0	3	3
5.		Open Elective – III <sup>***</sup>	OEC	3	0	0	3	3
6.		Open Elective – IV <sup>***</sup>	OEC	3	0	0	3	3
<b>PRACTICALS</b>								
7.	BT3761	Downstream Laboratory	PCC	0	0	3	3	1.5
8.	BI3711	Industrial Training/Internship II <sup>##</sup>	EEC	0	0	0	0	2
<b>TOTAL</b>				<b>17</b>	<b>0</b>	<b>3</b>	<b>20</b>	<b>20.5</b>

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

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

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

# Elective- Management shall be chosen from the Elective Management courses

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

**SEMESTER VIII/VII\***

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>PRACTICALS</b>								
1.	BI3811	Project Work / Internship <sup>#</sup>	EEC	0	0	20	20	10
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>20</b>	<b>20</b>	<b>10</b>

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

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

**TOTAL CREDITS: 163**

**ELECTIVE – MANAGEMENT COURSES**

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



**MANDATORY COURSES I**

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

**MANDATORY COURSES II**

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



**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

<b>Vertical I Bioprocess &amp; Biochemical Engineering</b>	<b>Vertical II Biosciences</b>	<b>Vertical III Medical Biotechnology</b>	<b>Vertical IV Computational Biotechnology</b>	<b>Vertical V Quality and Regulatory Affairs</b>	<b>Vertical VI Food &amp; Agriculture Engineering</b>	<b>Vertical VII Plant &amp; Animal Tissue culture</b>	<b>Vertical VIII Environmental Engineering</b>
Bioreactor engineering	Human anatomy, physiology	Molecular medicine and diagnostics	Clinical data management	Cancer management technology	Agricultural biotechnology	Plant tissue culture	Environmental Pollution Control Engineering
Sustainable bioprocess development	Pathology & microbiology	Cancer biology	Big data analysis	Clinical trials, bioethics	Algae biotechnology	Animal Biotechnology and Cell Culture	Medical waste treatment
Pilot plant, scale up practices	Molecular forensics	Pharmaceutical biotechnology	Genomics , proteomics	Regulation affairs in Biotechnology	Engineering properties of food materials	Advances in Animal Biotechnology,tissue culture	Role of Biotechnology in Environment
Process dynamics and control	Metabolic engineering	Drug design and discovery	Computational biology	Intellectual property rights in Biotechnology	Storage engineering	Crop improvement	Occupational Safety Management
Bioprocess modelling and simulations	Nanobiotechnology	Tissue engineering	Bioinformatics and basics of R programming	Entrepreneurship & Management	Green Tech in Food processing	Agrochemicals	Industrial Safety & Hazard Analysis
MATLAB programme	Stem cell therapeutics	Vaccine technology	Computer aided drug design	Bioethics and Biosafety	Biomass, Bioenergy	Advances in processing of Horticulture,species,planation products	Industrial Effluent Treatment

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

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

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

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL I: BIOPROCESS & BIOCHEMICAL ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3001	Bioreactor Engineering	PEC	3	0	0	3	3
2.	BI3002	Sustainable Bioprocess Development	PEC	3	0	0	3	3
3.	BI3003	Pilot Plant, Scale Up practices	PEC	3	0	0	3	3
4.	CH3651	Process dynamics and control	PEC	3	0	0	3	3
5.	CBT331	Bioprocess Modelling and Simulation	PEC	3	0	0	3	3
6.	BI3004	MATLAB programming	PEC	3	0	0	3	3

### VERTICAL II: BIOSCIENCES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PY3391	Human Anatomy and Physiology	PEC	3	0	0	3	3
2.	BI3005	Pathology and Microbiology	PEC	3	0	0	3	3
3.	BI3006	Molecular Forensics	PEC	3	0	0	3	3
4.	BI3007	Metabolic Engineering	PEC	3	0	0	3	3
5.	BI3008	Nanobiotechnolgy	PEC	3	0	0	3	3
6.	BI3009	Stem Cell Therapeutics	PEC	3	0	0	3	3

### VERTICAL III: MEDICAL BIOTECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3010	Molecular Medicine and Diagnostics	PEC	3	0	0	3	3
2.	CBT372	Cancer Biology	PEC	3	0	0	3	3
3.	BI3011	Pharmaceutical Biotechnology	PEC	3	0	0	3	3
4.	BI3012	Drug Design and Discovery	PEC	3	0	0	3	3
5.	CBT333	Tissue Engineering	PEC	3	0	0	3	3
6.	BI3013	Vaccine Technology	PEC	3	0	0	3	3

**VERTICAL IV: COMPUTATIONAL BIOTECHNOLOGY**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3014	Clinical Data Management	PEC	3	0	0	3	3
2.	BI3015	Big Data Analysis	PEC	3	0	0	3	3
3.	BI3016	Genomics and Proteomics	PEC	3	0	0	3	3
4.	BI3017	Computational Biology	PEC	3	0	0	3	3
5.	BI3018	Bioinformatics and Basics of R - Programming	PEC	3	0	0	3	3
6.	CPY331	Computer Aided Drug Design	PEC	3	0	0	3	3

**VERTICAL V: QUALITY AND REGULATORY AFFAIRS**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3019	Cancer Management Technology	PEC	3	0	0	3	3
2.	BI3020	Clinical Trials, Bioethics	PEC	3	0	0	3	3
3.	BI3021	Regulation Affairs in Biotechnology	PEC	3	0	0	3	3
4.	CBT332	Intellectual Property Rights in Biotechnology	PEC	3	0	0	3	3
5.	BI3023	Entrepreneurship and Management	PEC	3	0	0	3	3
6.	BI3024	Bioethics and Biosafety	PEC	3	0	0	3	3

**VERTICAL VI: FOOD & AGRICULTURE ENGINEERING**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3025	Agricultural Biotechnology	PEC	3	0	0	3	3
2.	BI3026	Algae Biotechnology	PEC	3	0	0	3	3
3.	BI3027	Engineering Properties of Food Materials	PEC	3	0	0	3	3
4.	BI3028	Storage Engineering	PEC	3	0	0	3	3
5.	BI3029	Green Technology in Food Processing	PEC	3	0	0	3	3
6.	BI3030	Biomass and Bioenergy	PEC	3	0	0	3	3

**VERTICAL VII: PLANT & ANIMAL TISSUE CULTURE**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3031	Plant Tissue Culture	PEC	3	0	0	3	3
2.	BI3032	Animal Biotechnology and Cell Culture	PEC	3	0	0	3	3
3.	BI3033	Advances in Animal Biotechnology and Tissue Culture	PEC	3	0	0	3	3
4.	BI3034	Crop Improvement	PEC	3	0	0	3	3
5.	BI3035	Agrochemicals	PEC	3	0	0	3	3
6.	BI3036	Advances in processing of Horticulture, Species and Plantation Products	PEC	3	0	0	3	3

**VERTICAL VIII: ENVIRONMENTAL ENGINEERING**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BI3037	Environmental Pollution Control Engineering	PEC	3	0	0	3	3
2.	BI3038	Medical Waste Treatment	PEC	3	0	0	3	3
3.	BI3039	Role of Biotechnology in Environment	PEC	3	0	0	3	3
4.	BI3040	Occupational Safety Management	PEC	3	0	0	3	3
5.	BI3041	Industrial Safety and Hazard Analysis	PEC	3	0	0	3	3
6.	BI3022	Industrial Effluent Treatment	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

### 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 (E OMA355 MERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

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

#### OPEN ELECTIVES - III

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

15.	OMR351	Mechatronics	OEC	3	0	0	3	3
16.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
17.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
18.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
19.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
20.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
21.	OEE352	Electric Vehicle Technology	OEC	3	0	0	3	3
22.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
23.	OCH351	Nano Technology	OEC	3	0	0	3	3
24.	OCH352	Functional Materials	OEC	3	0	0	3	3
25.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
26.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
27.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
28.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
29.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
30.	CPE334	Energy Conservation and Management	OEC	3	0	0	3	3
31.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
32.	OEC351	Signals and Systems	OEC	3	0	0	3	3
33.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
34.	CBM348	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
35.	CBM333	Assistive Technology	OEC	3	0	0	3	3
36.	OMA352	Operations Research	OEC	3	0	0	3	3
37.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
38.	OMA354	Linear Algebra	OEC	3	0	0	3	3

**OPEN ELECTIVES – IV**

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	CME343	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	AU3002	Batteries and Management System	OEC	3	0	0	3	3
14.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OIE353	Operations Management	OEC	3	0	0	3	3
19.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
20.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
21.	OML352	Electrical, Electronic and Magnetic Materials	OEC	3	0	0	3	3
22.	OML353	Nanomaterials and Applications	OEC	3	0	0	3	3
23.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
24.	OMR353	Sensors	OEC	3	0	0	3	3



25.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
26.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
27.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
28.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
29.	CRA332	Drone Technologies	OEC	3	0	0	3	3
30.	OGI352	Geographical Information System	OEC	3	0	0	3	3
31.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
32.	OEE353	Introduction to Control 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.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
36.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
37.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
38.	FT3201	Fibre Science	OEC	3	0	0	3	3
39.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
40.	OPE353	Industrial Safety	OEC	3	0	0	3	3
41.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
42.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
43.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
44.	OEC353	VLSI Design	OEC	3	0	0	3	3
45.	CBM370	Wearable Devices	OEC	3	0	0	3	3
46.	CBM356	Medical Informatics	OEC	3	0	0	3	3

## SUMMARY

NAME OF THE PROGRAMME										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		12
2	BSC	12	4	4	2					22
3	ESC	5	9		3					17
4	PCC		8	18	16	10.5	9	4.5		66
5	PEC					9	9			18
6	OEC						3	9		12
7	EEC	1	2	1		2		2	10	18
8	Non-Credit /(Mandatory)					√	√			
<b>Total</b>		<b>22</b>	<b>26</b>	<b>23</b>	<b>21</b>	<b>21.5</b>	<b>21</b>	<b>20.5</b>	<b>10</b>	<b>165</b>



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

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

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

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

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

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

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

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

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

SL · N O.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

**VERTICAL 2: ENTREPRENEURSHIP**

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

**VERTICAL 3: PUBLIC ADMINISTRATION**

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

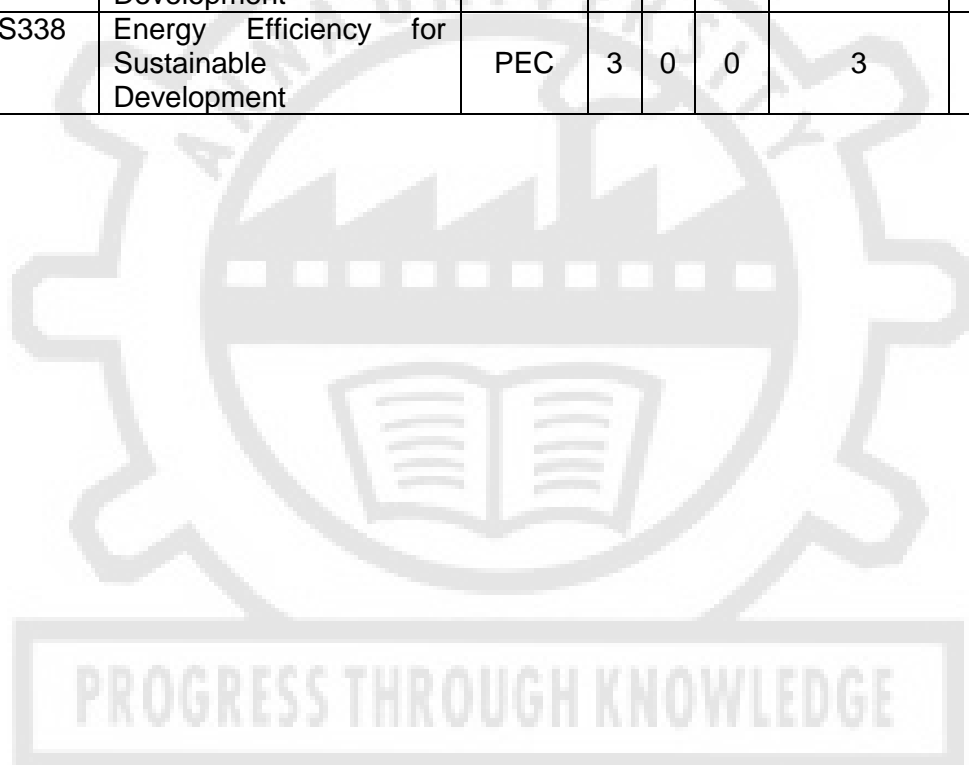
**VERTICAL 4: BUSINESS DATA ANALYTICS**

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

PROGRESS THROUGH KNOWLEDGE

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

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



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

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

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

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

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

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

(i) Physical Activity

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

(ii) Creative Arts

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

(iii) Universal Human Values

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

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

(iv) Literary Activity

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

(v) Proficiency Modules

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

(vi) Lectures by Eminent People

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

(vii) Visits to Local Area

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

(viii) Familiarization to Dept./Branch & Innovations

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

(ix) Department Specific Activities

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

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

**REFERENCES:**

Guide to Induction program from AICTE

**HS3152**

**PROFESSIONAL ENGLISH I**

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

**OBJECTIVES:**

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

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION**

**1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication?



What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

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

**UNIT II NARRATION AND SUMMATION 9**

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

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

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

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

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

**UNIT V EXPRESSION 9**

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

**TOTAL : 45 PERIODS**

**LEARNING OUTCOMES :**

At the end of the course, learners will be able

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

**TEXT BOOKS :**

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

**REFERENCE BOOKS:**

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.

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

### ASSESSMENT PATTERN

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

### CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
<b>Avg.</b>	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

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

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

**MA3151**

**MATRICES AND CALCULUS**

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

### COURSE OBJECTIVES :

To develop the use of matrix algebra techniques that is needed by engineers for practical applications.

- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

### UNIT I MATRICES

**9+3**

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

### UNIT II DIFFERENTIAL CALCULUS

**9+3**

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

### UNIT III FUNCTIONS OF SEVERAL VARIABLES

**9+3**

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

### UNIT IV INTEGRAL CALCULUS

**9+3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial

fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

### UNIT V MULTIPLE INTEGRALS

9+3

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

**TOTAL: 60 PERIODS**

#### COURSE OUTCOMES:

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

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

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

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

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

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

#### TEXT BOOKS :

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

#### REFERENCES :

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

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

**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.<sup>[SEP]</sup>Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO<sub>2</sub> laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS 9**

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

**UNIT V APPLIED QUANTUM MECHANICS 9**

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

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

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

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

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

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

CY3151

ENGINEERING CHEMISTRY

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

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

**UNIT I WATER AND ITS TREATMENT**

9

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

## **UNIT II NANO CHEMISTRY 9**

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

## **UNIT III PHASE RULE AND COMPOSITES 9**

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

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

## **UNIT IV FUELS AND COMBUSTION 9**

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

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

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

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

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

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

- CO1 :To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- CO2 :To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- CO3 :To apply the knowledge of phase rule and composites for material selection requirements.
- CO4 :To recommend suitable fuels for engineering processes and applications.
- CO5 :To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

### **TEXT BOOKS:**

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17<sup>th</sup> Edition, 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

GE3151

**PROBLEM SOLVING AND PYTHON PROGRAMMING**

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

### OBJECTIVES:

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

### UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING

9

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

### UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS

9

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

### UNIT III CONTROL FLOW, FUNCTIONS, STRINGS

9

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

**UNIT IV LISTS, TUPLES, DICTIONARIES****9**

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

**UNIT V FILES, MODULES, PACKAGES****9**

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

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

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

CO1: Develop algorithmic solutions to simple computational problems.

CO2: Develop and execute simple Python programs.

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

CO4: Decompose a Python program into functions.

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

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

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

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



**அலகு I மொழி மற்றும் இலக்கியம்****3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை:****3**

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

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்****3**

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

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்****3**

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

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு****3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிக்கள் - தமிழ்ப் புத்தகங்களின் 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. பொருளை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**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. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

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

**OBJECTIVES:**

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

**EXPERIMENTS:**

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

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

**TOTAL: 60 PERIODS**

**OUTCOMES:**

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

CO1: Develop algorithmic solutions to simple computational problems

CO2: Develop and execute simple Python programs.

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

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

**TEXT BOOKS:**

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

**REFERENCES:**

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

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

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

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

BS3171

PHYSICS AND CHEMISTRY LABORATORY

L T P C  
0 0 4 2

**PHYSICS LABORATORY : (Any Seven Experiments)****COURSE OBJECTIVES:**

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

### LIST OF EXPERIMENTS

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

**TOTAL: 30 PERIODS**

### **COURSE OUTCOMES:**

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

CO1 :Understand the functioning of various physics laboratory equipment.

CO2 :Use graphical models to analyze laboratory data.

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

CO4 :Access, process and analyze scientific information.

CO5 :Solve problems individually and collaboratively.

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

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

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

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

### CHEMISTRY LABORATORY: (Any seven experiments)

#### **OBJECTIVES:**

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

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

1. Preparation of  $\text{Na}_2\text{CO}_3$  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 (TiO<sub>2</sub>/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

**OUT COMES :**

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

**TEXT BOOK:**

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

**CO-PO & PSO MAPPING**

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

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

GE3172

ENGLISH LABORATORY

L T P C  
0 0 2 1

**OBJECTIVES :**

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

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION**

**6**

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

**UNIT II NARRATION AND SUMMATION**

**6**

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

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

**6**

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

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS**

**6**

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

**UNIT V EXPRESSION**

**6**

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

**TOTAL : 30 PERIODS**

**LEARNING OUTCOMES:**

At the end of the course, learners will be able

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

**ASSESSMENT PATTERN**

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

**CO-PO & PSO MAPPING**

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

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

**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 Jovani, Department of English, Anna University.

**REFERENCE BOOKS:**

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003



4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

### ASSESSMENT PATTERN

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

### CO-PO & PSO MAPPING

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

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

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

**MA3251**

**STATISTICS AND NUMERICAL METHODS**

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

### OBJECTIVES:

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

### UNIT I TESTING OF HYPOTHESIS

**9+3**

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

### UNIT II DESIGN OF EXPERIMENTS

**9+3**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design -  $2^2$  factorial design.

### UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

**9+3**

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

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**

**9+3**

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

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**

**9+3**

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

**TOTAL: 60 PERIODS**

**OUTCOMES:**

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

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.

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

**OBJECTIVES:**

- To make the students effectively to understand the basics of crystallography and crystal imperfections.
- To enable the students to get knowledge on various strengthening methods of materials, and also various mechanical properties and their measurement.
- To impart knowledge on the basics of phase diagrams and their applications.
- To learn about iron-carbon system, and about various ferrous and non-ferrous alloys.
- To introduce different types of biomaterials and their applications.

**UNIT I CRYSTALLOGRAPHY****9**

Crystallographic directions and planes – metallic crystal structures: BCC, FCC and HCP – linear and planar densities – crystal imperfections- edge and screw dislocations, Burgers vector and elastic strain energy- surface imperfections – grain and twin boundaries – Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation.

**UNIT II MECHANICAL PROPERTIES****9**

Tensile test - plastic deformation by slip – slip systems – mechanisms of strengthening in metals: strain hardening, grain size reduction, solid solution strengthening, precipitation hardening – Creep: creep curves, stress and temperature effects, mechanisms of creep, creep-resistant materials – Fracture: ductile and brittle fractures - the Griffith criterion – fracture toughness - Fatigue failure: the S-N curve – factors that affect fatigue life – Hardness: Rockwell and Brinell hardness tests, Knoop and Vickers microhardness tests.

**UNIT III PHASE DIAGRAMS****9**

Basic concepts - Gibbs phase rule –Unary phase diagram (iron) - Binary phase diagrams: isomorphous systems (Cu-Ni) –determination of phase composition and phase amounts – tie-line and lever rule - binary eutectic diagram with no solid solution and limited solid solution (Pb-Sn) – eutectoid and peritectic reactions - other invariant reactions – microstructural development during the slow cooling: eutectic, hypereutectic and hypoeutectic compositions.

**UNIT IV FERROUS AND NONFERROUS ALLOYS****9**

The Fe-Fe<sub>3</sub>C phase diagram: phases, invariant reactions, development of microstructure in eutectoid, hypoeutectoid and hypereutectoid alloys – influence of other alloying elements in the Fe-C system - phase transformations – isothermal transformation diagram for eutectoid iron-carbon alloy – microstructures: pearlite, bainite, spheroidite and martensite – steels, stainless steels and cast irons – copper alloys – aluminum alloys – titanium alloys.

**UNIT V MATERIALS FOR BIOLOGICAL APPLICATIONS****9**

Biocompatibility – host response – materials response – Metallic implants: Titanium and its alloys, stainless steel – Cobalt-Chromium alloys – Tantalum – Nitinol – magnesium based biodegradable alloys. Bioceramics: Alumina, Zirconia, hydroxyapatite, tricalcium phosphate, bioactive glasses, pyrolytic carbon, graphite, graphene. Polymeric implant materials: Polyethylene, polypropylene, polyacrylates – soft and hard tissue replacement materials.

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

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

- understand the basics of crystallography and its importance in materials properties
- understand the significance of dislocations, strengthening mechanisms, and tensile, creep, hardness and fracture behavior of materials
- gain knowledge on binary phase diagrams, and also will be able to determine the phase composition and phase amount.
- understand about the Fe-C system and various microstructures in it, and also about various ferrous and non-ferrous alloys.

- get adequate understanding on metallic, ceramic and polymeric biomaterials and their applications.

#### TEXT BOOKS:

1. R.Balasubramaniam, Callister's Materials Science and Engineering.Wiley (Indian Edition), 2014.
2. V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
3. Joon Park and R.S.Lakes, Biomaterials: An Introduction, Springer, 2007.

#### REFERENCES :

1. J.F.Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. J.C. Anderson, K.D. Leaver, P. Leever and R.D. Rawlings, Materials Science for Engineers, CRC Press, 2003.
4. Jean P.Mercier, G.Zambelli and W.Kurz, Introduction to Materials Science, Elsevier, 2002.
5. Sujata V.Bhat, Biomaterials, Narosa Publishers, 2002

<b>BE3252</b>	<b>BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING</b>	<b>L T P C 3 0 0 3</b>
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#### OBJECTIVES:

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

<b>UNIT I</b>	<b>ELECTRICAL CIRCUITS</b>	<b>9</b>
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DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

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

<b>UNIT II</b>	<b>MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS</b>	<b>9</b>
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Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.

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

<b>UNIT III</b>	<b>ELECTRICAL MACHINES</b>	<b>9</b>
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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.

<b>UNIT IV</b>	<b>ANALOG ELECTRONICS</b>	<b>9</b>
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Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction

Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

**UNIT V SENSORS AND TRANSDUCERS**

**9**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completing this course, the students will be able to

- CO1:** Compute the electric circuit parameters for simple problems
- CO2:** Explain the concepts of domestic wiring and protective devices
- CO3:** Explain the working principle and applications of electrical machines
- CO4:** Analyze the characteristics of analog electronic devices
- CO5:** Explain the types and operating principles of sensors and transducers

**TEXT BOOKS:**

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

**REFERENCES:**

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

**CO’s, PO’s & PSO’s MAPPING**

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

**GE3251**

**ENGINEERING GRAPHICS**

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

**COURSE OBJECTIVES:**

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

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**

### **OUTCOMES:**

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

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

### **TEXT BOOKS:**

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53<sup>rd</sup> Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.

3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

**REFERENCES:**

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

**Publication of Bureau of Indian Standards:**

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

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

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

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

PROGRESS THROUGH KNOWLEDGE

**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 Thooppu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING**

**3**

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

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**NCC Credit Course Level 1\***

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

**NCC Credit Course Level 1\***

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

1

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

<b>NCC Credit Course Level 1*</b>					
<b>NX3253</b>	<b>(AIR FORCE WING) NCC Credit Course Level - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

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

**COURSE OBJECTIVES:**

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

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

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

**WOOD WORK:**

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

## Wood Work Study:

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

**PART II ELECTRICAL ENGINEERING PRACTICES****15**

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

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

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

**BASIC MACHINING WORK:**

- (simple)Turning.

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

**ASSEMBLY WORK:**

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

**SHEET METAL WORK:**

- a) Making of a square tray

**FOUNDRY WORK:**

- a) Demonstrating basic foundry operations.

**PART IV ELECTRONIC ENGINEERING PRACTICES**

15

**SOLDERING WORK:**

- a) Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

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

**ELECTRONIC EQUIPMENT STUDY:**

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

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

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

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

**COURSE OBJECTIVES:**

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

**List of Experiments**

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

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

After completing this course, the students will be able to

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

**CO2:** Analyze experimentally the load characteristics of electrical machines

**CO3:** Analyze the characteristics of basic electronic devices

**CO4:** Use LVDT to measure displacement

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

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

PROGRESS THROUGH KNOWLEDGE

**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>	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

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

**OBJECTIVES**

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

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

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

**UNIT II FOURIER SERIES 9+3**

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

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

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

**UNIT IV FOURIER TRANSFORMS 9+3**

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

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

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

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

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

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

**TEXT BOOKS:**

1. Grewal B.S., "Higher Engineering Mathematics", 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.

	PO 01	PO 02	PO 03	PO '04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	1	1	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	-	-	-

**BT3392****BIOCHEMISTRY****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To enable students learn the fundamentals of Biochemical Processes and Biomolecules

**UNIT I INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES: 9**

Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, bio molecules structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate

**UNIT II STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES 9**

Structure and properties of Important Biomolecules.

**Lipids:** fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins.

**Protein:** Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.

**Nucleic acids:** purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes

**UNIT III METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM 9**

Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxalate shunt.

**UNIT IV INTERMEDIARY METABOLISM AND REGULATION 9**

Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

**UNIT V PROTEIN TRANSPORT AND DEGRADATION****9**

Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

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

- To ensure students have a strong foundation in the structure and reactions of Biomolecules.
- To introduce them to metabolic pathways of the major biomolecules and relevance to clinical conditions.
- To correlate Biochemical processes with Biotechnology applications.

**TEXT BOOKS**

1. Lehninger Principles of Biochemistry 6<sup>th</sup> Edition by David L. Nelson, Michael M. Cox
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3<sup>rd</sup> Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., et al., "Outlines of Biochemistry" 5<sup>th</sup> 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", 6<sup>th</sup> Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al "Harper's Illustrated Biochemistry", 27<sup>th</sup> Edition, McGraw-Hill, 2006.
3. Voet, D. and Voet, J.G., "Biochemistry", 3<sup>rd</sup> Edition, John Wiley & Sons Inc., 2004.

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	2	2	3	2	2	2	3	3	3	3	3	2
CO 2	2	2	3	2	2	2	2	2	-	3	2	3	2	2	2	1
CO 3	3	3	3	2	3	-	2	1	-	2	1	1	3	3	2	1
CO 4	2	3	3	3	2	-	3	-	1	2	1	1	3	3	2	2
CO 5	2	3	3	2	3	2	3	2	2	1	2	2	2	2	3	3
CO6	2	3	3	2	2	3	1	3	2	1	3	3	3	3	2	3

**BT3351****CELL BIOLOGY****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To provide knowledge on the fundamentals of cell biology
- To help students understand the signalling mechanisms

**UNIT I CELL STRUCTURE AND FUNCTION OF THE ORGANELLES****9**

Prokaryotic, Eukaryotic cells, Sub-cellular organelles and functions. Principles of membrane organization membrane proteins, cytoskeletal proteins. Extra cellular matrix, cell-cell junctions.

**UNIT II CELL DIVISION, CANCER, APOPTOSIS AND IMMORTALIZATION OF CELLS 9**

Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, cancer, role of Ras and Raf in oncogenesis and apoptosis. Stem cells, Cell culture and immortalization of cells and its applications.

**UNIT III TRANSPORT ACROSS CELL MEMBRANE 9**

Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na<sup>+</sup> / K<sup>+</sup> /Ca<sup>2+</sup>pumps, uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.

**UNIT IV SIGNAL TRANSDUCTION 9**

Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors antocrine / paracrine / endocrine models, Secondary messengers molecules.

**UNIT V TECHNIQUES USED TO STUDY CELLS 9**

Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

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

Upon completion of this course, the students

- Would have deeper understanding of cell at structural and functional level.
- Would have broad knowledge on the molecular interaction between cells.
- Would demonstrate a clear understanding of the signal transduction, secondary messengers.
- Would develop skill on working principles of microscopy and identification of cell types.

**TEXT BOOKS:**

1. Lodish, Harvey et al., "Molecular Cell Biology", 7<sup>th</sup> Edition, W.H. Freeman, 2005.
2. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", VII<sup>th</sup> Edition, ASM Press, 2007.
3. Alberts, Bruce et al., "Molecular Biology of the Cell", IV<sup>th</sup> Edition, Garland Science (Taylors Francis), 2002.
4. Sadava, D.E. "Cell Biology: Organelle Structure and Function", Panima Publishing, 2004.
5. Rastogi, S.C. "Cell Biology" II<sup>nd</sup> Edition, New Age International, 2002.

**REFERENCES:**

1. Becker, W.M. et al., "The World of the Cell", 9<sup>th</sup> Edition, Pearson Education, 2003.
2. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", VII<sup>th</sup> Edition, Pearson International, 2007.
3. Alberts, Bruce et al., "Essential Cell Biology", IV<sup>th</sup> Edition, Garland Press (Taylor & Francis), 2004.

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
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CO 1	3	-	-	3	3	2	2	-	3	-	-	1	3	3	3	1
CO 2	3	2	3	2	3	-	1	1	3	-	2	3	3	-	-	1
CO 3	2	3	3	2	1	-	2	-	2	-	1	1	2	3	-	-
CO 4	2	1	3	2	3	1	-	1	-	-	-	3	3	2	-	-
CO 5	3	3	2	1	-	-	-	2	2	-	2	2	3	2	2	2
CO6	2	1	2	-	2	-	2	2	3	-	-	-	2	-	1	1
	3	2	3	2	2	2	2	2	3	3	2	2	3	3	2	1

**COURSE OBJECTIVES**

- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.

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

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

**UNIT II MICROBES- STRUCTURE AND MULTIPLICATION****9**

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

**UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM****9**

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

**UNIT IV CONTROL OF MICROORGANISMS****9**

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

**UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY****9**

Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

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

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

CO1: Microorganisms and examination of microorganisms

CO2: Structural organization of microorganisms

CO3: Nutritional requirements of microorganisms, their growth and metabolism

CO4: Control of microorganisms

CO5: Metabolites, bioremediation, biofertilizers, biopesticides and biosensors

**TEXT BOOKS**

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India, 2009
2. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**REFERENCE BOOKS**

1. Black, Text book of microbiology. Freeman Publishers, 2016
2. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
3. Ananthanarayan, CK Jayaram Panikars. Text book of Microbiology, 2005, Orient Blackswan Publishers.

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
Cos	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2
CO 2	3	3	2	3	2	2	3	2	2	3	2	2	3	3	2	2
CO 3	2	3	2	3	3	2	3	2	2	3	2	2	3	2	3	3
CO 4	2	3	3	3	3	2	2	2	2	2	3	3	3	2	3	2
CO 5	2	3	2	3	3	2	2	-	2	-	2	2	3	3	3	2
CO6	3	2	3	3	3	3	3	2	2	-		2	2	2	3	2
	3	3	3	3	3	2	3	2	2	2	2	2	3	2	3	2

CH3352

**FLUID MECHANICS FOR CHEMICAL ENGINEERS**

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

**COURSE OBJECTIVE:**

- To acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries

**UNIT I**

**9**

Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

**UNIT II**

**9**

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.

**UNIT III**

**9**

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

**UNIT IV**

**9**

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

**UNIT V**

**9**

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

- Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.
- Apply Bernoulli principle, Navier - Stokes equation and compute pressure variation in static

fluid.

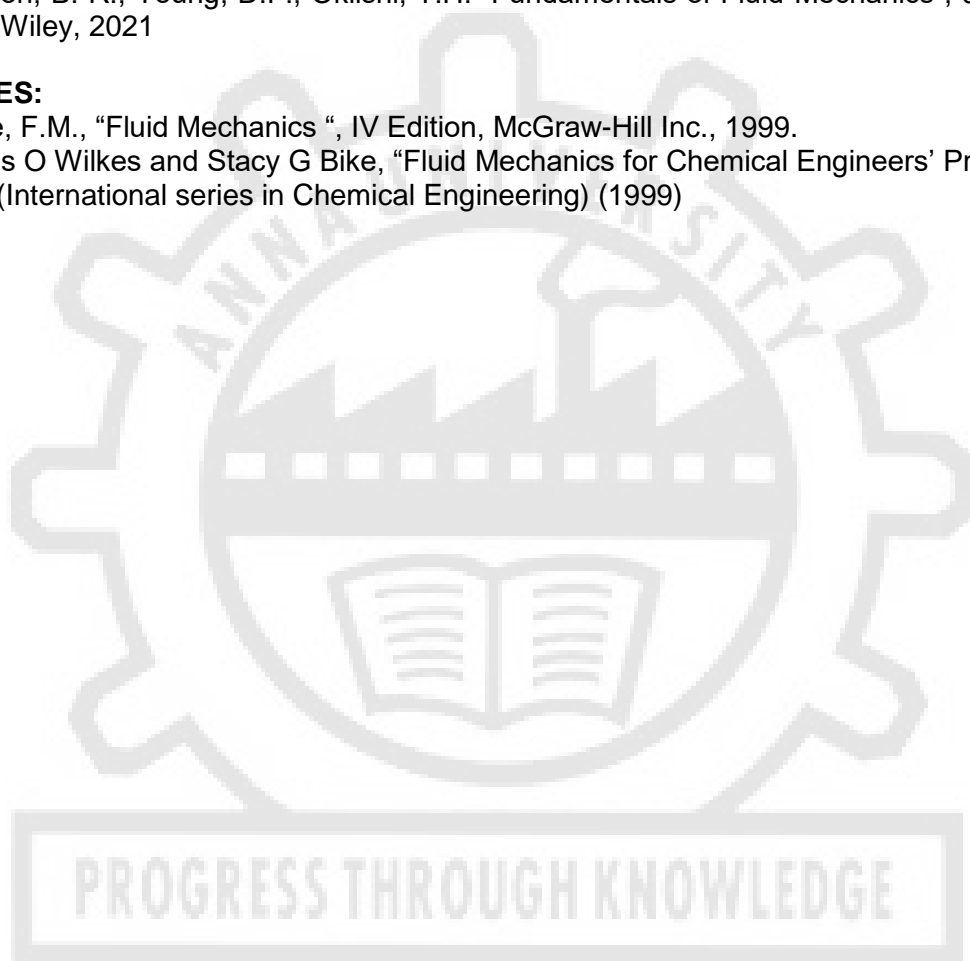
- Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.
- Understand the different types of flow conditions in fixed bed and fluidized beds.
- Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.

**TEXT BOOKS:**

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Third Edition, McGraw-Hill, (2017).
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2017
3. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 9<sup>th</sup> Edition", John Wiley, 2021

**REFERENCES:**

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)



Course articulation matrix:

	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.	3	3	-	-	-	-	-	-	-	1	2	-	3	1	-
<b>CO2</b>	Apply Bernoulli principle, Navier - Stokes equation and compute pressure variation in static fluid.	-	3	-	-	-	-	-	-	-	-	-	-	3	2	-
<b>CO3</b>	Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.	-	3	3	3	2	-	2	-	-	3	1	2	-	-	2
<b>CO4</b>	Understand the different types of flow conditions in fixed bed and fluidized beds.	3	-	3	3	2	-	2	-	-	-	-	3	3	-	-
<b>CO5</b>	Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.	2	3	-	3	-	2	1	1	-	-	-	-	-	2	2
<b>OVERALL CO</b>		<b>3</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>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>

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

**COURSE OBJECTIVE:**

- To enable the students to learn about basic concepts of chemical process and calculations
- The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics.
- This will enable the students to perform calculations pertaining to processes and operations.

**UNIT I BASIC CHEMICAL CALCULATIONS 9**

Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other – composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density.

**UNIT II IDEAL AND ACTUAL GAS EQUATIONS 9**

Ideal and actual gas equations, Vander Walls, compressibility factor equations, Application to pure gas & gas mixtures – partial pressures, partial volumes – Air-water vapour systems, Humidity, Molar Humidity, Relative Humidity, % Saturation, humid Volume – Humidity chart – wet, Dry bulb, Dew point temperatures, pH of solutions, Vapour pressure.

**UNIT III MATERIAL BALANCE 9**

Material balance concept – overall & component – material balance applications for evaporator, gas absorber without reaction, Distillation (Binary system), Liquid extraction, solid-liquid extraction, drying, crystallization, Humidification, Reverse Osmosis separation and Mixing Recycle and Bypass illustration

**UNIT IV ENERGY BALANCE 9**

General energy balance equation for open systems, closed system sensible heat calculation, Heat required for phase change thermo chemistry, application of steam tables, Saturated and superheated steam application in bioprocess

**UNIT V CHEMICAL REACTION 9**

Chemical Reaction-Limiting, excess component, Fractional conversion, Percent conversion, Fractional yield in multiple reactions. Simple problems, Combustion Reactions.

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

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

1. To recite the basics of enzyme and principles of catalysis
2. To understand the enzyme kinetics and various enzyme kinetic models
3. To gain the knowledge to develop the enzyme immobilization and biosensors
4. To analyze and learn enzyme reactions for the production and purification process
5. To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes
6. To apply the skills for the development of processes and products

**TEXT BOOKS:**

1. Bhatt B.I & SB Thakore, Stoichiometry - Fifth edition Tata McGraw Hill 2017
2. K.A.Kavhane, Introduction to Process calculations, Nirali Publishers, 1<sup>st</sup> Edition, 2016
3. Himmelblau D.M "Basic principles & Calculations in Chemical Engineering" 8th edn PHI 2014.

**REFERENCES:**

1. McCabe W.L & J.C.Smith & P.Harriot "Unit operations of chemical Engineering" 7th Edn McGraw Hill 2017
2. S. Pushpavanam, Introduction to Chemical Engineering, PHI Learning Pvt. Ltd., 2012
3. Geankoplis C.J. "Transport process & Separation process Principles 4th edition-PHI 2006.



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Cos	Programme Outcomes (POs)												PSOs			
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CO 1	3	-	1	-	2	1	-	2	1	1	-	-	2	1	-	1
CO 2	3	3	2	3	2	2	2	2	1	-	1	1	3	2	3	2
CO 3	2	1	3	2	2	2	2	3	2	2	2	3	3	3	3	3
CO 4	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3	3
CO 5	3	2	2	2	2	2	3	2	2	2	1	-	2	2	1	1
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

BT3361

BIOCHEMISTRY LABORATORY

L T P C

0 0 3 1.5

#### AIM

- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc..) and laboratory analysis of the same in the body fluids.

#### EXPERIMENTS

- General guidelines for working in biochemistry lab (theory)
- Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.
- Accuracy, precision, sensitivity and specificity (theory)
- Preparation of buffer –titration of a weak acid and a weak base.
- Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
- Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid.
- Protein estimation by Biuret and Lowry's methods.
- Protein estimation by Bradford and spectroscopic methods.
- Extraction of lipids and analysis by TLC.
- Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect (demo).
- Enzymatic assay: phosphatase from potato.
- Enzymatic assay: estimation of glucose by GOD-POD method after hydrolysis of starch with acid and specificity of the enzymatic method.

**TOTAL: 45 PERIODS**

#### TEXT BOOKS

- Practical Biochemistry by R.C. Gupta and S. Bhargavan.
- Introduction of Practical Biochemistry by David T. Phummer. (II Edition)

#### REFERENCES

- Harpers Biochemistry Ed. R.K. Murray , D.K. Granner, P.A. Mayes and V.W.Rodwell, Appleton and Lange ,Stanford ,Conneticut.
- Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
	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 O 2	PSO 3	PSO 4
CO 1	2	2	1	2	3	1	3	2	3	1	2	2	3	3	3	2
CO 2	2	2	3	3	3	3	2	3	2	2	3	1	2	2	1	1
CO 3	3	2	3	1	3	2	2	2	1	2	2	2	3	2	2	3
CO 4	1	3	3	2	2	3	2	1	2	2	1	1	2	1	3	2
CO 5	2	1	3	2	1	1	3	2	1	2	2	2	1	2	2	2
CO6	2	3	2	2	2	1	2	3	1	1	2	2	2	2	2	1

BT3362

CELL AND MICROBIOLOGY LABORATORY

L T P C

0 0 3 1.5

**COURSE OBJECTIVES:**

- To demonstrate various techniques to learn the morphology, identification and propagation of cells and microbes.
- To learn the staining techniques and culturing of microorganism.

**EXPERIMENTS**

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques
2. Microscopy – Working and care of Microscope, phase contrast and fluorescent microscopy
3. Culture Media-Types and Use; Preparation of Nutrient broth and agar
4. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid:Pour plates, streak plates, slants, stabs
5. Identification of given plant, animal, bacterial cells and yeast/mould
6. Staining Techniques Simple, Differential- Gram’s Staining, spore /capsule staining, Giemsa, and Leishman Staining
7. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
8. Effect of Disinfectants- Phenol Coefficient, Antibiotic Sensitivity Assay
9. Osmosis and Tonicity and Tryphan Blue Assay
10. Growth Curve in Bacteria and Yeast
11. Staining for different stages of mitosis in AlliumCepa (Onion)
12. Effect of pH, Temperature, UV radiation on Growth Bacteria

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to

- Understand the advanced technical information pertaining to laboratory bio-safety and preventive measures from pathogenic microorganism.
- Know the various aseptic techniques and sterilization methods.
- Develop the minimum skills to work on several important techniques for the study of microorganisms in the laboratory.
- Learn the various techniques of culturing of microorganisms and media preparation.
- Study the growth of microorganisms by varying the growth conditions.
- Identify the various stages of mitosis

**REFERENCES:**

1. Cappuccino, J.G. and N. Sherman “Microbiology: A Laboratory Manual”, 4<sup>th</sup> Edition, Addison-Wesley, 1999.
1. Collee, J.G. etal., “Mackie & McCartney Practical Medical Microbiology” 4<sup>th</sup> Edition, ChurchillLivingstone, 1996Rickwood, D. and J.R. Harris “Cell Biology: Essential

- Techniques”, Johnwiley, 1996.  
 2. Davis, J.M. “Basic Cell Culture: A Practical Approach”, IRL, 1994.

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COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
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CO 3	2	3	3	3	3	2	1	1	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO6	3	3	3	3	3	2	1	1	3	2	3	3	3	3	3	2

GE3361

**PROFESSIONAL DEVELOPMENT**

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

**OBJECTIVES:**

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

**MS WORD:**

**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.

**MA3391**

**PROBABILITY AND STATISTICS**

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

**COURSE OBJECTIVES**

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

**UNIT I PROBABILITY AND RANDOM VARIABLES**

**9+3**

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

**UNIT II TWO- DIMENSIONAL RANDOM VARIABLES**

**9+3**

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

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

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

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

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

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

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

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

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

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- 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 and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

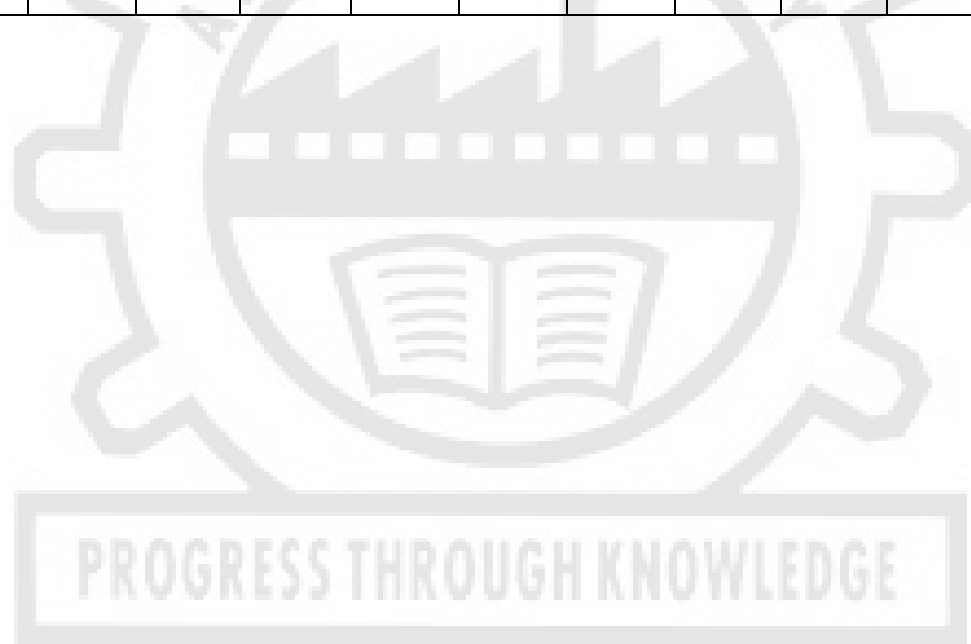
**TEXT BOOKS**

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

**REFERENCES:**

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

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
<b>Over all CO</b>	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-



**OBJECTIVES:**

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

**UNIT I ENVIRONMENT AND BIODIVERSITY 6**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II ENVIRONMENTAL POLLUTION 6**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

**UNIT III RENEWABLE SOURCES OF ENERGY . 6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

**UNIT IV SUSTAINABILITY AND MANAGEMENT 6**

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

**UNIT V SUSTAINABILITY PRACTICES 6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL:30 PERIODS**

**OUTCOMES:**

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

- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

#### TEXT BOOKS:

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

#### REFERENCE BOOKS :

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

#### CO-PO & PSO MAPPING

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

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

**BI3401 CHEMICAL THERMODYNAMICS AND BIO-THERMODYNAMICS**

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

#### COURSE OBJECTIVE:

- To enable the students to learn about basic concepts of classical and statistical thermodynamics

#### UNIT I THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS

First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.



## **UNIT II SOLUTION THERMODYNAMICS**

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

## **UNIT III PHASE EQUILIBRIA**

Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

## **UNIT IV CHEMICAL REACTION EQUILIBRIA**

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

## **UNIT V THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION**

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation

**TOTAL: 60 PERIODS**

### **COURSE OUTCOMES:**

At the end of this course, the student would have the ability

- To explain the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems.
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.

### **TEXT BOOKS:**

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", VI<sup>th</sup> Edition. Tata McGraw-Hill, 2003.
2. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.
3. Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

### **REFERENCE:**

Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989.

**BT3451**

**ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY**

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

### **COURSE OBJECTIVES:**

To enable the students

- To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence, NMR, Mass spectroscopy
- To acquire knowledge on the different chromatographic methods for separation of biological products.

**UNIT I INTRODUCTION TO SPECTROMETRY 9**

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

**UNIT II MOLECULAR SPECTROSCOPY 9**

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications

**UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9**

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of <sup>1</sup>H and <sup>13</sup>C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values –instrumentation.

**UNIT IV SEPARATION METHODS 9**

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

**UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9**

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

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

- On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.

**TEXT BOOKS:**

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch “Instrumental Methods of Analysis”.CengageLearning , 2007.
2. Willard, Hobart, etal., “Instrumental Methods of Analysis”. VII<sup>th</sup> Edition, CBS, 1986.
3. Fifield F.W., . Principles and Practice of Analytical Chemistry. Blackwell, Scientific Publishers,2016

**REFERENCES:**

1. Sharma, B.K. “Instrumental Methods of Chemical Analysis: Analytical Chemistry”, Krishna Prakashan Media (P) Ltd, 2014
2. Haven, Mary C., etal., “Laboratory Instrumentation “. 4<sup>th</sup> Edition, Wiley India Pvt Ltd, 2010
3. Philopose P.M.Analytical Biotechnology. Domihant Publishers & distributors, New Delhi, 2016.

**BT3391 BASIC INDUSTRIAL BIOTECHNOLOGY****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures

- UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 9**  
 Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.
- UNIT II PRODUCTION OF PRIMARY METABOLITES 9**  
 Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.
- UNIT III PRODUCTION OF SECONDARY METABOLITES 9**  
 Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.
- UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9**  
 Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.
- UNIT V PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS 9**  
 Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

- To explain the steps involved in the production of bioproducts and methods to improve modern biotechnology.
- To apply basic biotechnological principles, methods and models to solve biotechnological tasks.
- To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.
- To design and deliver useful modern biotechnology products to the Society..

**TEXT BOOKS:**

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. "A Textbook on Biotechnology" II<sup>nd</sup> Edition. Affiliated East West Press Pvt.Ltd., 1998.
3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" II<sup>nd</sup> Edition Cambridge University Press, 2001.
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd., 2006.

**REFERENCES:**

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.
2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.
3. Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology",II<sup>nd</sup> Edition, Panima Publishing, 2000.
4. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprintof Elsevier) 2004.
5. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", II<sup>nd</sup> Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
6. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
7. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	3	-	-	3	3	2	2	-	3	-	-	1	3	3	3	1
CO 2	3	2	3	2	3	-	1	1	3	-	2	3	3	-	-	1
CO 3	2	3	3	2	1	-	2	-	2	-	1	1	2	3	-	-
CO 4	2	1	3	2	3	1	-	1	-	-	-	3	3	2	-	-
CO 5	3	3	2	1	-	-	-	2	2	-	2	2	3	2	2	2
CO6	2	1	2	-	2	-	2	2	3	-	-	-	2	-	1	1
	3	2	3	2	2	2	2	2	3	3	2	2	3	3	2	1

BT3452

INDUSTRIAL ENZYMOLOGY

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

To enable the students

- To learn enzyme reactions and its characteristics along with the production and purification process
- To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes

**UNIT I INTRODUCTION TO ENZYMES**

9

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

**UNIT II KINETICS OF ENZYME ACTION**

9

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions - mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.

**UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS**

9

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

**UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES**

9

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays

**UNIT V BIOTRANSFORMATION APPLICATIONS OF ENZYMES**

9

Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions –aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger, Enzymes in organic synthesis – esters, amide, peptide , Modified and Artificial Enzymes , Catalytic antibodies

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.
- The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
- The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
- Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.

**TEXT BOOKS:**

1. Trevor Palmer , Enzymes II<sup>nd</sup> Horwood Publishing Ltd
2. Faber K , Biotransformations in Organic Chemistry, IV edition , Springer

**REFERENCES:**

1. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.
2. James M. Lee, Biochemical Engineering, PHI, USA.
3. James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
4. Wiseman, Enzyme Biotechnology, Ellis Horwood Pub.

**BI3411****CHEMICAL ENGINEERING LABORATORY-1  
(FLUID MECHANICS & HEAT TRANSFER)****L T P C  
0 0 3 1.5****COURSE OBJECTIVES:**

- To provide basic understanding of chemical engineering principles and operations

**EXPERIMENTS**

1. Flow measurement - Orifice meter
2. Flow measurement - Venturimeter,
3. Flow measurement - Rotameter
4. Pressure drop in flow through pipes
5. Pressure drop in flow through packed column
6. Pressure drop in flow through fluidized beds
7. Heat transfer in Composite wall
8. Heat transfer characteristics in double pipe heat exchanger
9. Heat transfer characteristics in shell and tube heat exchanger
10. Heat transfer characteristics in plate type heat exchanger
11. Heat transfer by radiation
12. Simple and steam distillation

**COURSE OUTCOMES:**

Upon completion of this practical course the student will

- Have knowledge on the basic principles of chemical engineering
- Be able to apply the skill of material balance and energy balance in unit operations unit process of chemical engineering and biotechnology
- Be able to analyze the principles of chemical engineering and its applications in chemical, mechanical and biological perspectives
- Understand the design and working principles of fluid moving machinery and transport phenomena

**TOTAL: 45 PERIODS**

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	2			2			3	2			2		3			2
CO 2	2		3		3		2	3			3		2	2		
CO 3	2		3		3		2	2			2		3	2	2	
CO 4	2		3		2		2				2	1	2			2
CO 5	2		3		3		3	2			2	2	2	2		
CO6	2		2	2	2		2	3			2	2	2	2	2	

BT3461

**ANALYTICAL INSTRUMENTATION LABORATORY**

**L T P C  
0 0 3 1.5**

**COURSE OBJECTIVES:**

To train the students

- To have a practical hands on experience on Absorption Spectroscopic methods
- To acquire experience in the purification by performing chromatography
- To validate and analysis using spectrometric and microscopic techniques

**EXPERIMENTS**

1. Precision and validity in an experiment using absorption spectroscopy . **60**
2. Validating Lambert-Beer's law using KMnO<sub>4</sub>
3. Finding the molar absorptivity and stoichiometry of the Fe (1,10 phenanthroline)<sub>3</sub> using absorption spectrometry.
4. Finding the pK<sub>a</sub> of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxolate.
7. Estimation of SO<sub>4</sub><sup>2-</sup> by nephelometry.
8. Estimation of Al<sup>3+</sup> by Fluorimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- The students would visualize and interpret the theory of spectroscopic methods by hands on experiments.

**REFERENCES:**

1. Skoog, D.A. etal. "Principles of Instrumental Analysis", V<sup>th</sup> Edition, Thomson / Brooks – Cole, 1998.
2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3. Willard, H.H. etal. "Instrumental Methods of Analysis", VI<sup>th</sup> Edition, CBS, 1986.
4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", V<sup>th</sup> Edition, McGraw-Hill, 1985.

BI3511

**INDUSTRIAL TRAINING / INTERNSHIP I\***

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

**OBJECTIVES:**

To enable the students to

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

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

**No. of. Weeks.04**

**OUTCOMES:**

On completion of the course, the student will know about

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

CO2: Analysis of industrial / research problems and their solutions

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

CO4: Preparing of Technical report and presentation

**SEMESTER V**

BT3551

**BIOPROCESS PRINCIPLES**

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

**OBJECTIVES:**

- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.

**UNIT I OVERVIEW OF FERMENTATION PROCESSES**

**9**

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor (CSTR) and ancillaries, main parameters to be monitored and controlled in fermentation processes.

**UNIT II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS**

**9**

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

**UNIT III STERILIZATION KINETICS**

**9**

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

**UNIT IV METABOLIC STOICHIOMETRY AND ENERGETICS**

**9**

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

**UNIT V KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 9**

Batch cultivation and continuous cultivation. Simple unstructured models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - Leudeking- Piret models, substrate and product inhibition on cell growth and product formation. Biomass estimation – Direct and Indirect methods.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course the student will be able to

- Identify suitable process instrumentation for monitoring and control of fermentor.
- Formulate the fermentation medium to facilitate improved product production.
- Select and apply the sterilization techniques in bioprocessing.
- Interpret the metabolic stoichiometry in microbial processes.
- Analyze the kinetics of microorganisms during fermentation processes.
- Develop strategies to solve the issues in bioprocessing.

**TEXT BOOKS:**

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Butterworth-Heinemann; 3<sup>rd</sup> Edition ,2016.
2. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier, 2<sup>nd</sup> Edition,2012

**REFERENCES:**

1. Michael L. Shuler, Fikret Kargi, Matthew De Lisa , Bioprocess Engineering , Prentice Hall, 3<sup>rd</sup> Edition, 2017
2. Bailey, James E. and David F. Ollis, “ Biochemical Engineering Fundamentals”, 2<sup>nd</sup> Edition. McGraw Hill , 1986.
3. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, CRC Press; 2nd Edition 1997

CO / PO Mapping													CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak																
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	2	2	1	2	-	2	1	3	2	3	2	3	1
CO 2	3	3	3	2	2	3	3	-	-	-	2	2	3	3	3	1
CO 3	3	3	3	2	2	-	-	-	-	-	2	3	3	1	3	2
CO 4	3	3	3	2	2	3	3	2	2	2	-	1	3	1	3	1
CO 5	3	3	3	2	2	3	3	1	2	2	-	1	3	-	3	1
CO6	3	3	3	2	2	3	3	3	2	2	3	3	3	3	3	3

**BT3552**

**IMMUNOLOGY**

**L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To discuss the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens/germs.
- To explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases.



- UNIT I INTRODUCTION TO IMMUNE SYSTEM 9**  
 Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex
- UNIT II HUMORAL AND CELLULAR IMMUNITY 9**  
 Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells, antigen processing and presentation, theory of clonal selection, TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions
- UNIT III IMMUNITY AGAINST PATHOGENS AND TUMORS 9**  
 Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy
- UNIT IV IMMUNE TOLERANCE AND HYPERSENSITIVITY 9**  
 Immune tolerance, Immuno deficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis
- UNIT V APPLIED IMMUNOLOGY 9**  
 Monoclonal antibodies, engineering of antibodies; T- Cell cloning - Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immuno diffusion ELISA, FACS), immune modulatory drugs

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, students will be able to

- Understand the structure, functions and integration of immune system.
- Understand the antigen-antibody interactions that offers defence mechanism.
- Gain knowledge in importance of learning immunoregulation in Immunity development
- Understand the importance of various techniques of therapeutically significant monoclonal and engineered antibodies production
- Aware of the concepts and mechanism behind tumour development, allergy and hypersensitivity reactions.
- Gain knowledge in Immunotherapeutic development for Clinical Applications

**TEXT BOOKS:**

1. Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts Essential Immunology, 13<sup>th</sup> Edition, Wiley –Blackwell, 2016.
2. Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan Internation, 7<sup>th</sup> Edition, 2012
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.

**REFERENCES:**

1. Coico, Richard “Immunology: A Short Course” VI<sup>th</sup> Edition. John Wiley, 2008.
2. Khan, Fahim Halim “Elements of Immunology” Pearson Education, 2009.
3. Robert R Rich, Thomas A Fleisher, William T Shearer, Harry Schroeder, Anthony J Frew, and Cornelia M Weyand, Clinical Immunology – Principles and Practive, Elsevier, 4<sup>th</sup> Edition, 2013.
4. Maurice R, G O`Gorman, and Albert D Donnnerberg, Handbook of human Immunology, Second edition, CRC Press, 2008
5. Gerd – Rudiger Burmester, , Antonio Pezzutto and Jurgen Wirth, Colour Atlas of Immunology, Thieme Medical Publishers, 1<sup>st</sup> Edition, 2003.

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Cos	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	2				1				2		2	2	3		2	
CO 2	2	1		2	2			2	2		2	2	2	2	2	
CO 3	1		2	1				1	2			2	3	1	2	
CO 4	2	2	2	2		2	3		3		2	3	2	2	3	3
CO 5	2	1	3	2	3	1	2	3	2	1	3	3	3	1	2	2
CO6	3	2	3	2	3	2	3	2	3	1	2	2	2	3	3	2

BI3501

## HEAT AND MASS TRANSFER

L T P C  
3 0 0 3

### COURSE OBJECTIVE:

1. To ensure students to having strong fundamental knowledge about heat transfer operations
2. To introduce them to the heat and mass transfer calculations for bioprocess and biochemical industries
3. To understand the industrial application and significance of these equipment in biotechnology

### UNIT I CONDUCTION

9

Introduction- Modes of heat transfer-Thermal conductance and resistance- Temperature field and temperature gradient-mechanism of heat transfer. Conduction-Heat transfer by conduction-General heat conduction equation -Thermal diffusivity and equivalent thermal conductivity -Linear one-dimensional steady state conduction through plane, cylinders, spheres and composite walls.

### UNIT II CONVECTION AND RADIATION

9

Convection– Types of convection-Individual and overall heat transfer coefficient- Reynolds's analogy Natural convection– Forced convection, Radiation-Thermal radiation Spectrum of electromagnetic radiation-Monochromatic Emissive Power of blackbody-Planck's Distribution Law – Kirchoff's Law - Total Emissive Power, problems on Stefan- Boltzmann's law and Wien's displacement law

### UNIT III HEAT EXCHANGER AND EVAPORATORS

9

Heat exchanger-Types of heat exchange equipment and design of heat exchangers-effectiveness of heat exchangers–Logarithmic mean temperature difference –solving problems. Concept of evaporationtypes - single effect evaporator -mass and energy balances, capacity, steam economics and effectiveness , Industrial evaporators.

### UNIT IV DIFFUSION AND INTER PHASE MASS TRANSFER

9

Diffusion concept – types- mechanism, equimolar and non- equimolar counter diffusion- calculation and measurements, interface theory concept, mass transfer coefficient.

### UNIT V DISTILLATION AND ABSORPTION

9

Raoult's law and VLE diagram and methods distillation, methods and types of distillation, calculation of number theoretical plates by McCabe –Thiele methods. Theories of absorption and design. Types of packing and merit and demerits.

**TOTAL :45 PERIODS**

### COURSE OUTCOME:

At the end of the course students will be able to

1. Understand the basic doctrine of heat transmits
2. Summarize and workout conduction effort
3. Recognize convection effort and amylase heat exchangers
4. Solve problems related to diffusion, leaching and adsorption
5. Estimate the number of stages for Distillation and absorption

6. Analyze the vertical of evaporators

#### TEXT BOOK

1. Holman, J. P., Heat Transfer, 9th Edition, McGrawHill, Singapore, 2002
2. Donald Q. Kern, Process Heat Transfer, Tata McGrawHill, New Delhi, 1997

#### REFERENCE BOOK

1. McCabe, W.L., Smith, J.C., and Harriott, P. Unit Operations of Chemical Engineering, McGraw Hill, New York, 6<sup>TH</sup> Edition, 2004
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

**BT3561**

**IMMUNOLOGY LABORATORY**

**L T P C**  
**0 0 3 1.5**

#### OBJECTIVES:

- To give practical training in the functioning of immune system.
- To give laboratory training in different immunological and immunotechnological techniques.

#### EXPERIMENTS

1. Animal Handling – Immunization – Bleeding techniques by Virtual methods
2. Identification of immune cells in a blood smear and Identification of blood group
2. Isolation of serum and plasma
3. Testing for typhoid antigens by Widal test
5. Immunodiffusion – SRID and Ouchterlony Double Diffusion
6. Immunoelectrophoresis – Classical, Counter Current and Rocket immunoelectrophoresis
7. Enzyme Linked ImmunoSorbent Assay (ELISA) - Types
8. Isolation of peripheral blood mononuclear cells
9. Isolation of monocytes from blood
10. Lymphocyte migration assay
11. Plaque forming cell assay
12. Identification of T cells by T-cell rosetting using sheep RBC.

**TOTAL: 45 PERIODS**

#### OUTCOMES:

- The students would be aware of immune system cells and tissues.
- The students would have knowledge on immunological /clinical tests.
- The students would be able to isolate lymphocytes and monocytes.
- The students would be able to identify various immune system cells.
- The students would become familiar with the techniques involved in antigen-antibody reaction
- The students will be able to identify the cellular and molecular basis of immune responsiveness

#### REFERENCES

1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 2002.
2. Kuby J, Immunology, WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 1998.

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CO 5	3	3	3	3	3	1	2	2	2	3	3	3	3	3	3	3
CO6	3	3	3	3	3	1	1	1	2	3	3	3	3	3	3	3
	3	3	3	3	3	2	1	1	2	3	3	3	3	3	2	3

## SEMESTER VI

**BI3601**

**CHEMICAL REACTION ENGINEERING**

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

**COURSE OBJECTIVES:**

1. To provide knowledge on estimation of kinetic parameter
2. To establish core foundation for the analysis and design of chemical reactors
3. To impart the knowledge of reaction rate

**UNIT I HOMOGENEOUS REACTIONS IN IDEAL REACTORS**

**9**

Overview of Chemical Reaction Engineering; Homogeneous Reactions, The Rate Equation, The reaction rate and reaction mechanisms, Temperature-Dependent and concentration dependent Term of a Rate Equation.

**UNIT II REACTION MECHANISM**

**9**

Searching for a Mechanism- reaction mechanisms and rate laws, reactive intermediate and steady state approximation in reaction mechanisms, rate limiting step.

**UNIT III INTERPRETATION OF BATCH REACTOR DATA**

**9**

Constant volume batch reactor - integral method of analysis of data, differential method of analysis of data.

**UNIT IV PERFORMANCE OF REACTORS**

**9**

Broad outline of chemical reactors, Performance equations for single batch reactor, ideal CSTR, ideal PFR Application to design, Industrial scale reactors. Single reactions and multiple reactor systems

**UNIT V NON IDEAL FLOW REACTORS**

**9**

The residence time distribution, State of aggregation of the flowing stream, Earliness of mixing, Experimental methods (Nonchemical) for finding E, conversion in non-ideal flow reactions, reactor performance with non-ideal flow, Tank in series model

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Understand the kinetics of reactions
2. Remember the design equations and the performance of ideal reactors
3. Create various models for describing non- ideal behaviour of reactors
4. Analyse performance of reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Design of various fermenter / bioreactors

**TEXT BOOKS:**

1. Levenspiel, Octave "Chemical Reaction Engineering", 3rd Edition, John – WileySons, 2006.
2. Fogler, H. Scott. Essentials of Chemical Reaction Engineering, Pearson Education, 2010.

**Reference Books:**

1. Missen, R.W. et al., "Chemical Reaction Engineering and Kinetics", John – Wiley, 1999.
2. Davis, Mark E., and Robert J. Davis. Fundamentals of chemical reaction engineering. Courier Corporation, 2013.
3. Li, Shaofen, Feng Xin, and Lin Li. Reaction engineering. Butterworth-Heinemann, 2017.

**REFERENCES**

1. Anton Moser, "Bioprocess Technology, Kinetics and Reactors", , Springer Verlag.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors,Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.
5. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc

**BT3651****BIOPROCESS ENGINEERING****L T P C  
3 0 0 3****OBJECTIVES:**

- To provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

**UNIT I CONFIGURATION OF BIOREACTORS****9**

Ideal reactors and its characteristics Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors

**UNIT II BIOREACTOR SCALE – UP****9**

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

**UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS****9**

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors

**UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES****9**

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

**UNIT V RECOMBINANT CELL CULTIVATION****9**

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris/ Saccharomyces cerevisiae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system

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

Upon completion of this course the student will be able to

- Describe various bioreactor configurations and operation modes.
- Apply the knowledge of bioreactor scale up on the basis of rule of thumbs.

- Define kinetic parameters and apply the bioreactor considerations for immobilized enzymes systems.
- Utilize modelling approaches and simulation concepts for bioprocess estimations.
- Apply bioreactor considerations for the development of recombinant products.
- Explore the engineering concepts of bioreactors.

#### TEXT BOOKS:

1. Michael L. Shuler, Fikret Kargi, Matthew De Lisa,.Bioprocess Engineering, 3rdEdition,Prentice Hal, 2017
2. Pauline Doran, Bioprocess Engineering Calculation, 2<sup>nd</sup> Edition, Blackwell Scientific Publications,2012.
3. Sarfaraz K. Niazi, Justin L. Brown , Fundamentals of Modern Bioprocessing, Taylor & Francis,2017

#### REFERENCES

1. Anton Moser, "Bioprocess Technology:Kinetics and Reactors", , Springer Verlag.2012
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill,1986
3. James M. Lee, Biochemical Engineering, PHI, USA.1992
4. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, CRC Press,1997

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CO 3	3	3	3	2	2	-	-	-	1	1	1	2	3	3	3	-
CO 4	3	3	3	3	2	1	3	1	2	2	1	1	3	1	2	1
CO 5	3	2	3	2	2	3	3	3	2	1	2	2	3	3	3	3
CO6	3	3	3	3	2	1	3	-	3	1	3	3	3	3	3	2

BI3611

**CHEMICAL ENGINEERING LAB-II**  
**(MASS TRANSFER AND CHEMICAL REACTION ENGINEERING)**

**L T P C**  
**0 0 3 1.5**

#### COURSE OBJECTIVE:

1. To learn chemical engineering principles
2. To provide knowledge on practical applications in the areas of mass transfer
3. To provide knowledge on reaction engineering and particle mechanics.

#### LIST OF EXPERIMENTS

1. Extraction of acetic acid by Liquid –liquid Extraction
2. Leaching of oils from solids
3. Study on drying characteristics of sample using light.
4. Precipitation of Casein from milk
5. Determination the HETP of the packed column by McCabe Thiele method
6. Efficiency Analysis of simple distillation
7. Analyze the efficiency of Absorption column
8. Determination of rate constant for the saponification of Ethyl acetate in a

- batch reactor
9. Determination of rate constant for a Semi batch reactor
  10. Estimation of reaction kinetics in a Continuous stirred tank reactor
  11. Estimation of reaction kinetics in a Plug flow reactor
  12. Residence time distribution in a PFR

**TOTAL:45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Ability to plan experiments and present the experimental data meaningfully
2. Ability to apply theoretical concepts for data analysis and interpretation
3. Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics
4. Understand the experimental techniques related to chemical reaction engineering
5. Understand the basic laws of mass transfer.
6. Learn to operate various reactors

**REFERENCE BOOKS:**

1. Robert Treybal, Mass Transfer Operations, McGraw Hill Education; 3 edition, 2017.
2. McCabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 6th Edition,2013
3. Levenspiel Octave “Chemical Reaction Engineering”, 3rd Edition, John – WileySons, 2012

**BT3661**

**BIOPROCESS LABORATORY**

**L T P C  
0 0 3 1.5**

**COURSE OBJECTIVES**

- To provide a practical exposure to the bioinformatics databases, tools and software.
- To select and use functions in Perl for processing sequence data.

**EXPERIMENTS**

1. Enzyme kinetics – Determination of Michaelis - Menten parameters
2. Enzyme activity – Effect of Temperature and Deactivation Kinetics
3. Enzyme activity – Effect of pH
4. Enzyme inhibition kinetics
5. Enzyme immobilization – Gel entrapment
6. Enzyme immobilization –Cross-linking
7. Enzymatic conversion in Packed bed Column
8. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient
9. Optimization by Plackett Burman Design
10. Optimization by Response Surface Methodology
11. Estimation of KLa – Dynamic by different methods
12. Estimation of Overall Heat Transfer Coefficient and mixing time in reactor

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Explain about Enzyme kinetics and characterization and how to use them for practical applications.
- Evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.
- Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.
- Demonstrate good lab citizenry and the ability to work in team.

## REFERENCES:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Butterworth-Heinemann; 3<sup>rd</sup> Edition ,2016.
2. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier, 2<sup>nd</sup> Edition,2012
3. Michael L. Shuler, Fikret Kargi, Matthew De Lisa , Bioprocess Engineering , Prentice Hall, 3<sup>rd</sup> Edition, 2017
4. Bailey, James E. and David F. Ollis, “ Biochemical Engineering Fundamentals”, 2<sup>nd</sup>Edition. McGraw Hill , 1986.

**BI3711**

**INDUSTRIAL TRAINING / INTERNSHIP II<sup>##</sup>**

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

### OBJECTIVES:

To enable the students to

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

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

**No. of. Weeks.04**

### OUTCOMES:

On completion of the course, the student will know about

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

CO2: Analysis of industrial / research problems and their solutions

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

CO4: Preparing of Technical report and presentation

**SEMESTER VII**

**BT3751**

**DOWNSTREAM PROCESSING**

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

### OBJECTIVES:

To enable the students to

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on Downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion

### UNIT I INTRODUCTION

Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre treatment and stabilisation of bio-products.

**9**



**UNIT II PHYSICAL METHODS OF SEPARATION** 9  
Unit operations for solid-liquid separation - filtration and centrifugation.

**UNIT III ISOLATION OF PRODUCTS** 9  
Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

**UNIT IV PRODUCT PURIFICATION** 9  
Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.

**UNIT V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS** 9  
Crystallization, drying and lyophilization in final product formulation

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing
- Describe the components of downstream equipment and explain the purpose of each
- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques

**TEXT BOOKS:**

1. Belter, P.A., E.L. Cussler and Wei-Houhu “Bioseparations – Downstream Processing for Biotechnology”, John Wiley, 1988.
2. Nooralabettu Krishna Prasad., Downstream Process Technology: A New Horizon in Biotechnology, Prentice Hall India, 2010.
3. Sivasankar, B. “Bioseparations: Principles and Techniques”. PHI, 2006.

**REFERENCES:**

1. Raja Ghosh “Principles of Bioseparations Engineering”. World Scientific, 2006
2. Michael R. Ladisch Bioseparations Engineering: Principles, practice and Economics, Wiley-Interscience, 1<sup>st</sup> Edition, 2001.
3. Product Recovery in Bioprocess Technology”. (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

PROGRESSTHROUGH KNOWLEDGE

**BT3761**

**DOWNSTREAM LABORATORY**

**L T P C  
0 0 3 1.5**

**OBJECTIVES:**

- To provide hands on training in Downstream processing through simple experimentations in the laboratory. This will be a pre-requisite for project work.
- The objectives of this course is to practice the students
- To understand the nature of the end product, its concentration, stability and degree of purification required
- To design processes for the recovery and subsequent purification of target biological products.

**EXPERIMENTS**

1. Solid liquid separation – centrifugation
2. Solid liquid separation - microfiltration

3. Cell disruption techniques – ultrasonication or French pressure cell or Dynomill
4. Precipitation – ammonium sulphite precipitation
5. Ultra filtration separation
6. Aqueous two phase extraction of biologicals
7. High resolution purification – affinity chromatography
8. High resolution purification – ion exchange chromatography
9. Product polishing – spray drying or freeze drying
10. Size exclusion chromatography

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon successful completion of this course, the students would have

- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Learned cell disruption techniques to release intracellular products
- Learned various techniques like evaporation, extraction, precipitation, membrane separation for concentrating biological products
- Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

**REFERENCES:**

1. P.A. Belter, E.L. Cussler And Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pub. (1988).
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
3. Michael R. Ladisch Bioseparations Engineering: Principles, practice and Economics, Wiley- Interscience, 1<sup>st</sup> Edition, 2001.
4. Product Recovery in Bioprocess Technology”. (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.
5. Raja Ghosh “Principles of Bioseparations Engineering”. World Scientific, 2006

**BI3811**

**PROJECT WORK / INTERNSHIP<sup>#</sup>**

**L T P C**  
**0 0 20 10**

**OBJECTIVES:**

To train the students in

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

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

**TOTAL: 300 PERIODS**

**OUTCOMES:**

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

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

CO2: Design and conduct experiments to find solution

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

**COURSE OBJECTIVES:**

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

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9**

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

**UNIT II PLANNING 9**

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

**UNIT III ORGANISING 9**

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

**UNIT IV DIRECTING 9**

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

**UNIT V CONTROLLING 9**

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

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

1. Robert Kreitner and Mamata Mohapatra, “ Management”, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.

4. Tripathy PC and Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

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

**GE3752**

**TOTAL QUALITY MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

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

**UNIT I INTRODUCTION**

**9**

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

**UNIT II TQM PRINCIPLES**

**9**

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

**UNIT III TQM TOOLS & TECHNIQUES I**

**9**

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

**UNIT IV TQM TOOLS & TECHNIQUES II**

**9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM**

**9**

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

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

CO1: Ability to apply TQM concepts in a selected enterprise.

CO2: Ability to apply TQM principles in a selected enterprise.

CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.

CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.

CO5: Ability to apply QMS and EMS in any organization.

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

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

### TEXT BOOK:

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

### REFERENCES:

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

### GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING

L T P C  
3 0 0 3

### COURSE OBJECTIVES:

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

### UNIT I DEMAND & SUPPLY ANALYSIS

9

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

### UNIT II PRODUCTION AND COST ANALYSIS

9

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

**UNIT III PRICING 9**  
 Determinants of Price - Pricing under different objectives and different market structures  
 - Price discrimination - Pricing methods in practice.

**UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9**  
 Balance sheet and related concepts - Profit & Loss Statement and related concepts -  
 Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative  
 financial statements - Analysis & Interpretation of financial statements.

**UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9**  
 Investments - Risks and return evaluation of investment decision - Average rate of return  
 - Payback Period - Net Present Value - Internal rate of return.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:** Students able to

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

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

CO3: Understand the market structures and integration concepts

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

CO5: Apply the concepts of financial management for project appraisal

**TEXT BOOKS:**

Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.

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

**OBJECTIVE:**

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

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

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

**UNIT II HUMAN RESOURCE PLANNING 9**

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

**UNIT III TRAINING AND EXECUTIVE DEVELOPMENT 9**

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

**UNIT IV EMPLOYEE COMPENSATION 9**

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

**UNIT V PERFORMANCE EVALUATION AND CONTROL 9**

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

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

CO1: Students would have gained knowledge on the various aspects of HRM

CO2: Students will gain knowledge needed for success as a human resources professional.

CO3: Students will develop the skills needed for a successful HR manager.

CO4: Students would be prepared to implement the concepts learned in the workplace.

CO5: Students would be aware of the emerging concepts in the field of HRM

**TEXT BOOKS:**

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

**REFERENCES:**

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

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

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

**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**

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT – I INTRODUCTION TO MANAGEMENT 9**

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

**UNIT – II FUNCTIONS OF MANAGEMENT - I 9**

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

**UNIT – III FUNCTIONS OF MANAGEMENT - II 9**

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

**UNIT – IV ORGANIZATION THEORY 9**

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

**UNIT – V PRODUCTIVITY AND MODERN TOPICS 9**

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

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

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

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

## TEXTBOOKS:

- 1 M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
- 2 Koontz. H. and 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:

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

BI3001

BIOREACTOR ENGINEERING

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

1. Aims to understand the principles and concepts of Bioreactor engineering.
2. To understand structured models of growth and product formation
3. To understand the oxygen transfer parameters to be monitored and controlled in bioreactors

## UNIT I DESIGN AND ANALYSIS OF BIOREACTORS

9

Design and operation of novel bioreactors-Air-lift loop reactors, Fluidized bed-bioreactors, packed bed reactor, Bubble column reactor, stability analysis of bioreactors

<b>UNIT II</b>	<b>BIOREACTOR SCALE-UP</b>	<b>9</b>
Oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed, other scale up criteria		
<b>UNIT III</b>	<b>MONITORING OF BIOPROCESSES</b>	<b>9</b>
On-line data analysis for measurement of important physico-chemical and biochemical parameters; State and parameter estimation techniques for biochemical processes.		
<b>UNIT IV</b>	<b>MODERN BIOTECHNOLOGICAL PROCESSES</b>	<b>9</b>
Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; bioreactor strategies for maximizing product formation; Bioprocess design considerations for plant and animal cell cultures		
<b>UNIT V</b>	<b>MODELLING AND SIMULATION OF BIOPROCESSES</b>	<b>9</b>
Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.		
		<b>TOTAL: 45 PERIODS</b>

#### **COURSE OUTCOMES:**

The students will be able to

1. Develop knowledge on various bioreactors.
2. Classify modern biotechnological process in host vector systems.
3. Understand methods to calculate oxygen and mass transfer coefficients in bioreactors.
4. Assess on-line data analysis for measurement of important physico-chemical and biochemical parameters in bioreactors.
5. Analyze structured models for analysis of various bioprocesses.
6. Design of various instrumentation for monitoring and control of bioreactors

#### **TEXT BOOK:**

1. Michael Shuler, Fikret Kargi, “Bioprocess Engineering Principles”, Second edition, Prentice Hall, 2008.

#### **REFERENCE BOOKS:**

1. P.Stanbury, A.Whitaker, SJ Hall “Principles of fermentation technology”, Second edition, Elsevier Pergamon Press, 2010.
2. Pauline Doran, “Bioprocess Engineering Principles”, Academic Press, 2010.
3. Elmar Heinzle, Arno P. Biwer, “Development of Sustainable Bioprocess: Modelling and Assessment”, Wiley, 2007.
4. Bjorn K. Lyderson, Nancy Ade’lia and Kim Nelson, “Bioprocess engineering (handcover)”, Wiley Interscience, 2014

**BI3002**                      **SUSTAINABLE BIOPROCESS DEVELOPMENT**                      **L T P C**  
**3 0 0 3**

#### **COURSE OBJECTIVES:**

1. To impart knowledge on design and operation of fermentation processes with all its prerequisites.
2. To familiar the students with the basics of microbial kinetics and reactor design
3. To develop bioengineering skills for the production of value added product using integrated biochemical processes

**UNIT I BIOPROCESS AND NATURE OF BIO-PRODUCTS 9**  
Microbial diversity, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up

**UNIT II BIOREACTOR DESIGN 9**  
Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor

**UNIT III MODELING AND SIMULATION OF BIOPROCESSES 9**  
Microbial growth model, Problem Structuring, Process Analysis, and Process Scheme, leudeking-piret models, Models with growth inhibitors, oxygen transfer model, volumetric mass transfer coefficient, Uncertainty Analysis- Sensitivity Analysis, error analysis, Application-cellulase based catalysis process

**UNIT IV SUSTAINABILITY ASSESSMENT 9**  
Sustainability, Economic Assessment- Capital-Cost Estimation, Operating-Cost Estimation, Profitability Assessment, Environmental Assessment, case study

**UNIT V REACTOR OPERATION 9**  
Batch Operation of a Mixed Reactor, Fed-Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**The students will be able to**

1. Develop growth model based on the microbial characteristics
2. Understand working procedure of bioprocess industries
3. Analyze the diversity and nature of bio-products
4. Evaluate enzyme reaction and its kinetics
5. Understand different configurations of bioreactors
6. Understand the sustainability assessment methods

**TEXT BOOK:**

1. Heinzle E, Biver AP and Cooney CL, "Development of Sustainable Bioprocesses Modeling and Assessment" 2006 John Wiley & Sons, Ltd

**REFERENCE BOOKS:**

1. Shuler, M.L. and Kargi, F. "Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2015.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, 1995

**BI3003 PILOT PLANT AND SCALE UP PRACTICES**

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

**COURSE OBJECTIVES:**

1. To provide basic knowledge of scale-up practice
2. To teach the details of pilot plant design.
3. To study about Pilot plants for reactors and mechanical operations equipments

**UNIT I** **9**  
Pilot plants, size estimation, sampling data, cost and safety factors, Pilot plants for reactors and mechanical operations equipments

**UNIT II** **9**  
Oxygen Pathways in cell cultivations, volumetric oxygen transfer coefficient (KLa), oxygen transfer coefficient, oxygen transfer mechanism, resistances to gas liquid interface, Maxing/ Agitation in Biofluids, Measurements of Dissolved Oxygen (DO) and KLa, Assessment of KLa

**UNIT III** **9**  
Scale up concerns of microbial, mammalian and plant cell processes, Scale up criteria, Selection of scale up criteria, Dimensional analysis, scale up equations.

**UNIT IV** **9**  
Pilot plant design for heat exchangers, mixer equipments, batch and continuous distillation columns. Pilot plants for reactors and mechanical operations equipments

**UNIT V** **9**  
Case studies, Economic analysis

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Acquire knowledge in pilot plants for reactors and mechanical operations equipments
2. Examine Pilot plant design for several unit operation equipments.
3. Assess sampling data and safety factors and dimensional analysis
4. Design the bioreactor incorporating scale up concept
5. Design bioreactor based on the process requirement

**TEXT BOOK:**

1. S.N. Mukhopadhyay, "Process Biotechnology Fundamentals", Viva Books, Second Edition, 2004.

**REFERENCE BOOKS:**

1. Johnson and Thring, "Pilot plants models and scale up methods in chemical engineering", McGraw Hill Book co. 2nd edition, 1987.
2. Henley and Staffin, "Stage-wise process design", John Wiley, 2nd edition, 1988.
3. Bisio and Kabel, "Scale up of Chemical Process", John Wiley, 2nd edition 1985.

**CH3651**

**PROCESS DYNAMICS AND CONTROL**

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

**OBJECTIVE:**

The course is aimed to

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

**UNIT I** **9**

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

**UNIT II** **9**  
Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag, FOPDT Model, Skogestad's rule for FOPDT and SOPDT, Lead- Lag systems

**UNIT III** **9**  
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, control valves, transient response of closed-loop control systems and their stability, Root locus diagram.

**UNIT IV** **9**  
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion

**UNIT V** **9**  
Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On the completion of the course students are expected to

- CO1: Understand the need to develop mathematical description of a chemical process as a Prerequisite to process design and to control the process.
- CO2: Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.
- CO3: Represent a physical system using FOPDT model and estimate parameters in FOPDT model.
- CO4: Convert a process and instrumentation diagram to a control block diagram
- CO5: Understand Frequency response of control systems and tune the PID controllers
- CO6: Appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.

**TEXT BOOKS:**

1. Stephanopoulos, G. (2015). Chemical process control, 3rd Ed New Jersey: Prentice hall.
2. Ogunnaike, B. A., & Ray, W. H. (1997). Process dynamics, modeling, and control (Vol. 1). New York: Oxford University Press.
3. Coughanowr, D. R., & Leblanc, S. E. (2017). Introductory concepts. Process Systems Analysis and Control, 3rd Ed, 1-6.

**REFERENCES:**

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

Course articulation matrix

Course Outcomes	Program Outcomes															
	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	Understand the need to develop mathematical description of a chemical process as a prerequisite to process design and to control the process.	3	3	3	2	2	3	3	-	2	2	2	2	3	3	2
<b>CO2</b>	Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.	3	3	3	2	2	3	3	-	-	-	2	2	3	3	-
<b>CO3</b>	Represent a physical system using FOPDT model and estimate parameters in FOPDT model.	3	3	3	2	2	-	-	-	-	-	2	2	3	3	-
<b>CO4</b>	Convert a process and instrumentation diagram to a control block diagram	3	3	3	2	2	-	-	-	-	-	2	2	3	3	-
<b>CO5</b>	Understand Frequency response of control systems and tune the PID controllers and appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.	3	3	3	2	2	2	-	-	-	-	2	2	3	3	-
<b>OVERALL CO</b>		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>1</b>

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES**

The student should be made to,

- To understand the mathematical models in Biochemical Engineering systems.
- To learn about different aspects of modelling in Bioprocess system.
- To learn various techniques to solve and simulate various bioprocess models.

**UNIT I BASIC MODELLING PRINCIPLES 9**

Introduction, definition of Modelling and simulation, different types of models, application of mathematical modelling. Fundamental laws: continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics with examples.

**UNIT II MATHEMATICAL MODELS FOR BIOREACTOR SYSTEMS 9**

Batch reactor, CSTR isothermal with cooling/heating jacket or coil, Fed Batch reactor.

**UNIT III MODELLING APPROACHES FOR BIOLOGICAL SYSTEMS 9**

Growth kinetic Models – structured and unstructured systems; Compartment models; Cybernetic models; Genetically structured models, Single cell models, Morphologically structured models. Thermal death kinetics models, Stochastic Model for thermal sterilization of medium.

**UNIT IV MODELLING APPROACHES FOR BIOLOGICAL PROCESSES 9**

Modelling for activated sludge process, Model for anaerobic digestion, Model for lactic acid fermentation, antibiotic production, Ethanol fermentation.

**UNIT V SIMULATION OF BIOPROCESSES 9**

Software packages for simulation of bioprocesses – MATLAB-SIMULINK, Creating bioprocess models in MATLAB and Simulink environment. Linear and non-linear estimation of the kinetic parameters for types and models.

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

Upon completion of this course the student will be able to

- To understand the basic modelling principles in Biochemical Engineering systems.
- Apply the knowledge of modeling concepts for bioreactor design.
- To formulate model for biological System.
- To utilize modelling approaches for various bioprocess estimation.
- To build kinetic simulation models of the cell growth and product formation.
- To connect different models together to build a bioprocess model.

**TEXT BOOKS:**

1. Luyben W.L., "Process Modeling, Simulation and control for Chemical Engineers", McGraw Hill, 2nd Edition, 2013.
2. Bailey J.A and Ollis D.F., "Biochemical Engineering Fundamentals", McGraw Hill (New York), 2nd Edition, 2010.
3. T.K.Ghose., "Bioprocess Computations in Biotechnology-Vol.I", Ellis Horwood Ltd. 1989

**REFERENCES:**

1. Perry R H , "Perry's Chemical Engineers' Handbook", McGraw-Hill, 8th Edition, 2008



CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	3	1	-	1	-	2	2	2	3	3	3	3	1
CO 2	3	3	3	3	2	1	3	2	1	-	1	2	3	3	3	3
CO 3	3	3	2	2	2	-	-	-	1	1	1	2	2	3	2	-
CO 4	2	3	3	3	2	1	3	1	2	2	1	1	3	1	3	1
CO 5	3	2	3	2	2	3	3	3	2	1	2	2	3	3	3	3
CO6	3	3	3	3	2	1	3	-	3	1	3	3	3	3	3	2

BI3004

### MATLAB PROGRAMMING

L T P C  
3 0 0 3

#### COURSE OBJECTIVE:

1. To impart knowledge on matlab installation, configuration and basic syntax.
2. To introduce them to various matrix, vector, data and string operations, functions and advanced matlab operations for multivariate data analysis, modelling, optimization tool
3. To understand the applications of Matlab for various biological data analysis

#### UNIT I FUNDAMENTALS

9

Matlab Local Environment Setup, Different window interface: script, and command prompt; working directory, Variables, Naming Variables, Workspace variables, clearing variables, and command windows, output formats, Creating Vectors - Creating Matrices. Basic structure of matlab scripts, main function

#### UNITII MATLAB COMMANDS

9

Commands for Managing a Session - Commands for Working with the System-Input and Output Commands (on screen input output for text, numeric data), data import from txt, xls, website data, exporting data into txt file, structure, Vector, Matrix and Array creation, manipulation, searching, arithmetic operation, statistical summary, Cell array, M-Files Creating and Running Script File. Data input and output to and from matlab script, environment.

#### UNIT III DATA TYPES, OPERATORS

9

Data Types Available in MATLAB (Cell, character, date time, floating-point, integer, logical, string, structure, table, timetable) Data Type Conversion - Determination of Data Types, storing data into cell and extracting from cell, Operators, Arithmetic, relational, and logical operators, Data structure, Table operation

#### UNIT IV CONTROL STRUCTURES

9

Control structures - Decision Making, Loops and conditional Statements, 'for', 'if else', 'while' Switch Case. String comparison, terminating control structure: Continue, pause, break, return

#### UNIT V MATLAB FOR BIOLOGICAL APPLICATIONS

9

Processing biological sequences with MATLAB– Sequence acquisition, Operations on nucleotide sequences, Joining sequences, Restriction site detection, Information retrieval from biological databases.

Application example: detect cancer using mass spectrometry data on protein profiles using ANN, Accessing  
 NCBI Data from the MATLAB® Workspace, Exploring Primer Design,  
<https://in.mathworks.com/solutions/biological-sciences/genomics.html>

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

1. Identify installation, configuration and environmental setup of Matlab.
2. Demonstrate the usage of basic syntax and structure of Matlab
3. Apply knowledge of data types, operators and control structures to pseudocode
4. Analyze script functionality and offer improved performance in structure
5. Appraise structural validity, reproducibility of used Matlab functions
6. Formulate biological applications in areas such as sequence processing, sequence analysis.

**TEXT BOOKS:**

1. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg “A Guide to MATLAB” Cambridge University Press, 2014
2. Timmy Siau, Alexandre M. Bayen “An Introduction to MATLAB Programming and Numerical Methods for Engineers” Academic Press, Elsevier, 2015
3. Amos Gilat “Matlab an introduction with applications” 6th Edition, Wiley, 2016.

**REFERENCES BOOKS:**

1. Stephen J. Chapman, “Essentials of MATLAB Programming”, CL Engineering, Second Edition, 2008.
2. William J. Palm III, “Introduction to MATLAB for Engineers”, McGraw-Hill Education, 2010.
3. Rafael E. Banchs, “Text Mining with MATLAB”, Springer, 2012.

**PY3391**

**HUMAN ANATOMY AND PHYSIOLOGY**

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

**OBJECTIVES:**

- To explain the gross morphology, structure and functions of various organs of the human body and describe the various homeostatic mechanism and their imbalance.

**UNIT I HEMOPOIETIC SYSTEM**

**9**

Composition and functions of blood, Hemopoiesis, blood components, blood groups, clotting factors and mechanism of coagulation, platelets.

**UNIT II CARDIOVASCULAR SYSTEM**

**9**

Anatomy and function of the heart, circulation: pulmonary, coronary, and systematic circulation; electrocardiogram (ECG), cardiac cycle and heart sounds, blood pressure - its maintenance and regulation.

**UNIT III RESPIRATORY SYSTEM**

**9**

Anatomy of respiratory organs and functions, mechanism/physiology of respiration and regulation of respiration, transport of respiratory gases, respiratory volumes and capacities.

**UNIT IV NERVOUS SYSTEM**

**9**

Classification of the nervous system, anatomy, physiology, and functional areas of the cerebrum, cerebellum, midbrain, thalamus, hypothalamus and basal ganglia, spinal cord: structure and reflexes.

**UNIT V ENDOCRINE SYSTEM**

**9**

Classification of hormones, mechanism of hormone action, structure and functions of pituitary gland, thyroid gland, parathyroid gland, adrenal glands, pancreas, pineal gland, thymus.

**TOTAL 45 PERIODS**

## COURSE OUTCOMES:

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

1. Acquire the gross histology, structure and functions of various organs of the human body
2. Implement the physiological tests and appreciate the interlinked mechanisms in the maintenance of normal functioning of human body
3. Perform basic physiological and pharmacological experiments and to record and interpret the results for its clinical significance.
4. Demonstrate laboratory procedures used to examine anatomical structures and evaluate physiological functions of each organ system
5. Interpret graphs of anatomical and physiological data.
6. Apply the methods to evaluate the potency of drugs, toxicity of drugs in animal models.

## TEXTBOOKS

1. Essentials of Medical Physiology by K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi.
2. Human Physiology (vol 1 and 2) by Dr. C.C. Chatterjee, Academic Publishers Kolkata.

## REFERENCE BOOKS

1. Anatomy and Physiology in Health and Illness by Kathleen J.W. Wilson, Churchill Livingstone, New York.
2. Vander's Human Physiology: The Mechanisms of Body Function, Eric Widmaier, Hershel Raff, Kevin Strang, 2015, Edition:14, Publisher: McGraw-Hill
3. Hole's human anatomy & physiology David Shier, Ricki Lewis, Jackie Butler Year: 2019, Edition: Fifteenth, Publisher: McGraw hill Education
4. Germann, W.J., Stanfield, C.L. (eds.) (2002) Principles of Human Physiology, Pearson Education, Inc./ Benjamin Cummings, San Francisco, CA.
5. Guyton AC and Hall JE (eds.) (2000) Textbook of Medical Physiology, 10th edition. W.B. Saunders Co., Philadelphia, PA.
6. Tortora, G.J. and Grabowski, S.R. (eds.) (2000) Principles of Anatomy and Physiology, 9th edition. John Wiley & Sons, Inc., New York, NY.
7. Anatomy and Physiology 2e J. Gordon Betts, Tyler, Texas Kelly A. Young, Long Beach, California James A Wise, Hampton, Virginia Copyright Year: 2021

## COURSE ARTICULATION MATRIX

Course outcome	Programme Outcomes(PO)												Programme specific outcomes (PSO)			
	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO1 2	PS O1	PS O2	PS O3	PS O4
CO1		3					2	1	2				3		2	
CO2	3	3			2		3							3	2	
CO3		3		3	2							3			3	
CO4	3	3					3						2	3		
CO5			3		2		2								3	2
CO6	3	3	3		3		2			1			2			3
Average CO	3	3	3	3	2.2	-	2.4	1	2	1	-	3	2.3	3	2.5	2.5

**COURSE OBJECTIVES:**

1. To learn the medical aspects of bacteriology, virology, mycology and parasitology along with concepts of symptoms, pathogenesis, transmission, prophylaxis and control
2. To understand how disease processes affect physiological function of the host
3. To analyze how disease processes can result in specific clinical signs and symptoms

**UNIT I GENERAL PATHOLOGY****9**

Cellular adaptation- atrophy, hypertrophy; Cell Injury- necrosis and apoptosis; Inflammation and repair (Healing); Thrombosis and embolism, Oedema, Haemorrhage, Shock, Infarction, Amyloidosis, Hyperlipidaemia and lipidosis, Neoplasia: Benign and Malignant; Carcinoma and Sarcoma. Tumor immunology. Laboratory diagnosis: Cytology, Biopsy, Tumor markers, Immunity: innate and specific immunity

**UNIT II SYSTEMIC PATHOLOGY****9**

General overview of the diseases: Cardiovascular system, Kidney and lower urinary tract, Male reproductive system and prostate, Female genitalia and breast, Eye, ENT and neck, Respiratory system, Gastro Intestinal System, Skin and soft tissue

**UNIT III BACTERIAL DISEASES****9**

Normal microflora (microbiome) of human body and its role – Skin, mouth and respiratory tract, intestinal tract, urogenital tract; Pathogenesis and virulence factors - Koch's postulates, Adherence and invasion, Toxins, Enzymes- Clostridium spp., Staphylococcal infections, E. coli, Helicobacter pylori, Mycobacterium spp. Antibacterial chemotherapy (with few examples of antibiotics) - antimicrobial activity in vitro

**UNIT IV VIRAL, FUNGAL AND PROTOZOAN INFECTIONS****9**

Viral Pathogenesis - Routes of entry, Viral spread (local and systemic infection); Dengue, Influenza virus Swine flu, HIV/AIDS; Emerging viral diseases – Ebola, Chikungunya; Fungal infections: Types of Mycoses (with specific example of causative fungi) – Superficial, Cutaneous, Sub-cutaneous; Endemic and Opportunistic; Mycotoxins- Aflatoxins; Protozoan diseases - Amoebiasis, Infection by Helminths – Nematodes

**UNIT V COLLECTION AND TRANSPORTATION OF SPECIMEN****9**

General Principles, Containers, Rejection, Samples- Urine, Faeces, Sputum, Pus, Swab; Care and Handling of Laboratory Animals- Fluid, Diet, Cleanliness, Cages, ventilation, Temperature, Humidity; Disposal of Laboratory/Hospital Waste- Non-infectious waste, Infected sharp waste disposal, infected non-sharp waste disposal.

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

The students will be able to

1. Recognize the basic elements concerning cell injury and death, tumors and the mechanisms of response to tissue injury
2. Compare different clinical manifestations of different types of pathogens
3. Compare and contrast experimental approaches with their advantages/disadvantages of each approach for specific pathogens.
4. Adapt the physical and chemical methods to control the growth of microbes
5. Evaluate immunopathology, oncology, general and organ-specific pathophysiology
6. Critically analyse the standards of practice of medical laboratory science in clinical/research microbiology laboratories including laboratory safety standards

**TEXTBOOKS:**

1. KC Carroll, SA Morse, T Mietzner, S Miller. (2016), Jawetz, Melnick and Adelbergs's Medical Microbiology, 27th edition, McGraw Hill.
2. V Kumar, AK. Abbas and JC Aster, (2015), Robbins & Cotran Pathologic Basis of Disease, 9th Edition, Elsevier.
3. Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2010.

**REFERENCE BOOKS:**

1. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2014.
1. Prescott, Harley and Klein, "Microbiology", 8th edition, McGraw Hill, 2013.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 5rd edition, 2010
3. Ananthanarayanan and Panicker, "Microbiology" Orient blackswan, 2015

**BI3006****MOLECULAR FORENSICS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

1. Provide knowledge in the field of forensic science and crime scene investigations.
2. To ensure students gain knowledge about the recovery of human remains.
3. Impart technical skills to know the procedures involved in the identification of the criminals using molecular tools

**UNIT I INTRODUCTION TO FORENSIC SCIENCE****9**

Introduction to crime laboratories, Responsibilities of the forensic scientist, Securing and Searching the Crime Scene, Recording and collection of crime scene evidence, Document examination, Ethics and Integrity

**UNIT II DISCOVERY AND RECOVERY OF HUMAN REMAINS****9**

History of Forensic Genetics, Biological sample collections, The Autopsy and handling of a Dead Body, The Stages and factors of decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks

**UNIT III PATTERN ANALYSIS****9**

Human Tissues, Body Fluids and Waste Products, Fingerprints, Hair, Teeth, Blood, Detecting the Presence of Blood, Bloodstain Pattern Analysis, Forensic anthropology, Paleontology, Toxicology

**UNIT IV METHODS OF IDENTIFICATION****9**

Methods used in forensic for human identification: Autosomal STR Profiling, Analysis of Y chromosome, Analysis of Mitochondrial DNA, Autosomal single-nucleotide polymorphisms (SNP) typing, Biomarkers in forensic identification, Polymorphic Enzymes, DNA Finger Printing- RFLP.

**UNIT V SEQUENCING METHODS IN FORENSICS****9**

PCR directed Y chromosome sequences, PCR Amelogenein Gene, Next generation Sequencing Case studies of Royal Romanov Family, Study of Kinship by DNA Profiling, Paternity disputes, Illegal hunting case identification using Molecular markers; detection of narcotics in body fluids.

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

1. Explain the steps involved in forensic investigation
2. Identify the methods involved in the collection of biological samples for molecular analysis
3. Interpret the results of molecular techniques for the identification of the criminals and the victims
4. Appraise the knowledge in paleo biology and anthropology and its importance in Forensics
5. Design experiments in molecular techniques and implementation in forensic science
6. Analyze forensic case studies

**TEXT BOOKS:**

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.
2. Sandy B. Primrose, Richard Twyman "Principles of Gene Manipulation and Genomics" Backwell Scientific Publications 2010

**REFERENCES BOOKS:**

1. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.
2. Brown T.A, Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010

**BI3007****METABOLIC ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

1. To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
2. To impart basic knowledge in the field of synthetic biology
3. To learn advanced molecular techniques in order to enhance the product yield

**UNIT I CELL METABOLIC ENGINEERING, METABOLIC PATHWAYS 9**

Improvement of cellular properties, altering transport of nutrients including carbon and nitrogen; Methods for metabolic characterization: Genome, Transcriptome, Proteome. Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- Auxotrophs lysine, purine nucleotides; trophophase- idiophase relationship; secondary metabolites- Antibiotics, Mycotoxins

**UNIT II MANIPULATION OF METABOLIC PATHWAYS 9**

Pathway manipulation strategies for overproduction of various metabolites, examples of ethanol overproduction, overproduction of intermediates in main glycolytic pathway and TCA cycle like pyruvate, succinate; Tools for multiple genomic modifications examples- TALENS CRISPR-Cas systems as well as traditional systems of gene knock ins and knock outs and promoter engineering.

**UNIT III METABOLIC FLUX ANALYSIS 9**

Metabolic flux analysis; Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Methods for experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques; GC-MS for metabolic flux analysis

**UNIT IV BASICS OF SYNTHETIC BIOLOGY 9**

Synthetic biology - definitions and concepts. History and evolution of synthetic biology and engineering perspectives. Natural vs Engineering systems. Tools of synthetic biology -Key enabling technologies in synthetic biology. BioBricks - Definition of a BioBrick

**UNIT V APPLICATIONS OF METABOLIC ENGINEERING AND SYNTHETIC BIOLOGY 9**

Product over production examples: amino acids, By-product minimization of acetate in recombinant E. coli, Extension of substrate utilization range for organisms such as S. cerevisiae for ethanol production; Application of synthetic biology with a case study.

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

1. Comprehend modern biology with engineering principles
2. Recall the basic principles and regulation of metabolic pathways
3. Construct suitable metabolic flux models using available metabolic engineering tools
4. Identify the appropriate host and/or metabolic pathways to produce a desired product
5. Compare the potential metabolic engineering strategies using quantitative metabolic modelling
6. Apply the concept of synthetic biology in interdisciplinary research

## TEXTBOOKS:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt. Ltd., 1st edition, 1998.
2. Cortassa S., Aon M.A., Iglesias A.A. and Llyod D., "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
3. Smolke, C.S. (2010) Metabolic Pathway Engineering Handbook: Fundamentals. 1st ed. New York: CRC Press.

## REFERENCE BOOKS:

1. Freemont, P.S and Kitney, R.I. (2012). Synthetic Biology – a Primer. World Scientific Publishing Co pvt Ltd
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 3rd edition, 2016
3. Crueger W. and Crueger A., "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
4. Cheng Q. "Microbial Metabolic Engineering: Methods and Protocols", Humana Press, First Edition (2011).
5. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, Seventh edition, 2017

BI3008

NANOBIOTECHNOLOGY

L T P C  
3 0 0 3

## COURSE OBJECTIVE

1. To introduce the concepts and fundamentals of nanotechnology
2. To understand the synthesis and characterization of nanomaterials and their application in biomedical fields
3. To identify the risk assessments involved nanomaterials in biological application and the impact on environment.

## UNIT I NANOBIMATERIALS

9

DNA and Protein based Nano structures. Biomaterial nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Function and application of DNA based nanostructures. Bionanomaterials in Nature: Lotus leaf as a model self cleansing system. Gecko foot as a case study for biological generation of adhesive forces. Diatoms as an example for silicon biomineralization. Mussel inspired nanofiber for tissue engineering. Biomechanical strength properties of Spider silk

## UNITII MICRO & NANO ELECTROMECHANICAL SYSTEMS AND MICROFLUIDICS 9

BioMEMS/BioNEMS: Types of transducers: mechanical, electrical, electronic, magnetic and chemical transducers. Nano sensors: Types: Electronic nose and electronic tongue, magnetic nanosensors. mechanical nanosensors: Cantilever Nanosensors, Microfluidics: Laminar flow, Hagen-Peouiseleequation, basic fluid ideas, Special considerations of flow in small channels, micro mixing, microvalves&micropumps, Body on a chip and lab on a chip.

## UNIT III NANOSENSORS

9

Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, NanoBiosensors: NanoBiosensors in modern medicine





**COURSE OBJECTIVES:**

1. The history and future of the emerging field of Stem Cell Therapy
2. The impact of Stem Cell therapy in health care system.
3. The impact of Stem Cell Therapy in Human civilization.

**UNIT I CULTURING CELLS, STEM CELL-TYPES 9**

Overview of Stem Cells. Introduction to Cell Culture, Pros & Cons of Cell culture, Primary and Secondary cultures, Aseptic Technique and Cell culture Lab equipments & etiquette. Types of Stems Cells, Embryonic stem cells, Pluripotent Stem Cells, Adult Stem cells, Induced Pluripotent Stem Cells, Transit amplifying cells, Symmetry during cell division in Stem cells.

**UNIT II LOCATION, NATURE & CULTURING OF STEM CELLS 9**

Stem Cell Niche, Isolation of Stem Cells, & Growth factors, chord cells, Derivation & differentiation of ES Cells, Derivation & differentiation of Pluripotent Cells Induced Pluripotent cell-Methods & Genetic & epigenetic reprogramming. Transdifferentiating, FACS

**UNIT III APPLICATIONS OF STEM CELL TECHNOLOGY 9**

Application of stem cells in disorders of nervous system, Stem cells of the skin- Wound healing & cosmetics, Application of Stem cells in Cancer, Application of stem cells in autoimmune disorders.

**UNIT IV 9**

Stem cell in tissue engineering & Regenerative medicine Scaffolds, types & topology and effect on tissues, Tissue regeneration and angiogenesis Organoids and organ generation, Organ on Chip, Body on Chip

**UNIT V ETHICAL IMPLICATIONS OF STEM CELL THERAPEUTICS. 9**

Benefits, Problems and perspectives of stem cell therapy. Beginning of human life, legal, scientific, ethical, Religio-spiritual explanations. Treating infertility, multiple parents, Somatic Cell Nuclear Transfer & Human cloning, Extinction prevention, Stem cells and meat production, Alternatives to stem cells. Deeper concerns in stem cell technology- Ageing longevity, Immortality.

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

The students will be able to

1. Understand the basic concepts in culturing animal and mammalian cells
2. Understand the aspects of cellular ageing
3. Understand the types of Stem cells, their development and function.
4. Learn the various methods to isolate and culture Stem cells
5. Learn the various therapeutic applications of stem cells
6. Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization.

**TEXT BOOK:**

1. Robert Lanza, Handbook of Stem Cells edited by Anthony Atala,. (Vol-1) Second edition. Academic press, 2013.

**REFERENCE BOOKS:**

1. Paul Knoepfler, Stem Cells - An Insider's Guide, 30 July 2013.
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology, Second Edition, Academic Press, 2013.
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, 16 March 2010.
4. Warburton David, Stem Cells, Tissue Engineering an Regenerative Medicine, 1st Edition, 15 December 2014

**COURSE OBJECTIVES:**

1. Learn to self-reliantly analyze and understand research results and technologies.
2. Learn techniques for emerging novel molecular diagnostics and therapies.
3. Be able to study applications in healthcare, research and industry.

**UNIT I INTRODUCTION TO MOLECULAR MEDICINE, NANOMEDICINE 9**

Extracellular and intracellular signaling systems. Methods of DNA analysis and gene technology. Nanomedicine - Overview. Identification of genes and variants in the genome and gene mapping.

**UNIT II MOLECULAR AND MEDICAL MICROBIOLOGY 9**

Molecular methods for detection and characterization of microorganisms, Primer and probe design. Databases - Molecular genetic assays, genotypic assays for molecular epidemiology.

**UNIT III CELL IMAGING AND BIOBANKING 9**

Cell Imaging: Preparation and microscopy of biological specimens, tissue and cell morphology. Biobanks: classifications, common and distinctive features of the different types of biobanks. National regulations, international conventions, use of human biological materials and personal data, Research biobanks, Ethical aspects, role of Research Ethics Committees, consent for biobanking, alternatives to consent, Logistics and quality management, quality assurance and quality control of collection, storage, retrieval and use of samples, Role of biobanks in health surveys like HUNT, Mother-Child etc.,

**UNIT IV INTRODUCTION TO MOLECULAR DIAGNOSTICS 9**

Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. - Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host -Parasite relationships.

**UNIT V DIAGNOSTIC TESTS AND DISEASES 9**

Duchenne muscular Dystrophy (Creatine phosphokinase-CPK), Amino acid deficiency - PKU (phenylketonuria) -- Inborn error, G6PD deficiency syndrome (G6PD), Sickle cell anemia, PCR diagnosis of Tuberculosis, Prenatal screening of Cystic Fibrosis. Endocrine disorders related to thyroid and reproduction (TSH, T3, T4, Estradiol, Testosterone, LH, FSH). Pyrosequencing. Lab on a Chip. Personalized Medicine - Pharmacogenomics.

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

The students will be able to

1. Recognize molecular mechanisms in development of disease
2. Predict the use of molecular genetic methods in the detection, identification and quantification of different microorganisms.
3. Apply the principles of molecular diagnostics and advantages/limitations of its applications
4. Develop technological integration of chemistry, physics and molecular biology for use in bioanalysis relevant for biomedical research and diagnostics.
5. Design advanced study in the theoretical and practical aspects of the genetic basis and diagnosis of disease from both human and pathogen perspectives.
6. Appraise the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as: nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA sequencing

**TEXT BOOKS**

1. Textbook of Molecular medicine, Jones and Bartlett Publishers, 2008
2. Jawetz, Melnick, &Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.



- Outline the steps involved in metastasis and tumour cell invasion
- Develop novel drugs and technologies for the treatment of cancer
- Summarize the microenvironment of cancer cells and their attack on immune cells

#### TEXT BOOKS:

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004.
3. Pezzella, F., Tavassoli, M., & Kerr, D. J. (Eds.). (2019). Oxford textbook of cancer biology. Oxford University Press.
4. Pelengaris, S., & Khan, M. (Eds.). (2013). The molecular biology of cancer: A bridge from bench to bedside.
5. Hejmadi, M. (2014). Introduction to cancer biology. Bookboon.

#### REFERENCES:

1. King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996.
2. Rudson, Raymond W. " Cancer Biology" Illrd Edition . Oxford University Press, 1995
3. Margaret A. Knowles, Peter J Selby, An Introduction to Cellular and Molecular Biology of Cancer, 4th Edition, Oxford Medical Publication, 1991.
4. <https://oncousd.files.wordpress.com/2014/09/cancer-principles-and-practice-of- oncology-6e.pdf>
5. <https://archive.org/details/biologyofcancera00burc>.
6. <http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to- cancer-biology.pdf>

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	2	-	3	-	3	-	1	-	2	-	2	1	1	-	-	3
CO 2	3	1	2	1	3	-	1	-	3	-	2	2	2	-	-	2
CO 3	2	2	2	-	2	1	2	-	2	-	1	2	3	3	-	-
CO 4	2	2	2	-	2	-	2	-	-	-	1	2	2	-	-	-
CO 5	3	3	3	3	3	2	1	2	3	-	3	3	3	3	1	3
CO6	2	2	3	2	2	-	2	2	3	-	2	2	2	2	1	3
	2	2	3	2	3	2	2	2	3	-	2	2	2	3	1	3

BI3011

PHARMACEUTICAL BIOTECHNOLOGY

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

To improve knowledge on

1. To provide the student well versed with recent advances in the field of Pharmaceutical Biotechnology.
2. To make foundation for understanding the various events at molecular level, keeping a balance between health and disease.
3. To enabling the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

#### UNIT I BIOTECHNOLOGY WITH REFERENCE TO PHARMACEUTICAL SCIENCES 9

Introduction to Biotechnology with reference to Pharmaceutical Sciences, Biosensors- Working and applications of biosensors in Pharmaceutical Industries. Brief introduction to Protein Engineering. Use of microbes in industry. Production of Enzymes- General consideration – Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillin's.

**UNIT II GENETIC ENGINEERING 9**

Basic principles of genetic engineering. Study of cloning vectors, restriction endonucleases and DNA ligase. Recombinant DNA technology. Application of genetic engineering in medicine. Application of rDNA technology and genetic engineering in the products: Interferon b) Vaccines- hepatitis- B c) Hormones- Insulin. Nanodrops, Gene expression analysis.

**UNIT III PHARMACEUTICAL IMMUNOLOGY 9**

Structure of Immunoglobulin's, Structure and Function of MHC. Hypersensitivity reactions, Immune stimulation and Immune suppressions. General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity. Storage conditions and stability of official vaccines. Hybridoma technology- Production, Purification and Applications

**UNIT IV IMMUNOLOGICAL TECHNIQUES AND ANALYSIS 9**

Immunoblotting techniques- ELISA, Western blotting, Southern blotting. Genetic organization of Eukaryotes and Prokaryotes. Microbial genetics including transformation, transduction, conjugation, plasmids and transposons. Introduction to Microbial biotransformation and applications.

**UNIT V GENE MUTATION AND FERMENTATION 9**

Mutation. Types of mutation/mutants. Fermentation methods and general requirements, study of media, equipments, sterilization methods, aeration process, stirring. Large scale production fermenter design and its various controls. Study of the production of – penicillin, citric acid, Vitamin B12, Glutamic acid, Griseofulvin.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Will be familiar with resources, of DNA based vaccine delivery systems.
2. Will be able to analyze Screening, isolation, characterization and scale-up of microbial products (enzymes, antibiotics and other secondary metabolites) from microorganisms of commercial interest and its pharmacological evaluation.
3. Will be able to Microbial synthesis of nanoparticles: Biosynthesis, isolation and characterization.
4. Will develop skills in molecular signalling pathways in pathogenesis and therapy.
5. Will be familiar in Immunoproliferators: Isolation, characterization and evaluation of cytokine like molecules from microbial source.
6. Will be familiar with the Peptide therapeutics: Design, evaluation and formulation of peptides for therapeutics.

**TEXT BOOKS**

1. Gene transfer and expression protocols – methods in Molecular Biology, Vol. VII, Edit E.T. Murray.
2. Therapeutic Peptides and Proteins; Formulation, processing and delivery systems: Ajay K Banga.
3. Immobilisation of cells and enzymes: Hosevear kennady Cabral & Bicker staff.

**REFERENCES**

1. Biotechnology of antibiotics and other bioactive microbial metabolites : Gianeario Lancini and Rolando Lorenzetti.
2. Pharmaceutical Biotechnology by Daan J. A. Crommelin, et al
3. Goodman and Gilman's The Pharmacological Basis of Therapeutics Book by J.Hardman, Lee Limbird and A.G. Gilman.
4. "Principles of Pharmacology by D. Golan, A. Tashjian, E. Armstrong, J.Galanter, A.W.Armstrong, R. Arnaout and H.Rose. 2005, Lippincott Williams and Wilkins.

**COURSE OBJECTIVES:**

To improve knowledge on

1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

**UNIT I DRUG AND THEIR INTERACTION 9**

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; How drugs work -Drug targets, drug-target interaction and dose-response Relationships.

**UNIT II DRUG DESIGN PIPELINE 9**

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD)

**UNIT III FUNDAMENTAL OF DRUG ACTIONS 9**

Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der Waals interactions and the associated energies. Cation-and-OH interactions. Receptorology : Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

**UNIT IV DRUG TOXICITY, ASSAYS AND TESTING 9**

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs: Phase I, Phase II and Phase III testing; Good clinical practice (GCP) guidelines -Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

**UNIT V DRUG REGULATORY AGENCIES 9**

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

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

The students will be able to

1. Will be able to describe the process of drug discovery and development
2. Will be able to discuss the challenges faced in each step of the drug discovery process
3. Will be able to gain a basic knowledge of computational methods used in drug discovery
4. Will be able to organise information into a clear report
5. be able to demonstrate their ability to work in teams and communicate scientific information effectively
6. Will be familiar with the Construct, review and evaluate preclinical and clinical pharmaceutical studies with a general understanding of aim, choice of procedures, results, conclusions and Importance.

## TEXT BOOK

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)
2. Essentials of Medical Pharmacology, 6th Edition (Hardcover) by Tripathi Kd. Publisher: Jaypee Brothers (2008)
3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development. 6th Edition. Ed Donald J Abraham Wiley-Interscience.

## REFERENCES

1. Intellectual Property Rights In India: General Issues And Implications by Prankrishna Pal. Publisher: Deep & Deep Publications Pvt.Ltd (2008)
2. Stromgaard, Kristian, Povl Krosggaard-Larsen, and Ulf Madsen. Textbook of drug design and discovery. CRC Press, 2009.
3. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. Basic and Clinical Pharmacology (LANGE Basic Science). McGraw-Hill Education, 2012.
4. Spriet, Alain, et al. Methodology of clinical drug trials. Basel: Karger, 1994.

CBT333

TISSUE ENGINEERING

L T P C  
3 0 0 3

### OBJECTIVES:

- To enable the students
- To learn the fundamentals of tissue engineering and tissue repairing
- To acquire knowledge on clinical applications of tissue engineering
- To understand the basic concept behind tissue engineering focusing on the stem cells
- To study the biomaterials and its applications

### UNIT I INTRODUCTION

9

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

### UNIT II TISSUE ARCHITECTURE

9

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix & Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

### UNIT III BIOMATERIALS

9

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

### UNIT IV BASIC BIOLOGY OF STEM CELLS

9

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pluripotent stem cells.

## UNIT V CLINICAL APPLICATIONS

9

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of of tissue-engineered products, ethical issues.

**TOTAL: 45 PERIODS**

### OUTCOMES:

Upon completion of this course, the students would get

- Ability to understand the components of the tissue architecture
- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy

### TEXT BOOKS:

1. Bernhard O.Palsson, Sangeeta N.Bhatia, "Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

### REFERENCES:

1. Bernard N. Kennedy (editor). Stem cell transplantation, Tissue engineering, and cancer applications, Nova Science Publishers, 2008.
2. Raphael Gorodetsky, Richard Schäfer.Stem cell-based tissue repair. RSC Publishing, 2011.
3. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004.
4. R. Lanza, J. Gearhart, B. Hogan, D. Melton, R. Pedersen, E. .I Thomas, J. Thomson, I. W.Gearhart, Essential of Stem Cell Biology, Elsevier Academic Press, 2<sup>nd</sup> Edition , 2009.
5. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine" Artech House, INC Publications, 2008.
6. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,.and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press, 2007.

**BI3013**

**VACCINE TECHNOLOGY**

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

### COURSE OBJECTIVES:

1. To impart knowledge on the role vaccination in improving the immune system.
2. To gain an understanding of recent developments in vaccine technology.
3. To make aware about the commercialization and regulatory guidelines in vaccine production

## UNIT I INTRODUCTION TO VACCINATION

9

Vaccination: Introduction, history and principles of vaccine development. Conventional and modern strategies for vaccine improvement. Immunization strategies: Active and Passive. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus, Hepatitis, Human papillomavirus.

## UNIT II CLASSIFICATION OF VACCINES AND ITS PRODUCTION

9

Types of vaccines: Live, attenuated, subunit, killed vaccines, Recombinant peptide vaccines, recombinant live vector vaccines, conjugate vaccines, toxoid vaccines, Naked DNA vaccines, cell-based vaccines, edible vaccines. Reverse vaccinology. Adjuvants: history, classification, mechanisms. Factors affecting adjuvants selection and production.



**UNIT III DELIVERY OF VACCINES 9**

Controlled delivery system for vaccines: emulsions, microparticles, immune-stimulating complexes (ISCOMs, liposomes), Virosomes. Application of Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle-based vaccine. Role of polymeric nanoparticles in vaccine delivery. Transdermal vaccine delivery system.

**UNIT IV VACCINE DESIGN AND DEVELOPMENT 9**

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Fundamentals of Immune recognition, implications for manipulating the T-Cell repertoire, Targeting Dendritic cells; a rational approach for Vaccine development, Cellular basis of T- Cell memory, Rational design of new vectors, CpG adjuvant activity, Transcutaneous immunization.

**UNIT V COMMERCIAL PRODUCTION AND REGULATORY GUIDELINES 9**

Quality control and regulations in vaccine research, In-vitro experimental validations for predictions of vaccines by software, Animal testing, Rational design to clinical trials, Large scale production, Commercialization, ethics. Overview of national and international regulatory requirements/guidance for production of vaccines, quality control and implementation of good clinical practices. Overview of currently approved methods and alternative methods under development. Storage and handling, assessment of vaccine safety.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Describe the role of immune cells and their mechanism and concept of vaccination.
2. Categorize the different types of vaccines available for diseases.
3. Understand the modern strategies and routes of immunization.
4. Apply the concept of vaccine technology for development of vaccines
5. Evaluate various delivery methods suitable for vaccines.
6. Relate the quality control and regulatory guidelines involved in vaccine production.

**TEXT BOOKS**

1. Emily P. Wen Ronald Ellis Narahari S. Pujar, Vaccine Development and Manufacturing. Wiley online, 2014
2. Jose Ronnie Vasconcelos, Vaccines & Vaccine Technologies. OMICS International, 2015
3. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.

**REFERENCE BOOKS**

1. Myrone M. Levine , Myron M. Levine, Gordon Dougan , Michael F. Good , Margaret A. Liu , Gary J. Nabel , James P. Nataro, RinoRappuoli., New Generation Vaccines. Fourth Edition, 2016
2. Stanley Plotkin Walter Orenstein Paul Offit, Vaccines, 6th Edition, 2012

**BI3014**

**CLINICAL DATA MANAGEMENT**

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

Course Objectives:

1. To learn and understand clinical data management and its role in clinical research.
2. To impart clear understanding on various essential elements of Clinical Research and Clinical Data Management.
3. To train you on different aspects and activities involved: CRF Designing, Data entry, Data Collection, AE Management, and Report Creation etc.

- UNIT I INTRODUCTION OF CLINICAL TRIALS 9**  
 Basic statistics for clinical trials, Roles & Responsibilities of Key Stakeholders, Preparations & Planning for Clinical Trials, Essential Documentation in Clinical Research & Regulatory Submissions, Clinical Trials Project Planning & Management, Study Start Up Process, Clinical Monitoring Essentials, Compliance, Auditing & Quality Control in Clinical Research
- UNIT II CLINICAL DATA MANAGEMENT 9**  
 Introduction to Data Management, Data Definition & Types, Study Set Up, CRF Design Considerations, Data Entry, Remote Data Entry, Identifying and Managing Discrepancies, Medical Coding, Database Closure, Data Management Plan, Electronic Data Capture, Tracking CRF Data, Managing Lab Data, Collecting Adverse Event Data, Creating Reports and Transferring Data, Enterprise Clinical Data Management Tools.
- UNIT III CLINICAL DATA ANALYSIS AND MANAGEMENT 9**  
 Study set-up, Introduction to Clinical Database , Documents, guidelines used in CDM, Data Entry, Data Review/Data Validation, Query Management, Data management plan, Project management for the clinical data manager, Vendor selection and management, Data management standards in clinical research, Design and development of data collection, Edit check design principles
- UNIT IV CLINICAL CASE REPORT FORMS 9**  
 CRF Completion Guidelines, CRF printing and vendor selection, Data validation, programming and standards, Laboratory data handling, External data transfer, Patient –reported outcomes, CDM presentation at investigator meetings, Metrics for clinical trials, Systems Software Validation Issues Clinical Trials Database Environment
- UNIT V CLINICAL QUALITY AUDIT & REGULATIONS 9**  
 Audit –Definition, types & procedures, Audit standards, Audit trail & its role in authenticity of data, Audit plan, Audit by regulatory authorities,GMP, GDP & logistics, Preparing and delivering audit reports, what makes a good audit, New product development & GxP Regulations.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Outline on clinical trials, data management and preparation
2. Describe the analytics and decision support using various tools.
3. Utilize enterprise-wide information assets in support of organizational strategies and objectives.
4. Inspect the concepts of database architecture and design.
5. Interpret the roles and responsibilities of healthcare workspace commodities.
6. Elaborate the reliability and accuracy of secondary data sources.

**TEXT BOOKS**

1. Susanne Prokscha, Practical Guide to Clinical Data Management, Third Edition, CRC Press; 3 edition, 2011.
2. Richard K Rondel (2000) Clinical Data Management, Second Edition. Wiley Publishing House, 2000.

**REFERENCE BOOKS**

1. Rondel, R.K., Varley, S.A. and Webb, C.F. eds., Clinical data management. New York: Wiley, 2000
2. Smith, Jonathan A., ed. Qualitative psychology: A practical guide to research methods. Sage, 2015.
3. Machin, D., Day, S. and Green, S. eds., Textbook of clinical trials. John Wiley & Sons, 2007.

BI3015

**BIG DATA ANALYTICS**

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

**COURSE OBJECTIVES:**

1. Fundamental concepts and methods of Big data analysis.
2. Data exploration, visualization and statistical analysis for given data set.
3. Managing big data analytics for Biological data set.

**UNIT I INTRODUCTION**

**9**

Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies

**UNIT II DATA EXPLORATION AND VISUALIZATION**

**9**

Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization

**UNIT III BIG DATA METHODS**

**9**

Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

**UNIT I V CHARTS & GRAPHS**

**9**

Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

**UNIT V BIG DATA ANALYTICS FOR HEALTH CARE**

**9**

Big data analytics in bioinformatics, Health care, Data mining using RNA seq data, Text mining on complex biomedical literature, Biological sequence motifs and patterns.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Know various types of big data platform and cloud computing model.
2. Understand the fundamentals of big data technologies
3. Apply the big data tools and software in handling the biological data.
4. Evaluate variety of big data analytics tools.
5. Explore use of R platform for biological big data analysis.
6. Design and develop Biological models based on big data techniques.

**TEXT BOOKS:**

1. VenkatAnkam, "Big Data analytics", Packt publishing 2016
2. Parag Kulkarni, ihsoJ gnaSaS, "610sa Sainihss IHPs,"snhsyS SsSiSaD ni
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition, 2014

**REFERENCE BOOKS:**

1. Mark Gardener. Beginning R: The Statistical Programming Language. John Wiley & Sons, 2012.
2. Avril Coghlan, A Little Book of R For Bioinformatics, Release 0.1, 2017
3. Robert Gentleman, R Programming for Bioinformatics, CRC press, Taylor & Francis,2008

BI3016

**GENOMICS AND PROTEOMICS**

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

**COURSE OBJECTIVES:**

To improve knowledge on

1. Genomics and Proteomics including fundamentals, current techniques and applications.
2. To propose appropriate methods for analysis of given sample type with respect to purpose of analysis
3. Recent trends in Genomics and Proteomics research

<b>UNIT I</b>	<b>INTRODUCTION TO GENOMICS</b>	<b>9</b>
Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaeobacteria and Eukaryotes, Human Genome Project		
<b>UNIT II</b>	<b>DNA SEQUENCE AND MAPPING</b>	<b>9</b>
Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types		
<b>UNIT III</b>	<b>FUNCTIONAL GENOMICS AND ITS APPLICATIONS</b>	<b>9</b>
Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, identifying the function of new gene, Gene Ontology. Pharmacogenomics, Comparative genomics		
<b>UNIT IV</b>	<b>INTRODUCTION TO PROTEOMICS</b>	<b>9</b>
Proteomics- Introduction, The proteome, Genomics vs Proteomics, Proteomics and the new biology		
<b>UNIT V</b>	<b>ANALYTICAL PROTEOMICS</b>	<b>9</b>
2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis (MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays		

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able

1. Relate and comprehend the concepts in genome organization, genomics and proteomics.
2. Explain some of the current genomics technologies and illustrate how these can be used to study gene function.
3. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
4. Analyze and infer genomes and proteomes by employing database search, algorithms and tools.
5. Appraise the applications of genomics and proteomics in medicine
6. Compile, discuss and critically review the recent updates / progress in genomics and proteomics research

**TEXT BOOKS:**

1. Brown T.A., "Genomes", BIOS Scientific Publishers Ltd, Oxford, 4th Edition, 2018.
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for the New Biology", Humana Press, Totowa, New Jersey, 2002

**REFERENCE BOOKS:**

1. Sandor Suhai, "Genomics and Proteomics- Functional and computational Aspects", Springer, New York, 2000.
2. Malcolm Campbell A. and Laurie J. Heyer, "Discovering genomics, proteomics and Bioinformatics", Pearson/Benjamin Cummings, New Delhi, 2006.
3. Mount, D. "Bioinformatics; Sequence and Genome Analysis", Cold Spring Harbor Laboratory Press, New York, 2004

**BI3017**

**COMPUTATIONAL BIOLOGY**

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

**COURSE OBJECTIVES:**

1. To understand the fundamental concepts, tools and resources in Computational Biology.
2. To improve knowledge on machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To facilitate the specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

**UNIT I BIOMOLECULAR COMPUTING 9**

DNA Structure, and Processing , Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length, Beginnings of Molecular Computing Adelman Experiment. RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm, Design of covariance models, Application of RNA fold.

**UNIT II MOLECULAR MECHANICS 9**

Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Dipole interactions. Types of Potentials: Lennard-Jones, Truncated Lennard-Jones. Types of Force Fields: AMBER, CHARMM, Merck Molecular Force Field, Consistent Force Field, MM2, MM3 and MM4 force fields.

**UNIT III MOLECULAR DYNAMICS SIMULATION 9**

Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations.

**UNIT IV NEXT GENERATION SEQUENCING 9**

NGS Platforms: Introduction to NGS, Roche/454 FLX, Illumina/Solexa Genome Analyzer, Applied Biosystems SOLiD system, Helicos Heliscope, Pacific Biosciences/single molecule real time (SMRT) sequencing. Biological applications of NGS: Whole-genome sequencing, Exome sequencing, Transcriptome sequencing, Epigenome sequencing, Interactome sequencing, methylome sequencing.

**UNIT V DATA MINING AND DATA WAREHOUSING 9**

Need for data warehouse, definition, goals of data warehouse, Data Mart, Data warehouse architecture, extract and load process, clean and transform data, Designing fact tables, partitioning, Data warehouse and OLAP technology. Importance of Data Mining, Relational Databases, Data Warehouses, Transactional Databases, Advance Database Systems and Applications, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Understand the principles of, biological data and interpretation.
2. Demonstrate high throughput biological data and perform statistical analysis.
3. Make use of advanced data mining and machine learning techniques
4. Create skills on molecular modeling and simulation, whole cell modeling, drug discovery, and Systems Biology
5. Clarify the implementation of algorithms which may help them design their own.
6. Explain the theory and practical aspects of important computational experimental techniques.

**TEXT BOOKS:**

1. Neil C. Jones, Pavel Pevzner. An introduction to bioinformatics algorithms MIT Press ,(2011)
2. Alan Hinchliffe, Molecular Modelling for Beginners, (2nd Edition) John Wiley & Sons Ltd. (2008)
3. Stuart M. Brown, Next-generation DNA sequencing Informatics, Cold Spring Harbor Laboratory, (2013).

**REFERENCE BOOKS:**

1. Andrew R. Leach, Molecular Modeling Principles and Applications, Second Edition, Prentice Hall. (2001)
2. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. John Wiley & Sons Inc (2015)
3. Kriete A. Kriete, R.Eils,, R.Eils, Computational systems biology, Academic Press. (2005)

- Pengcheng Fu, Systems Biology and Synthetic Biology Sven Panke, Wiley InterScience. (2009)
- Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. Sinauer Associates, Inc; (2009)

**BI3018                      BIOINFORMATICS AND BASICS OF R- PROGRAMMING                      L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To explore various tools and database to understand the Biomolecules at structural and functional level
- To perform big data analytics for Biological data set.
- To familiarize with Predictive Analytics and Data Visualization.

**UNIT I                      BIOLOGICAL DATABASES                      9**

Nucleotide databanks – Genbank, NCBI, EMBL, DDBJ – protein databanks –sequence databanks – PIR, SWISSPROT, TrEMBL- structural databases – PDB, SCOP, CATH.

**UNIT II                      SEQUENCING ALIGNMENT AND DYNAMIC PROGRAMMING                      9**

Local, Global alignment, pairwise and multiple sequence alignments. Alignment algorithms. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm and Smith Waterman Algorithm, Aminoacid Substitution matrices (PAM, BLOSUM).

**UNIT III                      MOLECULAR MODELING AND DRUG DISCOVERY                      9**

Basic concepts of Molecular modeling, Structure Identifications and Validations, Computer Aided Drug Design, HTVS, QSAR

**UNIT IV                      INTRODUCTION & R OBJECTS                      9**

R console, CRAN, Installation, configuration, R studio environment setup, Basic syntax, Data types, Variables, Operators, Vectors , Lists, Matrices, Arrays, Factors , Data frames

**UNIT V                      R PACKAGES & DATA INTERFACES                      9**

Installing a package from CRAN, Manual installation and configuration of a package, loading package to library, Exploring R packages for Bioinformatics applications

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

- Familiarized with various biological database and software tools
- Predict the structure and functions of biomolecules
- Apprehend the knowledge on ligand and structure based drug design
- Enable to write, compile, and run R programs.
- Analyze data from different interfaces
- Develop R script for various biological problems.

**TEXT BOOK:**

- A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.
- S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
- Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition

**REFERENCE BOOK:**

- VenkatAnkam, “Big Data analytics”, Packt publishing 2016
- Parag Kulkarni, Sarang Joshi, “Big Data analytics”, PHI learning 2016
- D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.

**OBJECTIVES**

The objective of this course is to

- find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
- to know the informatics approaches to the prediction of chemical properties of new drugs
- to present the appropriate tools for such a modelling, ranging from electronic Structure methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR,
- Molecular docking and Molecular dynamics

**UNIT I ELECTRONIC STRUCTURE METHODS 8**

Quantum chemical methods semi-empirical and ab initio methods. Conformational analysis, energy minimization, predicting the mechanism of organic reactions using electronic structure methods.

**UNIT II MOLECULAR MODELING 9**

Bioactive vs. global minimum conformations. Automated methods of conformational search. Advantages and limitations of available software. Molecular graphics. Computer methodologies behind molecular modeling including artificial intelligence methods.

**UNIT III STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN 9**

Qualitative versus quantitative approaches advantages and disadvantages. Random screening, Non-random screening, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations. Insights into molecular recognition phenomenon. Structure based drug design, ligand based drug design.

**UNIT IV QSAR: ELECTRONIC EFFECTS 9**

Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation. Experimental and theoretical approaches for the determination of physicochemical parameters, parameter inter-dependence: Regression analysis, Descriptor calculation. The importance of biological data in the correct form; 2D QSAR; 3D-QSAR examples of CoMFA and CoMSIA.

**UNIT V MOLECULAR DOCKING 10**

Rigid docking, flexible docking, manual docking. Advantages and disadvantages of Flex-X, Flex-S, Autodock and Dock softwares, with successful examples. Dynamics of drugs, biomolecules, drug receptor complexes, Monte Carlo simulations and Molecular dynamics in performing conformational search and docking.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Gain knowledge about fundamental concepts, challenges, and rich opportunities in developing and applying algorithms for structural bioinformatics and healthcare.
2. Interpret and practice the fundamental concepts of Molecular Modeling and Computer aided Drug Design.
3. Develop practical skills in computational approaches to analyse, predict, and engineer biomolecules and biomolecular systems.
4. Find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
5. Present the appropriate tools for such a modelling, ranging from electronic Structure methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR, Molecular docking and Molecular dynamics
6. Apply the fundamental tools in techniques like docking, modelling, electronic structure methods which leads to new drug target design.

**TEXT BOOKS:**

1. Andrew R. Leach, Molecular Modelling Principle and Application, 2nd Edition, Prentice Hall, England, 2001.
2. Richard B. Silverman, Mark W. Holladay, Organic Chemistry of Drug Design and Drug Action, 3rd Edition, Academic Press, USA, 2014.
3. Paul S. Charifson, Practical Applications of computer aided drug design, 1st Edition, Marcel Dekker, New York, 1997.
4. J. M. Goodman, Chemical Applications of Molecular Modelling, The Royal Society of Chemistry, Cambridge, 1998.

**REFERENCES:**

1. Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol V, 6th Edition, John Wiley and Sons, Inc., 2003.
2. John B. Taylor and David J. Triggle, Comprehensive Medicinal Chemistry II, Vol IV, Elsevier Science, 2006.
3. Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, UK, 2013.
4. David. C. Young, Computational Drug Design – A Guide for Computational and Medicinal Chemists, John Wiley and Sons Ltd, Hoboken, United States, 2009.
5. Alan Hinchliffe, Molecular Modelling for Beginners, 2nd Edition, Wiley, United University of California, 2008.

Course outcome	Programme Outcomes (PO)												Programme specific outcomes (PSO)			
	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	PS O4
1	3	2	3		3	3					1	3	3	2		
2	3	3	2	2		3					1	3	2	3		
3	3	3	2	3		1		1				2		3	2	
4	3	2	1	2		2					1	3	2		3	
5	3	2	3	3	3		1				2	3		3	2	
6	3	3	2	2	3		2				2	3		2		3
<b>Average</b>	3	2.5	2.1	2.4	3.0	2.2	1.5	1	-	-	2.3	2.8	2.3	2.6	2.3	3

**BI3019****CANCER MANAGEMENT TECHNOLOGY****L T P C****3 0 0 3****COURSE OBJECTIVES:**

1. To understand the pathology, grades and molecular biology of cancer
2. To analyze cancer type specific symptoms and early diagnostic markers
3. To develop skills in the cancer management techniques like detection, treatment, prevention and palliative care

**UNIT I PATHOLOGY AND TYPES OF CANCER****9**

Benign and cancer tumor; Characteristics and hallmarks of cancer; Histopathology of cancer, Cancer malignancy – spread, invasion and metastasis; Cancer classes and types; Cancer inflammation, Cancer immunology, Cancer stem cells, Cancer death - obstructions.

**UNIT II MOLECULAR CELL BIOLOGY OF CANCER****9**

Cell growth regulation abnormalities in cancer – Alteration in Growth factors and cell signaling pathways, signal targets; Cell adhesion defects in cancer; Cell migration promoters in cancer-



Proteases; Metastatic spread promoters, cancer cells mimicking inflammatory immune cells; Apoptosis regulation defects in cancer; Angiogenesis promoters in cancer.

**UNIT III                    CANCER SYMPTOMS, METABOLISM AND MARKERS                    9**

Cancer Symptoms – General and specific; Cancer metabolism – Metabolic alterations and role of mitochondria; Cancer Markers – Proteins – Enzymes, Antigens, Antibodies, Hormones; Testing samples - Urine, Blood, Stool, Tumor tissue, other body fluids; Genetic markers – DNA, mRNA and Protein expressions.

**UNIT IV                    CANCER DETECTION METHODS AND TECHNIQUES                    9**

Cancer Screening: Clinical Examination; Laboratory Tests for cancer markers;- Immunodetection techniques (Shift before imaging); Imaging Techniques – Ultra sound and Endoscopic Examinations; Xray; CT, and MRI scans; Nuclear and isotopic techniques - PET scans; Confirming cancer by pathologic report - Biopsy and Smear examinations; Cancer staging and grading; Genetic marker Testing Techniques – PCR, RT-PCR, qPCR, Microchip; Scope for early diagnosis: Early diagnostic methods – Mammography, PAP test

**UNIT V                    CANCER PREVENTION AND PALLIATIVE CARE                    9**

Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment recurrence preventive measures; Palliative care; Herbal remedies and plant derived cancer drugs. Review on recent advancements in cancer management- Role of IoT, Theranostics, Nano-therapy.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Understand the pathology and metabolism of cancers and their reporting systems.
2. Recall the molecular pathways and relate them in cancer development, progression, detection and therapy.
3. Identify the potential molecular and cellular targets for diagnosis and therapy
4. Evaluate the technologies available for early diagnosis-prevention, targeted therapy and for effective management of post therapy – palliative care
5. Analyze the challenges in the present cancer management methods
6. Apply the knowledge and discuss new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.

**TEXT BOOKS:**

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

**REFERENCE BOOKS:**

1. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
2. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach, 11th illustrated edition, Oncology Publishers, 2003
3. Thomas N. Sayfried, Cancer as a Metabolic Disease: On the Origin, Management, and Prevention of Cancer 1st Edition, Wiley Publications; 2012

**BI3020**

**CLINICAL TRIALS, BIOETHICS**

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

**COURSE OBJECTIVES:**

1. To Explain key concepts in the design of clinical trials
2. To identify key issues in data management for clinical trials.
3. To describe the roles of Regulatory Affairs in clinical trials.

**UNIT I INTRODUCTION TO DRUG DISCOVERY AND DEVELOPMENT 9**

Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India–The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV –methods, Principles of sampling -Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial.

**UNIT II ETHICAL REGULATION 9**

Historical guidelines in Clinical Research -Nuremberg code, Declaration of Helsinki, Belmont report, Research ethics and Bioethics –Principles of research ethics; ethical issues in clinical trials; Use of humans in Scientific Experiments; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology

**UNIT III REGULATION IN CLINICAL RESEARCH 9**

International Conference on Harmonization (ICH) Brief history of ICH, Structure of ICH, ICH Harmonization Process, Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors, Institutional ethics committee

**UNIT IV CLINICAL TRIAL IMPORTANT DOCUMENTATION 9**

Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and 95Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form

**UNIT V CLINICAL DATA MONITORING 9**

CRF Review & Source Data Verification, Drug Safety Reporting, Drug Accountability Work, Routine Site Monitoring, Site Close Out Visit. Case study in recent epidemics-clinical trials.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Understands the principles and methodology of clinical trials
2. Comprehend the theory and practical aspects of important techniques
3. Develop analytical skills and expertise to formulate and implement a research oriented real time problem.
4. Asses in major high throughput statistical methods in clinical research.
5. Evaluate experimental component to undertake interdisciplinary work.
6. Equips skills to pursue a career either in academia or industry.

**TEXT BOOKS:**

1. Lee, Chi -Jen; etal.,“Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor &Francis, (2011)
2. Matoren, Gary M. “The Clinical Research Process in the Pharmaceutical Industry” Marcel Dekker, (2001).
3. Spriet A., Dupin-Spriet T., Simon P. Methodology of Clinical Drug Trials, 2ndEdition. Publisher: Karger. (1997)

**REFERENCE BOOKS:**

1. Shein-Chung Chow, Jen-Pei Liu.Design and Analysis of Clinical Trials: Concepts and Methodologies, 3rd Edition. Publisher: Wiley. (2014)
2. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Publisher: Wiley-Blackwell. (2011)
3. OMurray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Handbook of Clinical Medicine, 9th Edition. Oxford Medical Handbooks.(2014)

**OUTCOME:**

- This course is designed to impart the fundamental knowledge on the regulatory affairs related to clinical trials, pharmaceutical, medical devices and in vitro diagnostics, biologics
- To impart the basis of classification and product life cycle of medical devices, regulatory requirements for approval of medical devices in regulated countries like US, EU and Asian countries along with WHO regulations.
- It prepares the students to learn in detail on the harmonization initiatives, quality and ethical considerations, regulatory and documentation basics , process of development in industries

**UNIT I REGULATIONS GOVERNING CLINICAL TRIALS 9**

Clinical Research regulations in India – CDSCO guidelines, ICMR guidelines, Clinical trial application requirements in India- IND, ANDA, AADA and NDA., USFDA regulations to conduct drug studies, Clinical Research regulations in UK – Medicines and Healthcare Products Regulatory Agency (MHRA) ,Clinical Research regulations in Europe (EMA).

**UNIT II REGULATORY REQUIREMENTS IN PHARMACEUTICAL INDUSTRIES 9**

Pharmaceuticals: Bulk drug manufacture; Practice of cGMP, Personnel, Drugs and Cosmetics Act 1940 and Rules 1945: DPCO and NPPA, Buildings and Facilities, Process Equipment, Documentation and Records, Materials Management, Production and In-Process Controls, Packaging and Identification Labelling of API's and Intermediates, Storage and distribution, – Biotechnology derived products; Principles, Personnel, Premises and equipments, Animal quarters and care, production, labelling, Lot processing records and distribution records, quality assurance and quality control.

**UNIT III REGULATORY ASPECTS OF MEDICAL DEVICES 9**

Differentiating medical devices IVDs and Combination Products from that of pharmaceuticals, History of Medical Device Regulation, Product Lifecycle of Medical Devices and Classification of Medical Devices, Regulatory Guidelines, Working Groups, Summary Technical Document (STED), Global Medical Device Nomenclature (GMDN), Regulatory approval process for Medical Devices- (510k) Premarket Notification, Pre-Market Approval (PMA), Investigational Device Exemption (IDE) Regulatory registration procedures

**UNIT IV REGULATORY ASPECTS OF FOOD & NUTRACEUTICALS 9**

History of Food and Nutraceutical Regulations, Food Safety and Standards Act, Food Safety and Standards Authority of India: Organization and Functions, Regulations for import, manufacture and sale of nutraceutical products in India, Recommended Dietary Allowances (RDA) in India, US FDA Food Safety Modernization Act, Dietary Supplement Health and Education Act. U.S. regulations for manufacture and sale of nutraceuticals and dietary supplements, Labelling Requirements and Label Claims for Dietary Supplements, Recommended Dietary Allowances (RDA) in the U.S, European Food Safety Authority (EFSA): Organization and Functions. EU Directives and regulations for manufacture and sale of nutraceuticals and dietary supplements. Nutrition labelling.

**UNIT V REGULATORY ASPECTS IN BIOLOGICS AND DIAGNOSTICS 9**

Introduction to Biologics; biologics, biological and biosimilars, scientific guidelines and guidance related to biologics in EU, comparability/ biosimilarity assessment, Plasma master file, TSE/ BSE evaluation, development and regulatory approval of biologics, Blood and Blood Products Regulations in India, US and European Union.

**TOTAL:45 PERIODS****OBJECTIVES :**

Upon completion of the course,

- The student shall be able to know harmonization initiatives for approval and marketing of medical devices
- Quality considerations clinical evaluation and investigation of medical devices and IVDs

- Regulatory approval process for medical devices and IVDs in India, US, Canada, EU, Japan and ASEAN and IVDs

#### TEXT BOOKS:

1. Drugs & Cosmetics Act & Rules and Amendments
2. Ira R. Berry, The Pharmaceutical Regulatory Process, marcel dekker Series: Drugs and the 73 Pharmaceutical Sciences, by CRC Press, Newyork, 2004.
3. FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics by Douglas J. Pisano, David Mantus
4. Regulation of Functional Foods and Nutraceuticals: A Global Perspective by Clare M. Hasler (Wiley Online Library)
5. Nutraceutical and Functional Food Regulations in the United States and Around the World by Debasis Bagchi (Academic Press, Elsevier)

#### REFERENCES

1. N Udupa, Krishnamurthy Bhat, A Concise Textbook of Drug Regulatory Affairs, Manipal University Press (MUP); First Edition, 2015.

<b>CBT332</b>	<b>INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY</b>	<b>L T P C</b>
		<b>3 0 0 3</b>
<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Introduction to IPRs, Basic concepts and need for Intellectual Property - IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.		
<b>UNIT II</b>	<b>REGISTRATION OF IPRs</b>	<b>10</b>
Meaning and practical aspects of registration of CopyRights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad		
<b>UNIT III</b>	<b>AGREEMENTS AND LEGISLATIONS</b>	<b>10</b>
International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.		
<b>UNIT IV</b>	<b>DIGITAL PRODUCTS AND LAW</b>	<b>9</b>
Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.		
<b>UNIT V</b>	<b>ENFORCEMENT OF IPRs</b>	<b>7</b>
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.		
		<b>TOTAL:45 PERIODS</b>

#### OUTCOME:

Ability to manage Intellectual Property portfolio to enhance the value of the firm.

#### TEXT BOOKS:

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2. S. V. Satakar, "Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

#### REFERENCES:

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.

2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

**BI3023**

**ENTREPRENEURSHIP AND MANAGEMENT**

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

**COURSE OBJECTIVES:**

To improve knowledge on

1. To impart various aspects of product design and development
2. To inculcate concept generation and selection
3. To understand technology behind the product of the service

**UNIT I INTRODUCTION 9**

Entrepreneurship and economic development. evolution of entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

**UNIT II PRODUCT DESIGN 9**

Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

**UNIT III INNOVATION AND PROTOTYPE 9**

Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

**UNIT IV IPR AND COPYRIGHT 9**

IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship. GMO and IPR; WTO, GATT and TRIPS agreement; Indian Patent Act; Patenting procedures

**UNIT V START UP PROCESS 9**

Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, Funding agencies – BIRAC, NEN, STEP, DST-NIMAT, TSDB; The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

**TOTAL:45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

**TEXT BOOKS**

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt.



1. Recall different rDNA technology of transgenic in animals, humans and plants
2. Understand the various biosafety regulations in transgenics
3. Illustrate IPR and patent procedures
4. Comprehend on various techniques of genome, stem cells and organ research in humans
5. Aware of modern rDNA research and its ethical procedures
6. Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications

**TEXT BOOK:**

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007

**REFERENCE BOOKS:**

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

**BI3025**

**AGRICULTURAL BIOTECHNOLOGY**

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

**COURSE OBJECTIVE:**

1. To demonstrate the basics of genes, genomes and breeding principles.
2. To motivate students in analyzing techniques in tissue culture and genetic engineering.
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

**UNIT I PLANT BIOTECHNOLOGY CONCEPTS 9**

Basic concepts and history of biotechnology, Different branches of biotechnology, Tools of Genetic Engineering: Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors, Recombinant DNA technology

**UNIT II PLANT BREEDING TECHNIQUES 9**

Significance of plant breeding in crop development. Methods of plant breeding in self and cross pollinated crops. Clonal selection, population improvement programme. Heterosis, Genetical and physiological basis. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression. Polyplidy its types. Mutation breeding Gene actions, heritability, genotype and environmental interactions.

**UNIT III PLANT CELL AND TISSUE CULTURE 9**

Scope and importance of tissue culture in crop improvement , totipotency and morphogenesis, Organogenesis, Rhizogenesis, Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture. Protoplast isolation, culture Manipulation and fusion. Cybrids, Products of somatic hybridization, Cryopreservation of germplasm. Secondary metabolites production

**UNIT IV BIODIVERSITY CONSERVATION 9**

Geographical causes of diversity. Types of diversity. Biodiversity and centers of origins of plant. Hot spots in India. Principles of conservation biology. Biosphere concept, Genetical and evolutionary principles of conservation. Collection Maintenance and conservation of biodiversity. endangered plants, endemism and Red Data Book

**UNIT V INTELLECTUAL PROPERTY RIGHTS 9**

Intellectual Property Rights and legal concerns of Bio-resources. Case study on Basmati Rice, Turmeric and Neem

**TOTAL:45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Acquire knowledge on plant breeding
2. Outline the principles of plant breeding and its techniques
3. Demonstrate various tools involved in genetic engineering
4. Illustrate the different strategies for biodiversity conservation
5. Acquire knowledge on IPR and its importance in patent rights
6. Demonstrate different tools of plant genome analysis

**TEXT BOOKS:**

1. Chawla H S, Introduction to Plant Biotechnology, 3Ed Oxford & IBH Publishing 2020
2. B.D.Singh, Plant Breeding Principles and Methods, Kalyani Publisher 2018
3. Razdan M K, Introduction to Plant Tissue Culture, Oxford & IBH Publishing 2019
4. Satish Kumar Sinha, Plant Tissue Culture: Theory and Practice, Oxford Book Company 2012
5. Jeyabalan Sangeetha, Devarajan Thangadura, Goh Hong Ching, Saher Islam. Biodiversity and Conservation, Apple Academic Press, 2019
6. Ram Kumar, Intellectual Property Rights-Demystified, New India Publishing House, New Delhi. (2008).
7. Satish Kumar Sinha, Elementary Bioinformatics , Oxford Book Company, 2012

**REFERENCE BOOKS:**

1. TA Brown, Gene Cloning and DNA analysis, an introduction, Fourth edition, Blackwell science, 2001.
2. From Genes to clones, Introduction to gene Technology. Panima Publishing Corporation, 2003.
3. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, Lewin's Genes XII, 2017.

**BI3026****ALGAE BIOTECHNOLOGY****L T P C  
3 0 0 3****COURSE OBJECTIVE:**

1. Impart the knowledge of different techniques employed in algae technology
2. Improve the understanding of applications and products derived from microalgae
3. Illustrate the characterization of algae using biochemical and molecular tools

**UNIT I ALGAE CELLS 9**

Algae and its culture - Isolation Techniques (Downstream Techniques) - Growth curve – Microscopy –Streaking - Culture Collection and Maintenance.

**UNIT II CULTURE MEDIUM/NUTRIENTS AND CONDITION 9**

Culturing Media – Types of Media (BB, CFTRI, Fog's Medium, Shibin, Guillard's F/2 medium, Walne Medium) – Media Modification – Maintaining Conditions (Temperature, pH, Light, Salts etc).

**UNIT III PHYCOREMEDIATION 9**

Adsorbing – Application in Environmental Clean up – Heavy Metal uptake, Wastewater treatment – Dye remediation –Agricultural application

**UNIT IV VALUE ADDED COMPOUNDS 9**

Oils and fatty acids – PUFA – Single Cell Protein – Biofilms – Secondary metabolites – Pigments – Proteins – Feed and Food – Biofuels

**UNIT V CHARACTERIZATION AND GENOMIC STUDIES 9**

GC of Fatty acid – MS in Result analysis – FTIR – SEM ;Molecular Techniques – DNA isolation – PCR – Molecular Identification – Phylogentic analysis – Pathway Analysis – Biomarkers.

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

The students will be able to



1. Understand the importance of algae and their culture techniques
2. Summarize the value added products of algae
3. Outline the application of algae in Industry and environment.
4. Elaborate the cell characteristics of microalgae
5. Investigate different products from algal sources through technological interventions
6. Infer algal characterization using molecular tools

#### TEXT BOOKS

1. M. Arumugam, S. Kathiresan., N. Subramani, Applied Algal Technology. Nova Science Publishers, New York, (2020).
2. AVSS Sambamurthy A Textbook of Algae, I.K. International Pvt. Ltd. New Delhi, (2017)
3. C. Vanden Hoek, D.G. Mann and H.M. Jahns . Algae – An introduction to Phycology, Cambridge University Press, (1995).
4. Kristian N. Hagen, Algae - Nutrition, Pollution Control and Energy Sources, Nova Science Publishers, 2009

#### REFERENCE BOOKS:

1. FaizalBux, Yu ufs Cgn n.s AahS s snJ igiJaJhD:s 6aJdui s Sids 6aJi ,s apanih as Oi aiS nJiSas 6uban gnih,sawn z aaSid,s IHP.
2. Gokare A. Ravishankar, Ambati Ranga Rao. Handbook of Algal Technologies and Phytochemicals, CRC Press, Taylor and Francis Group, 2019.

**BI3027**

**ENGINEERING PROPERTIES OF FOOD MATERIALS**

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

#### COURSE OBJECTIVES:

To study about the different methods of determining the quality and properties of different foods

To gain knowledge of engineering properties during processing, packing, storage and transport.

To impart knowledge about electrical properties of food and its applications in food engineering

#### UNIT I

#### PHYSICAL PROPERTIES OF FOODS

**9**

Methods of estimation of Shape, Size, volume, density, porosity and surface area, sphericity, roundness specific gravity. Frictional properties-coefficient of friction, Storage and flow pattern of agricultural crops

#### UNIT II

#### RHEOLOGICAL PROPERTIES OF FOODS

**9**

Definition – classification – Newton’s law of viscosity – momentum-diffusivity-kinematic viscosity – viscous fluids – Newtonian and Non Newtonian fluids Viscosity Measurements-Viscometers of different types and their applications-Texture measuring instruments Hardness and brittleness of Food materials.

#### UNIT III

#### THERMAL PROPERTIES OF FOODS

**9**

Definitions of Heat capacity, specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient, Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity, DTA, TGA, DSC.

#### UNIT IV

#### AERODYNAMIC PROPERTIES OF FOODS

**9**

Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials.

**UNIT V HYDRODYNAMIC PROPERTIES OF FOODS****9**

Water activity- measurement-vapor pressure method –freezing point depression method- Effect of temperature, and pressure on water activity-moisture sorption isotherms- models-Henderson, PET and GAB models.

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

The students will be able to

1. Understand Engineering properties of food materials.
2. Identify the structure and chemical composition of foods.
3. Determine the physical properties of food materials.
4. Calculate the water activity, food stability sorption and desorption isotherm of food materials.
5. Study the difference between Newtonian and non-Newtonian fluids.
6. Examine the thermal properties, electrical and magnetic properties of food.

**TEXT BOOKS**

1. Serpil Sahin and Servet Gulum Sumnu “Physical Properties of Foods”, Springer,USA, 2006.
2. Nuri N. Mohsenin: “Thermal Properties of Food & Agricultural materials”, Gordon and Reach science publishers, 1970.

**REFERENCE BOOKS**

1. Rao, M.A and S.S.H. Rizvi:”Engineering Properties of Foods”, Mercel Dekker inc. New York, 1998.
2. Lewis M.J, “Physical properties of foods and food processing systems” Woodhead publishing Cambridge, UK, 1990.
3. Reyonid Jewitt and others: “Physical properties of foods “Allied science publishers, 1983.
4. Shafiur Rehman: Food Properties Hand book CRC press inc. New York, 1995.
5. Micha Peleg and Edward B. Bagley, “Physical Properties of Foods” AVI publishing company inc, Westport USA, 1983.
6. Kachru R.P.and R.K. Gupta, “Physico – Chemical Constituents and Engineering Properties of Food crops”, Scientific publishers, Jodhpur.

**BI3028****STORAGE ENGINEERING****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

1. To enable the student to understand: The need for effective and scientific storage of food commodities.
2. To provide an opportunity for students to develop skills in evaluating storage structures and also to design structures for various perishable commodities.

**UNIT I STORAGE ENGINEERING****9**

Importance of scientific storage systems, post harvest physiology of semi-perishables and perishables, climacteric and non climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis; Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting).

**UNIT II INSECTS, PESTS AND RODENTS****9**

Destructive agents (rodents, birds, insects, etc.). Physico chemical and biological changes due to infestation, sources of infestation; Damage caused by rodents; Storage pests

**UNIT III INTEGRATED PEST CONTROL MECHANISMS****9**

Seed coating, fumigations- choice of fumigants, properties of fumigants, under wrap fumigation, fumigation of warehouses, detection of residual fumigants – mechanism and devices.. etc.

**UNIT IV STORAGE STRUCTURES****9**

Traditional storage structures, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos; Design of

storage structures: pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos.

**UNIT V STORAGE OF PERISHABLES 9**

Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage; functional, structural and thermal design of cold stores.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES :**

The students will be able to

1. Recognize the need for adaptation of scientific storage methodologies for food commodities.
2. Distinguish between traditional storage structures and modern storage structures.
3. Design and construct modified storage structure based on the requirement on the farm.
4. Calculate the amount of CO<sub>2</sub> & O<sub>2</sub> that can be permissible in systems that require a manipulation of the storage structures in terms of atmospheric conditions.
5. Criticize, evaluate and judge the efficiency of commercial storage structures.
6. Modify structures and environments to better fit the needs of commodities and consumer alike.

**TEXT BOOKS**

1. P.H. Pandey. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
2. Sahay K.M and K.K.Singh. "Unit Operations of Agricultural Processing" Vikas Publications, New Delhi, ISBN-81-259-1142-1, 2007.
3. A.M. Michael and T.P. Ojha. 2004. Principal of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.

**REFERENCE BOOKS**

1. Myer Kutz. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
2. L.W. Newbaver and H.B. Walker. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.
3. J. Whitaker. 2002. Agricultural Buildings and Structures. Reston Publishing Home, Reston, Virginia, USA

**BI3029 GREEN TECHNOLOGY IN FOOD PROCESSING L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

1. To provide basic knowledge of Green chemistry.
2. To provide the importance of eco-friendly methods of manufacture of various products.
3. To introduce the process intensification for Green chemistry.

**UNIT I INTRODUCTION TO GLOBAL AGRI FOOD SYSTEM 9**

Introduction – Characteristics of Global agri-food system – Types of food systems – Structures and layers - Agri-food supply chain – Key drivers of the Food chain – Industrialization of agriculture – Green revolution - Globalisation and agriculture – Environmental and sustainable agriculture certification

**UNIT II SUSTAINABILITY AND LIFE CYCLE ASSESSMENT (LCA) 9**

Concept of Sustainability – Green Chemistry and Sustainability parameters – LCA methodology – Methodological Framework – Applications of LCA – Product Oriented LCA – Process Oriented LCA

**UNIT III 9**

Green Technology in Food Processing – Supercritical and near-supercritical CO<sub>2</sub> processing and Sub-critical water extractions Properties of CO<sub>2</sub> – Environmental and safety advantages of using CO<sub>2</sub> in process- Operating a process economically with CO<sub>2</sub> - principles and

practice of supercritical fluid extraction – process systems and industrial applications - Sub critical water extraction – Industrial applications

**UNIT IV ELECTRODIALYSIS IN FOOD PROCESSING 9**

Basic principles of conventional Electrodialysis – Membranes – operating variables – Bipolar membranes and principle of Bipolar membranes - Green technologies applications of conventional and bipolar ED in food processing

**UNIT V EMERGING TECHNOLOGIES IN GREEN PROCESSING 9**

Microbial control in Foods using biopreservatives – Novel Thermal Technologies – Microwave Technology – Green technology in Food dehydrations – “Green drying” scheme - Energy efficient dryers – Green Packaging

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

The student will be able to

1. Understand the basics of Green Technology
2. Predict the efficiency of a system and relate it with Green Technology
3. Examine suitable processes towards Green processing of Foods
4. Choose an eco-friendly and cost-effective method of manufacture of products
5. To Improve existing methods for improved efficiency and economics
6. Develop novel methods for improved efficiency and economics

**TEXT BOOK:**

1. Joyce I. Boye and Yves Arcand. “Green Technologies in Food Production and Processing”, Springer Publications, 2012. e-ISBN 978-1-4614-1587-9

**REFERENCE BOOKS:**

1. James Clark and Duncan Macquarrie, “Handbook of Green Chemistry and Technology”, Blackwell Publishing, First Edition, ISBN – 0632057157, 2002.
2. Stanley E. Manahan. “Green Chemistry and the Ten commandments of Sustainability”, ChemChar Res. Inc., 2006. ISBN 0-9749522-4-9

**BI3030**

**BIOMASS AND BIOENERGY**

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

**COURSE OBJECTIVE:**

1. To make aware of various renewable feedstocks available for bioenergy
2. To elaborate on the concept of biofuel production from biomass
3. To analyze the policies & legislation in bioenergy sector

**UNIT I ENERGY CONCEPTS 9**

Fundamental concepts in understanding biofuel/bioenergy production, Renewable feedstocks and their production, Feedstocks availability, characterization and attributes for biofuel/bioenergy production

**UNIT II BIOMASS FEEDSTOCKS AND PROCESSING 9**

Biomass Conversion Technologies - Biorefinery Concept , Hydrolysis, enzyme & acid hydrolysis – Fermentation, Anaerobic digestion - Trans-esterification, Various biofuels/bioenergy from biomass

**UNIT III BIOMASS CONVERSION TECHNOLOGIES 9**

Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion, Biomass conversion to biofuel: thermochemical conversion, syngas fermentation, Biochemical conversion to ethanol: biomass pretreatment, Different enzymes, enzyme hydrolysis, and their applications in ethanol production

**UNIT IV BIODIESEL 9**  
Biodiesel production from oil seeds, waste oils and algae, Environmental impacts of biofuel production Value-added processing of biofuel residues and co-products, Emissions of biomass

**UNIT V WASTE TO ENERGY 9**  
Waste composition and Classification: Organic municipal waste, clinical waste, sewage sludge, agricultural waste, Waste & biomass materials handling. Energy processing from waste/biomass, Bio-energy policies & legislation at national and international level

**TOTAL:45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Understand the fundamental concepts of energy
2. Relate the principles underlying the design and operation of biomass to energy
3. Identify the bioconversion techniques and limitations in Biomass processing
4. Compare Biomass conversion processes
5. Analyze research issues in biodiesel production
6. Measure the Environmental impacts of biofuels and legislation

**TEXT BOOKS:**

1. Vaughn C. Nelson, Kenneth L. Starcher, Introduction to Renewable Energy. CRC Press; 2 edition 2016
2. Simona Ciuta, Demetra Tsiamis, Gasification of Waste Materials. Marco J. Castaldi. Academic Press (2017)
3. P. Chartier G.L. Ferrero U.M. Henius S. Hultberg J. Sachau M., Biomass for Energy and the Environment. Wiinblad. Pergamon (1997)
4. Bioenergy and Biochemicals Production from Biomass and Residual Resources, Editors: Dimitar Karakashev and Yifeng Zhang MDPI Publisher 2018

**REFERENCE BOOKS:**

1. Jianzhong Sun, Shi-You Ding, Joy D. Peterson, Laurie Peter, Heinz Frei, Ferdi Schuth, Tim S. Zhao, Tao Ling. Biological Conversion of Biomass for Fuels and Chemicals: Explorations from Natural Utilization Systems. Royal Society of Chemistry; 1 edition (2013).
2. Jens Holm-Nielsen, Ehiازه Augustine Ehimen Biomass Supply Chains for Bioenergy and Biorefining.. Woodhead Publishing (2016).

**BI3031 PLANT TISSUE CULTURE L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

1. To create awareness in plant biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants.

**UNIT I CELL AND TISSUE CULTURE 9**  
Definition and need; Types of Methods in plant Biotechnology; Cell and Tissue Culture; Micro propagation; Callus Culture; Somatic Embryogenesis; Hairy Root Culture; Culture Medias.

**UNIT II PLANT GENETIC ENGINEERING TOOLS 9**  
Vectors and Genetic Engineering; Agro bacterium mediated gene transfer and cloning; Agro bacterium types; Plant viruses and Genetic Engineered viruses as a tool of deliver foreign DNA; major plant viruses, Camv, TMV, BBTv, Gemini viruses etc.

**UNIT III APPLICATION OF PLANT BIOTECHNOLOGY 9**  
Hairy Root Cultures and Secondary Metabolite production; Plant as Bioreactors- edible Vaccines;

Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N<sub>2</sub> Fixation; Regulation of NIF and NOD Genes.

**UNIT IV SECONDARY METABOLITE PRODUCTION IN TISSUE CULTURE 9**  
Culture initiation, biotransformation, elicitation, hairy root culture, immobilization, permeabilization.

**UNIT V GREEN HOUSE OPERATION AND MANAGEMENT 9**  
Hardening and acclimatization of tissue cultured plants

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

1. Acquire knowledge in cell and tissue culture techniques.
2. Gain the knowledge about to plant genetic engineering tools.
3. Learn the various applications of plant tissue culture.
4. Understand the molecular concepts of disease resistance factors in plants.
5. Study the development of transgenic plants on abiotic and biotic factors
6. Assess about the scope and applications in plant biotechnology

**TEXT BOOKS:**

1. Mantal S.H., Mathew J.A., Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 2006.
2. Marx J.L., Revolution in Biotechnology, Cambridge University Press, 2002.

**REFERENCE BOOKS:**

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 2005.
2. R.C. Dubay and Maheswari. Introduction to Microbiology, S.Chand, 2002.

**BI3032 ANIMAL BIOTECHNOLOGY AND CELL CULTURE**

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

**COURSE OBJECTIVE:**

1. Develop skills of the students in the area of animal biotechnology
2. To impart technical knowledge in cell culture techniques
3. Provide knowledge in the various applications in cell culture and tissue engineering

**UNIT I INTRODUCTION TO CELL CULTURE 9**

Layout of cell culture laboratory, Introduction to basic culture techniques, chemically defined, serum and serum free media. Primary cell culture and types of primary culture, Establishment of cell line, Maintenance and preservation of cell line. Types of cell line, Availability of cell line

**UNIT II CELL SEPARATION AND CHARACTERIZATION 9**

Cell separation by density gradient, Fluorescent activated cell sorting, Characterization: Morphology, Chromosome analysis, Isoenzymes

**UNIT III SCALING UP OF CELL CULTURES AND TISSUE ENGINEERING 9**

Scaling up of Adherence and Suspension Cultures, Continuous flow culture, Cell culture as a source of various Products- Vaccine Production, 3D culturing, Protocols for 3D culturing of cells, Tissue Engineering applications with examples and Protocols

**UNIT IV MICROMANIPULATION OF EMBRYOS 9**

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals: Artificial insemination and germ cell manipulation, In vitro fertilization and Embryo transfer technology.

**UNIT V TRANSGENIC ANIMALS 9**

Molecular Diagnosis of animal diseases, Concepts of Transgenic Animal technology: Strategies for the development of Transgenic animals and their importance in Biotechnology,



## **COURSE OUTCOMES:**

The students will be able to

1. Define concepts in Animal Biotechnology
2. Describe the importance of Cryopreservation of embryos and embryo sexing in animals
3. Relate and evaluate the genetic defects in animal embryos through molecular diagnosis
4. Experiment the technology used for animal breeding
5. Comprehend the fundamental concepts of mammalian cell and generation of cell line and to demonstrate tissue engineering applications for implantable materials.
6. Design the strategies for livestock improvement through transgenesis with ethical concern.

## **TEXT BOOKS:**

1. R. Ian Freshney. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. John R.W. Masters, Animal cell culture 3rd ed., A Practical Approach Oxford University press New York 2009
3. Birbal Singh, Gorak Mal, Sanjeev K Goutam. Advances in Animal Biotechnology Springer; 1st ed. 2019 edition

## **REFERENCE BOOKS:**

1. Niemann, Heiner, Wrenzycki, Christine, Animal Biotechnology, Springer Publishing. 2018.
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare
3. John R.W. Masters, Animal Cell Culture 3rd ed., Oxford University Press, 2009.

**BI3034**

**CROP IMPROVEMENT**

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

## **COURSE OBJECTIVE:**

- To impart knowledge to the students on the botanical description, origin, distribution and various breeding approaches used for the development of varieties / hybrids in various kharif crops

## **UNIT I**

**9**

Centers of origin, distribution of species, wild relatives – Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeon pea, Urdbean, Mungbean, Soybean, Groundnut, Sesame, Castor, Cotton, Cowpea, Tobacco, Brinjal, Okra and Cucurbitaceous.

## **UNIT II**

**9**

Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative character. Important concept of plant breeding - self pollinated, Cross pollinated, Vegetatively propagated crops.

## **UNIT III**

**9**

Breeding objective and methods, procedure for developing hybrids / varieties - Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeon pea, Urdbean, Mungbean, Soybean, Groundnut, Sesame, Castor, Cotton, Cowpea.

## **UNIT IV**

**9**

Breeding objective and methods, procedure for developing hybrids / varieties - Tobacco, Brinjal, Okra and Cucurbitaceous. Breeding for abiotic stress and biotic stress. Genotype – Environment interaction and adaptation.

## **UNIT V**

**9**

Hybrid seed production technology – Rice, Maize, Sorghum, Pearl millet and Pigeon pea, Cotton. Ideotype concept and climate resilient crop varieties for future.



**COURSE OUTCOME:**

- The student will learn about basic concepts of classical, wild species methodologies employed for Kharif crops and current trends in plant breeding will be exposed.

**TEXT BOOKS**

1. Singh, B.D. 2007. Plant breeding - Principles and methods. Kalyani Publishers, New Delhi
2. Chopra, V.L. 2000. Breeding of Field Crops (Edt.). Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi
3. Manjit S. Kang 2004. Crop Improvement: Challenges in the Twenti-First Century (Edt). International Book Distributing Co. Lucknow.

**REFERENCE BOOKS**

1. Ram, H.H. and H.G. Singh. 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.
2. Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.
3. Phoelman, J.N. and Borthakur, 1969. Breeding Asian field crops .Oxford & IBH Publishing Co., New Delhi
4. Briggs, F.N. and P.F. Knowels, 1970. Introduction to plant breeding. Reinhold, New York.
5. Harihar Ram and Hari Govind Singh, 1994. Crop breeding and Genetics. Kalyani Publishers, New Delhi.

**BI3035****AGROCHEMICALS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To know about various agrochemicals and its usage in agricultural production
- To know about classification of herbicides, fungicides, insecticides

**UNIT I AN INTRODUCTION TO AGROCHEMICALS 9**

type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture.

**UNIT II HERBICIDES 9**

Major classes, properties and important herbicides. Fate of herbicides. Fungicides - Classification – Inorganic fungicides-characteristics, preparation and use of sulfur and copper, Mode of action Bordeaux mixture and copper oxychloride. Organic fungicides- Mode of action-Dithiocarbamates-characteristics, preparation and use of Zineb and maneb.Systemic fungicides-Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use.

**UNIT III INTRODUCTION AND CLASSIFICATION OF INSECTICIDES 9**

inorganic and organic insecticides Organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids Neonicotinoids, Biorationals, Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil & plant. IGRs Biopesticides, Reduced risk insecticides, Botanicals, plant and animal systemic insecticides their characteristics and uses. Plant biopesticides for ecological agriculture, Bio-insect repellent

**UNIT IV FERTILIZERS AND THEIR IMPORTANCE. NITROGENOUS FERTILIZERS 9**

Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers. Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers: Natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate.

**UNIT V MIXED AND COMPLEX FERTILIZERS 9**

Sources and compatibility–preparation of major, secondary and micronutrient mixtures. Complex fertilizers:Manufacturing of ammonium phosphates, nitro phosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing.



### **COURSE OUTCOMES:**

The students will be able to

1. Define the different unit operations and its equipments involved in coffee, tea and cocoa processing.
2. Gain knowledge in processing of plantation crops and spices and also its value added products.
3. Outline ways in which quality loss can be minimised during preparation and processing.
4. Develop value added products from plantation products and spices.
5. Demonstrate appropriate technique for the extraction of spice oil and oleoresin with quality standards.
6. Acquire a confidence to get placement in any kind of cereals and spices industry with minimum post harvest losses and maximum benefit to the industry.

### **TEXT BOOKS:**

1. Srivastava RP & Sanjeev Kumar. 1994. Fruit and Vegetable Preservation. Principles and Practices. International Book Distr. ISBN 13: 9788123924373
2. Verma LR & Joshi VK. 2000. Post Harvest Technology of Fruits and Vegetables. Vols. I-II. Indus Publ. ISBN : 8173871086
3. Banerjee, B. Tea Production and Processing, (Oxford & IBH Pub. Co., 1993). ISBN : 8120408020, 9788120408029
4. Sivetz, M. Coffee Technology, (AVI publishing Co., 1979). ISBN-13: 978-0870552694
5. Purthi, J. S. Major Spices of India: Crop Management and Post Harvest Technology, (ICAR publication, 2003)
6. Purthi, J. S. Minor Spices and Condiments: Crop Management and Post Harvest Technology, (ICAR publication, 2001)

### **REFERENCE BOOKS:**

1. Salunkhe, D. K. and Kadam, S. S. Handbook of Fruit Science and Technology: Production, Composition, Storage, and Processing, (CRC Press, 1995). ISBN-13: 978-0824796433
2. Sumanbhatti & Uma Varma. 1995. Fruit and Vegetable Processing. CBS. ISBN 10: 8123904045 ISBN 13: 9788123904047
3. Thompson AK. 1996. Post Harvest Technology of Fruits and Vegetables. Blackwell. ISBN13: 978-0632040377
4. Jain, N. K. Global Advances in Tea Science, (Aravali Books International, 1999). ISBN-10: 8186880127
5. Clifford, M. N. and Willson, K. C. Coffee: Botany, Biochemistry and Production of Beans and Beverage, (AVI publishing Co., 1985). ISBN 978-1-4615-6657-1

**BI3037**

**ENVIRONMENTAL POLLUTION CONTROL ENGINEERING**

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

### **COURSE OBJECTIVE:**

1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

### **UNIT I POLLUTION CONTROL ACTS**

**9**

The water (prevention and control of pollution) act 1974 and rules 1975- CPCB-form XIII,XIV,XV, The air (prevention and control of pollution) act 1981 and rules 1982,CPCB-form I,VI. National ambient air quality standards.

### **UNIT II ENVIRONMENT PROTECTION ACT**

**9**

The environment (protection) act 1986, rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants. Form V

**UNIT III ENVIRONMENTAL IMPACT ASSESSMENT 9**  
Environmental impact assessment notification, 2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA, Environment management, Environment Audit

**UNIT IV BIOSAFETY 9**  
The manufacture, use, import, export and storage of hazardous microorganisms genetically engineered organisms or cells rules, 1989-definitions, competent authorities, animal and human pathogens

**UNIT V WASTE DISPOSAL 9**  
Biomedical waste (management and handling) 1998,-categories of biomedical waste, colour coding and type of container for disposal of biomedical wastes. Transport of biomedical waste containers/bags (schedule IV), standards for treatment and disposal of biomedical wastes (schedule V), waste management facilities like incinerator/autoclave/microwave system, form-I,II,III.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

The students will be able to

1. Understand basics of pollution and its types
2. Remember Pollution control acts and regulations.
3. Apply bio safety principles in pollution control.
4. Evaluate audit reports on pollution control.
5. Evaluate various approaches for biomedical waste treatment and disposal
6. Analyse various recycling methods

**TEXT BOOK:**

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

**REFERENCE BOOKS**

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman Hall, 1995.

**BI3038**

**MEDICAL WASTE TREATMENT**

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

**COURSE OBJECTIVES:**

1. To identify the modes of medical waste treatment
2. To understand the pollution and health hazards
3. To analyze the methods of water treatment

**UNIT I CLASSIFICATION OF MEDICAL WASTES 9**  
Sources and classification of medical waste-color code-handling, sterilization, treatment.

**UNIT II ENVIRONMENTAL HAZARDS 9**  
Hazards –personal safety-environmental pollution-health hazards.

**UNIT III WASTE TREATMENT AND MONITORING SYSTEM 9**  
Medical waste treatment system-temperature and level control, toxic gas detector-design of alarm system-central monitoring- pollution monitoring system

**UNIT IV INSTRUMENTS FOR MONITORING 9**

Water pollution-central monitoring system, Proper disposal of wastes , incinerator. Temperature level and flow control for computer applications in central monitoring system

**UNIT V CASE STUDIES 9**

Hospital Managements , collection , transportation and safe disposal-regulations, ethical issues in waste disposal.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Outline about Medical wastes and its disposal
2. Practice the ways of preventing pollution and personal safety
3. Design of instrumentation and control techniques for potable water treatment
4. Gains knowledge in computer monitoring system
5. Summarize the instruments in waste disposal and its uses
6. Develop knowledge for medical waste disposals in hospitals.

**TEXT BOOK:**

1. P.K. Behera, "Sustainable biomedical waste management", Dominant Publishers And Distributors, 3rd edition, 1993.

**REFERENCES:**

1. Dr. Shalini Sharma, SVS Chauhan, "An analysis of medical waste management", Lambert publisher, 2000.
2. Etcalf & Eddy, "Wastewater Engineering (Treatment and Reuse)", 4th Edn, Tata – McGraw Hill, New Delhi, 2003.
3. Mark J. Hammer.: "Water and waste water technology" – 5th Edn", Prentice Hall of India Pvt. Limited, New Delhi, 2007.
4. James M. Montgomery.: "Water treatment principles and design" – A Wiley Interscience Publication, New York, 1985.

**BI3039**

**ROLE OF BIOTECHNOLOGY IN ENVIRONMENT**

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

**COURSE OBJECTIVES:**

1. To learn the importance of biotechnology
2. To impart knowledge on environment
3. To understand the significance of conservation

**UNIT I SCOPE OF ENVIRONMENTAL BIOTECHNOLOGY 9**

Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust.

**UNIT II INDUSTRIAL WASTE WATER MANAGEMENT 9**

Purification of waste water; Aerobic and anaerobic treatments; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors. Bio accumulation – Bio magnification. Biological control. Principles of environment Impact. Assessment and environmental monitoring.

**UNIT III BIOMASS, ENERGY AND SOLID WASTE MANAGEMENT 9**  
Biomass waste as renewable source of energy; Methods of energy production; Conversion of Solid Waste to Methane; Biogas production; Biofuels, Management of Sludge and Solid waste treatment- Land filling, lagooning, Composting and Vermi Composting.

**UNIT IV BIODIVERSITY TYPES 9**  
Definition, Types, Genetic, Species, Ecosystem; Biodiversity at Global Levels; Values of Biodiversity; Hotspots in Biodiversity; Loss of Biodiversity and its causes threats to Biodiversity; A general account on multilateral treaties- the role of CBD, IUCN, GEF, IBPGR, NBPGR, WWF, FAO, UNESCO and CITES Bioresources

**UNIT V BIOREMEDIATION AND BIODEGRADATION 9**  
Types- Ex situ and In situ , Bioremediation genetically Engineered Microbes for Bioremediation. Applications of genetic engineering- Transgenic animals-cow, sheep and rabbit

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

1. Acquire knowledge on the scope of biotechnology
2. Classify the health hazards of various pollutants
3. Explain importance of waste water treatment
4. Understand the significance of waste management
5. Outline the various bioremediation techniques
6. Adapt the conservation of biodiversity

**TEXT BOOKS:**

1. Dubey, R.C. "Text Book of Biotechnology", S. Chand & Co, 2nd edition, 2004.
2. Chatterjee, Introduction to Environmental Biotechnology, PHI Learning Pvt Ltd, 3rd Edition 2011
3. Indu Shekhar Thakur Environmental Biotechnology: Basic Concepts and Applications, IK International Publishing House Pvt Ltd, 2011

**REFERENCE BOOKS:**

1. Foster C.F; Johnware D.A, "Environmental Biotechnology", Ellis Harwood Ltd. 3rd edition, 2003.
2. Gupta P.K. "Elements of Biotechnology", Rastogi Publications, 2004.

**BI3040 OCCUPATIONAL SAFETY MANAGEMENT L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

1. To know about the health issues and safety principles
2. To apply safety practice through training methods
3. To know the occupational safety and health Act and its applications

**UNIT I 9**  
Personal Health and Safety - personal health and safety at home and in the workplace, blood borne virus, hepatitis B, HIV, dermatitis, skin care, Personal Safety - emergency first aid treatment - reaction to accidents, reporting of accidents, pro-active procedures when accidents occur, cleaning the accident site, personal safety wear and protective equipment.

**UNIT II 9**  
Accidents & Their Effect on Industry - costs of accidents, work accident costs and rates, time lost - work injuries, parts of the body injured on the job - chemical burn injuries, Carpal Tunnel, Syndrome Injuries, Drugs and Alcohol in the Workplace. Theories of Accidents - Domino Theory of Accident Causation, Human Factors Theory of Accident Causation, Accident/Incident Theory of Accident Causation, Epidemiological Theory of Accident Causation, Systems Theory of Causation, Combination Theory of Accident Causation.

**UNIT III****9**

Regulatory matter-Occupational Safety and Health Act (OSHA) of 1971, compliance with established regulations-safe equipment and management supervision, Hazardous Material Information, System - routes of entry into the body of toxic materials, general safety precautions, cleaning chemical spills, MSDS sheets, Falling, Impact, Acceleration and Lifting Hazards - correct lifting techniques, selecting correct lifting procedures in the workplace, safety equipment, safe storage of materials at home and in the workplace, dealing with manual handling, Workers Compensation -injuries and workers compensation, workers' compensation legislation, resolution of workers' compensation disputes. Roles of Health and Safety Personnel - the modern health and safety team, health and safety manager, engineers and safety

**UNIT IV****9**

Stress and Safety - workplace stress defined, sources of workplace stress, human reaction to workplace stress, measurement of workplace stress, shift work, stress and safety, improving safety by reducing stress, stress in safety managers, stress and workers compensation. Mechanical Hazards and Safeguarding - common mechanical injuries, safeguarding defined, lockout/tag out systems, taking corrective action, Heat and Temperature Hazards - the body's response to heat, heat stress and its prevention, overview of cold hazards, preventing cold stress, Fire Hazards - sources of fire hazards, fire dangers to humans, detection of fire hazards, reducing fire hazards, development of Fire Safety Standards, fire safety myths, fire hazards defined, Noise and Vibration Hazards, hazards levels and risks, identifying and assessing hazardous noise conditions, noise control strategies, vibration hazards.

**UNIT V****9**

First aid in emergencies - reporting accident, Promoting Safety, safety committees. Health and Safety Training - rationale for health and safety training, Industrial Hygiene - hazards in the workplace, entry points for toxic agents, airborne contaminants, asbestos hazards, hazard recognition, evaluation and control. Importance of Computers, Automation and Robots, Safety and the Environment, Product Safety and Liability and Ergonomics and Safety.

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

The students will be able to

1. Identify hazards in the home or workplace that pose a danger to their safety or health.
2. Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
3. Present a coherent analysis of a potential safety or health hazard.
4. Discuss the role of health and safety in the workplace pertaining to the responsibilities of workers, managers, supervisors.
5. Indicate a comprehension of the changes created by OSHA in everyday life.
6. Identify the decisions required to maintain protection the environment, home and workplace as well as personal health and safety.

**TEXT BOOK:**

1. Mark A. Friend, James P. Kohn, "Fundamentals of Occupational Safety and Health, Bernan Press, 23-Jun-2014.

**REFERENCE BOOKS:**

1. Geoff Taylor, Kellie Easter, Roy Hegney, "Enhancing Occupational Safety and Health", Elsevier ButterworthHeinemann, 2004.
2. Occupational safety Manual, BHEL, Trichy, 1988

**COURSE OBJECTIVE:**

1. To inculcate the knowledge among students about safety procedures
2. To understand the risk analysis and assessment
3. To learn and understand hazard identification

**UNIT I NEED FOR SAFETY****9**

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

**UNIT II SAFETY PROCEDURES****9**

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

**UNIT III PLANNING AND RISK ASSESSMENT****9**

Overall risk analysis-emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies.

**UNIT IV QUANTITATIVE RISK ASSESSMENT****9**

Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

**UNIT V SAFETY AUDITS****9**

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag Bopal analysis .Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop studycase studies-pumping system-reactor-mass transfer system.

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

The students will be able to

1. Understand plant safety in selection and layout of chemical plants and the usage of safety codes.
2. Distinguish the chemical, fire and explosion hazards
3. Relate the occupational diseases
4. Analyze the bio medical and engineering response to health hazards
5. Evaluate the effective process control and instrumentation methods
6. Create awareness the usage of safety codes

**TEXT BOOKS**

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 3rd edn. 2011.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

**REFERENCES**

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994.



**COURSE OBJECTIVES:**

- The study of the subject constitutes the sources, characteristics of waste water Provides various methods for treatment of wastewater.
- It imparts the knowledge of basic principles of science and engineering applied to the problem of water pollution.
- The study also focuses on a creative perspective in using equipments used for effluent treatment and knowing how it is designed and how it works.

**UNIT I****9**

Introduction to industrial effluents and their treatments, Waste water constituents (Physical, Biological and Chemical). Metallic and Non metallic constituents.

**UNIT II****9**

Mixing, types of mixers. Screening, types of industrial screening devices. Grit removal, Sedimentation and their Processes

**UNIT III****9**

Aeration Systems, Filtration Systems and devices. Coagulation- definition and types of coagulation processes and types of coagulants used (Chemical, Biological)

**UNIT IV****9**

Adsorption – Types of natural adsorbants, Chemical Adsorption for phosphorous removal, removal of heavy metals (Cadmium,Lead,Mercury) by adsorption techniques.

**UNIT V****9**

Biological treatment and processes involved for effluents- Activated Sludge process, Oxidation ponds, Attached growth and biological trickling filters.

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

The students will be able to

1. Gain basic knowledge on waste water treatment.
2. Understand the principles to design equipments for waste eater treatment.
3. Apply principles on real time environment.
4. Analyze conceptually the need for the effluent treatment.
5. Evaluate the volumetric flow rates and output rates of the treatment devices.
6. Create basic parameters or equipments for using in the effluent treatment processes.

**TEXT BOOKS:**

1. Metcalf & Eddy, "Wastewater Engineering (Treatment and Reuse)", 4th Edn, Tata – McGraw Hill, New Delhi, 2003.

**REFERENCE BOOKS**

1. Mark J. Hammer.: "Water and waste water technology" – 5thEdn", Prentice Hall of India Pvt. Limited, New Delhi, 2007

## 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 Univ Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

#### **3.1 Textbook:**

3.2 \*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

### **4. OTHER SESSION:**

4.1\*Tutorials:

4.2\*Laboratory:

4.3\*Project: The students will write a term paper to show their understanding of a particular piece of literature

### **5.\*ASSESSMENT:**

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL : 45 PERIODS**

### **OUTCOME OF THE COURSE:**

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

### Theme - A: The Component of Films

- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making... structure of a film

### Theme - B: Evolution of Film Language

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

### Theme - C: Film Theories and Criticism/Appreciation

- C-1: Realist theory; Auteurs
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

### Theme – D: Development of Films

- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

### Theme - E: Indian Films

- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

### READING:

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

### COURSE OBJECTIVE

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

### UNIT I HAZARDS, VULNERABILITY AND DISASTER RISKS

9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

**UNIT II           DISASTER RISK REDUCTION (DRR)****9**

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

**UNIT III           DISASTER MANAGEMENT****9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmes and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

**UNIT IV           TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT****9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

**UNIT V           DISASTER MANAGEMENT: CASE STUDIES****9**

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

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

- 1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
- 2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
- 3 Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
- 4 Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10: 1259007367, ISBN-13: 978-1259007361**

**REFERENCES**

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

**COURSE OUTCOME:**

- CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)
- CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction
- CO3:** To develop disaster response skills by adopting relevant tools and technology
- CO4:** Enhance awareness of institutional processes for Disaster response in the country and
- CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

## CO's – PO's & PSO's MAPPING

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

### MANDATORY COURSES II

**MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA** **LT PC**  
**3 0 0 0**

#### **COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

#### **UNIT I HEALTH AND ITS IMPORTANCE** **2+4**

**Health: Definition - Importance of maintaining health** - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.

**Present health status** - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders** - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness** - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health** - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

#### **UNIT II DIET** **4+6**

**Role of diet in maintaining health** - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension

– PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components** - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

#### **Definition of BMI and maintaining it with diet**

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

#### **Common cooking mistakes**

Different cooking methods, merits and demerits of each method

### **UNIT III      ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH      4+4**

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory - Panchekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

#### **Prevention of illness with our traditional system of medicine**

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

### **UNIT IV      MENTAL WELLNESS      3+4**

**Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management** - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep** - Sleep and its importance for mental wellness - Sleep and digestion.

**Immunity** - Types and importance - Ways to develop immunity

### **UNIT V      YOGA      2+12**

**Definition and importance of yoga** - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

#### **TEXT BOOKS:**

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners\_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

## REFERENCES:

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
  1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/>
  2. **Simple lifestyle modifications to maintain health** <https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.>
  3. **Read more:** <https://www.legit.ng/1163909-classes-food-examples-functions.html>
  4. <https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926>
  5. **Benefits of healthy eating** <https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html>
  6. **Food additives** <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives>
  7. **BMI** <https://www.hsph.harvard.edu/nutritionsource/healthy-weight/>  
<https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
  8. **Yoga** <https://www.healthifyme.com/blog/types-of-yoga/>  
<https://yogamedicine.com/guide-types-yoga-styles/>  
**Ayurveda** : <https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda>
  9. **Siddha** : [http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid\\_Siddha\\_Concepts.asp](http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp)
  10. **CAM** : <https://www.hindawi.com/journals/ecam/2013/376327/>
  11. **Preventive** herbs : <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/>

## COURSE OUTCOMES:

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

**MX3086**

**HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA**

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

### **UNIT-I CONCEPTS AND PERSPECTIVES**

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

### **UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

### **UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology





(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 posture and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

### **UNIT V HAZARD IDENTIFICATION TECHNIQUES**

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES**

on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

### **TEXTBOOKS**

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

### **REFERENCES**

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring. (1996). Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

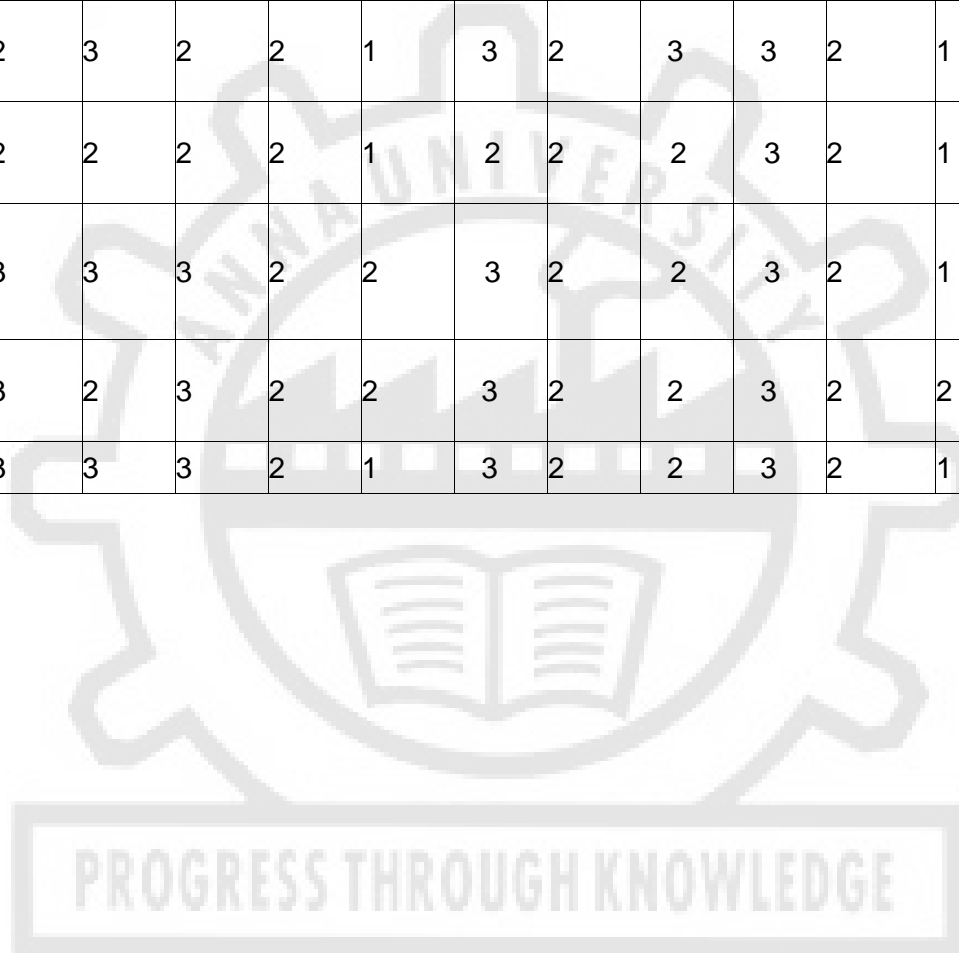
### **ONLINE RESOURCES**

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>

Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
<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 PERIODS: 60**

## TEXT BOOK

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

## REFERENCES

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352**

**IOT CONCEPTS AND APPLICATIONS**

**L T P C**  
**2 0 2 3**

## OBJECTIVES:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

## UNIT I INTRODUCTION TO INTERNET OF THINGS

**5**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

## UNIT II COMPONENTS IN INTERNET OF THINGS

**5**

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

## UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT

**6**

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

**UNIT IV OPEN PLATFORMS AND PROGRAMMING** **7**  
IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

**UNIT V IOT APPLICATIONS** **7**  
Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture  
**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5. Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10. Design an IOT based system

**OUTCOMES:**

**CO 1:** Explain the concept of IoT.

**CO 2:** Understand the communication models and various protocols for IoT.

**CO 3:** Design portable IoT using Arduino/Raspberry Pi /open platform

**CO 4:** Apply data analytics and use cloud offerings related to IoT.

**CO 5:** Analyze applications of IoT in real time scenario.

**TOTAL PERIODS:60**

**TEXTBOOKS**

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

**REFERENCES**

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. ArshdeepBahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015
6. <https://www.arduino.cc/>  
[https://www.ibm.com/smarterplanet/us/en/?ca=v\\_smarterplanet](https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet)

**OCS353**

**DATA SCIENCE FUNDAMENTALS**

**L T P C**  
**2 0 2 3**

**COURSE OBJECTIVES:**

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.



**UNIT I INTRODUCTION 6**  
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

**UNIT II DATA MANIPULATION 9**  
Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

**UNIT III MACHINE LEARNING 5**  
The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

**UNIT IV DATA VISUALIZATION 5**  
Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

**UNIT V HANDLING LARGE DATA 5**  
Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS**

**PRACTICAL EXERCISES:**

**30 PERIODS**

**LAB EXERCISES**

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
  - a) Frequency distributions
  - b) Mean, Mode, Standard Deviation
  - c) Variability
  - d) Normal curves
  - e) Correlation and scatter plots
  - f) Correlation coefficient
  - g) Regression
6. Use the standard benchmark data set for performing the following:
  - a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
  - b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

**Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.**

## COURSE OUTCOMES:

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

- CO1: Gain knowledge on data science process.
- CO2: Perform data manipulation functions using Numpy and Pandas.
- CO3: Understand different types of machine learning approaches.
- CO4: Perform data visualization using tools.
- CO5: Handle large volumes of data in practical scenarios.

**TOTAL PERIODS:60**

## TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

## REFERENCES

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

**CCS333**

**AUGMENTED REALITY/VIRTUAL REALITY**

**L T P C**  
**2 0 2 3**

## OBJECTIVES:

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

## UNIT I INTRODUCTION

**7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

## UNIT II VR MODELING

**6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants – Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

## UNIT III VR PROGRAMMING

**6**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

## UNIT IV APPLICATIONS

**6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY**

5

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-  
Navigation-Wearable devices**30 PERIODS****PRACTICAL EXERCISES:****30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL PERIODS:60****OUTCOMES:****On completion of the course, the students will be able to:****CO1:** Understand the basic concepts of AR and VR**CO2:** Understand the tools and technologies related to AR/VR**CO3:** Know the working principle of AR/VR related Sensor devices**CO4:** Design of various models using modeling techniques**CO5:** Develop AR/VR applications in different domains**TEXTBOOKS:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003

**CO's – PO's & PSO's MAPPING**

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
<b>1</b>	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2
<b>2</b>	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2
<b>3</b>	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2
<b>4</b>	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2
<b>5</b>	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3
<b>AVg.</b>	<b>3.00</b>	<b>2.60</b>	<b>2.40</b>	<b>2.00</b>	<b>3.00</b>	-	-	-	<b>2.80</b>	<b>2.20</b>	<b>1.80</b>	<b>2.60</b>	<b>2.80</b>	<b>1.80</b>	<b>2.20</b>

### OPEN ELCTIVE III

OHS351

ENGLISH FOR COMPETITIVE EXAMINATIONS

L T P C  
3 0 0 3

#### **Course Description:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

#### **Objectives:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

#### **UNIT I**

9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

#### **UNIT II**

9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

#### **UNIT III**

9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

#### **UNIT IV**

9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

#### **UNIT V**

9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS**

## LEARNING OUTCOMES:

At the end of the course, learners will be able

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence
- understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- communicate effectively in group discussions, presentations and interviews
- write topic based essays with precision and accuracy

## CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
AVg.	2	2.6	2.6	2	2.6	2.6	2.6	2.6	2	3	2.4	3	-	-	-

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

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

### Teaching Methods:

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

### Evaluative Pattern:

Internal Tests – 50%

End Semester Exam - 50%

### TEXTBOOKS:

1. R.P.Bhatnagar - *General English for Competitive Examinations*. Macmillan India Limited, 2009.

### REFERENCEBOOKS:

1. Educational Testing Service - *The Official Guide to the GRE Revised General Test*, Tata McGraw Hill, 2010.
2. *The Official Guide to the TOEFL Test*, Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations*, McGraw Hill Education (India) Private Limited, 2008.

### Websites

<http://www.examenenglish.com/>, <http://www.ets.org/>, <http://www.bankxams.com/>

<http://civilservicesmentor.com/>, <http://www.educationobserver.com>

<http://www.cambridgeenglish.org/in/>

**OBJECTIVE:**

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

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

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

**UNIT II LEAN MANAGEMENT****9**

Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction -Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

**UNIT III CORE CONCEPTS IN LEAN****9**

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

**UNIT IV LEAN TOOLS AND TECHNIQUES****9**

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting-Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

**UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY****9**

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

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

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

**CO1** Explains the contemporary management techniques and the issues in present scenario.

**CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.

**CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.

**CO4** Apply lean techniques to achieve sustainability in construction projects.

**CO5** Apply lean construction techniques in design and modeling.

**REFERENCES:**

- 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 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.

**CME365**

**RENEWABLE ENERGY TECHNOLOGIES**

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

**COURSE OBJECTIVES**

- 1 To know the Indian and global energy scenario
- 2 To learn the various solar energy technologies and its applications.
- 3 To educate the various wind energy technologies.
- 4 To explore the various bio-energy technologies.
- 5 To study the ocean and geothermal technologies.

**UNIT – I**

**ENERGY SCENARIO**

**9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

**UNIT – II**

**SOLAR ENERGY**

**9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.



**UNIT – III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

**UNIT – IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

**UNIT – V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

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

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

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

- Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
- Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

**REFERENCES:**

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

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

**OBJECTIVES:**

The course aims to

- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

**UNIT I DESIGN THINKING PRINCIPLES 9**

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

**UNIT II ENDUSER-CENTRIC INNOVATION 9**

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

**UNIT III APPLIED DESIGN THINKING TOOLS 9**

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

**UNIT IV CONCEPT GENERATION 9**

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

**UNIT V SYSTEM THINKING 9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

**TOTAL: 45 PERIODS**

**Course Outcomes**

**At the end of the course, learners will be able to:**

- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

**TEXT BOOKS**

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadacos, (2014), Value 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.

<b>OPR351</b>	<b>SUSTAINABLE MANUFACTURING</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:**

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT – I ECONOMIC SUSTAINABILITY 9**

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

**UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9**

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT – III SUSTAINABILITY PRACTICES 9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model.

**UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT – V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

CO1: Discuss the importance of economic sustainability.

CO2: Describe the importance of sustainable practices.

CO3: Identify drivers and barriers for the given conditions.

CO4: Formulate strategy in sustainable manufacturing.

CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

Mapping of COs with POs and PSOs															
COs/Pos & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

**TEXT BOOKS:**

- 1 Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
- 2 Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.

**REFERENCES:**

- 1 Jovane F, Eµper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer,2009, United States, ISBN 978-3-540-77011-4.
- 2 Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
- 3 Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

**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

**OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I          STANDARD ATMOSPHERE****6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II          AERODYNAMICS****10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III        PERFORMANCE AND PROPULSION****9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

**UNIT IV        AIRCRAFT STABILITY AND STRUCTURAL THEORY****10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V          SPACE APPLICATIONS****10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

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

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

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

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions

- To know about the Supply Chain Management

### UNIT I INTRODUCTION

9

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

### UNIT II FUNCTIONS OF MANAGEMENT

9

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

### UNIT III ORGANIZATIONAL BEHAVIOUR

9

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

### UNIT IV GROUPOYNAMICS

9

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

### UNIT V MODERN CONCEPTS

9

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

CO1: Understand the basic concepts of industrial management

CO2: Identify the group conflicts and its causes.

CO3: Perform swot analysis

CO4 : Analyze the learning curves

CO5 : Understand the placement and performance appraisal

### REFERENCES:

Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008

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



3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
AVg.	2	2.2	2.3	3									1.8	2	2.6

OIE354

**QUALITY ENGINEERING**

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

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION**

**9**

Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROL CHARTS**

**9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X, R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES**

**9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICAL PROCESS CONTROL**

**9**

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

**UNIT V ACCEPTANCE SAMPLING**

**9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to:

**CO1:** Control the quality of processes using control charts for variables in manufacturing industries.

**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.

**CO3:** Control the occurrence of defects in services.

**CO4:** Analyzing and understanding the process capability study.

**CO5:** Developing the acceptance sampling procedures for incoming raw material.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
AVg.	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1



- 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	-	-	-
<b>Avg.</b>	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-

**OML351 INTRODUCTION TO NON-DESTRUCTIVE TESTING**

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

**COURSE OBJECTIVES:**

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

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

**UNIT I INTRODUCTION TO NDT & VISUAL TESTING**

**9**

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibrosopes – light sources and special lighting.

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

**9**

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.  
Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

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

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

**UNIT IV      ULTRASONIC TESTING & AET      9**

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V      RADIOGRAPHY TESTING      9**

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Realize the importance of NDT in various engineering fields.
2. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
3. Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.
4. Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.
5. Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCES:**

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3			2	2				2	1	2	
C02	3	1	2	2			2	2				2	2	2	1
C03	3	2	1	2			2	2				2	2	2	
CO4	3	1	2	2			2	2				2	2	2	2
CO5	3	2	2	2			2	2				2	2	2	1
Avg	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

**OMR351**

**MECHATRONICS**

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

**COURSE OBJECTIVES:**

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

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

**UNIT – I INTRODUCTION AND SENSORS 9**

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.

**UNIT – II 8085 MICROPROCESSOR 9**

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE 9**

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

- CO1: Select sensors to develop mechatronics systems.  
CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.  
CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

CO 4: Apply PLC as a controller in mechatronics system.

CO 5: Design and develop the apt mechatronics system for an application.

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

### TEXT BOOKS

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

### REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

**ORA351**

**FOUNDATION OF ROBOTICS**

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

### COURSE OBJECTIVES:

1. To study the kinematics, drive systems and programming of robots.
2. To study the basics of robot laws and transmission systems.
3. To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4. To familiarize students with the various Programming and Machine Vision application in robots.
5. To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

### UNIT – I FUNDAMENTALS OF ROBOT

**9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

### UNIT – II ROBOT KINEMATICS

**9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation

matrices, translation and rotation matrices.

**UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT – IV SENSORS IN ROBOTICS 9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT – V PROGRAMMING AND APPLICATIONS OF ROBOT 9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

- CO1: Interpret the features of robots and technology involved in the control.
- CO2: Apply the basic engineering knowledge and laws for the design of robotics.
- CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.
- CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.
- CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

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

**TEXT BOOKS:**

1. Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 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

**TEXTBOOKS :**

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

**REFERENCES :**

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

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

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

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

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

OEE352

**ELECTRIC VEHICLE TECHNOLOGY**

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

**COURSE OBJECTIVES**

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

**UNIT I ROTATING POWER CONVERTERS**

**9**

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

**UNIT II STATIC POWER CONVERTERS**

**9**

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

**UNIT III CONTROL OF DC AND AC MOTOR DRIVES**

**9**

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and

braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

**UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9**

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

**UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES 9**

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1: Able to understand the principles of conventional and special electrical machines.
- CO2: Acquired the concepts of power devices and power converters
- CO3: Able to understand the control for DC and AC drive systems.
- CO4: Learned the electric vehicle architecture and power train components.
- CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	2			3								3	3	3
<b>CO2</b>	3	2	2			3			3				3	3	3
<b>CO3</b>	3			3		2	2						3	3	3
<b>CO4</b>	3	2	2		3								3	3	3
<b>CO5</b>	3		2								2		3	3	3
<b>Avg</b>	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 andApplications, Pearson publication

**List of Open Source Software/ Learning website:**

1. <https://nptel.ac.in/courses/108105063>
2. <https://www.electrical4u.com/industrial-automation/>
3. <https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf>
4. <https://www.electrical4u.com/industrial-automation/>

**MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES**

PO,PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1					1		1					
CO2	3	3	2					1		1	2				2
CO3	3	3	3	3	1			1		1					
CO4	3	3		3	3			1		1			3	3	
CO5	3	3	3	2	1			1		1			3	3	3
<b>Avg</b>	3	2.9	2.25	2.6	1.6			1		1			3	3	2.9

**OCH351**

**NANO TECHNOLOGY**

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

**UNIT I INTRODUCTION**

**8**

General definition and size effects–important nano structured materials and nano particles-importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT II SYNTHESIS OF NANOMATERIALS**

**8**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT III NANO COMPOSITES**

**10**

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

**UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES**

**10**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

**UNIT V APPLICATIONS OF NANO MATERIALS**

**9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots-Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS**



## OUTCOMES:

- CO1 Understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.
- CO2 Able to acquire knowledge about the different types of nano material synthesis
- CO3 Describes about the shape, size, structure of composite nano materials and their interference
- CO4 Understand the different characterization techniques for nanomaterials
- CO5 Develop a deeper knowledge in the application of nanomaterials in different fields.

## TEXT BOOKS

1. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" Imperial College Press, 2004
3. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 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	Statements	Program Outcomes															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	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	2	2	1	3	3	1	1	1	1	1	1	3	2	1	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 MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**  
Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**  
Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**  
Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**  
Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**  
International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

**REFERENCES:**

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

**COURSE OUTCOME**

The student will be able to

- C1** Understand and differentiate the categories of intellectual property rights.
- C2** Describe about patents and procedure for obtaining patents.
- C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
- C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
- C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
- C6** Understand the interrelationships between different Intellectual Property Rights on International Society

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

OTT351

**BASICS OF TEXTILE FINISHING**

**LT PC  
3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

**UNIT I RESIN FINISHING**

**9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

**UNIT II FLAME PROOF & WATERPROOF**

**9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES**

**9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES**

**9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING**

**9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

CO: 1 Basics of Resin Finishing Process.

CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

**TEXT BOOKS:**

- V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
- Perkins, W.S., "Textile colouration and finishing", Carolina Academic Press., U.K, ISBN: 0890898855.2004.

**REFERENCES:**

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

**OTT352****INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY****L T P C****3 0 0 3****OBJECTIVES:**

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

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

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

**UNIT II WORK STUDY****9**

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

**UNIT III METHOD STUDY****9**

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

**UNIT IV WORK MEASUREMENT****9**

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

**UNIT V WORK STUDY APPLICATION****9**

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

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

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity

CO2: Method study

CO3: Motion analysis

CO4: Work measurement and SAM

CO5: Ergonomics and its application to garment industry

### TEXTBOOKS:

1. George Kanwaty, "Introduction to Work Study ", ILO, Geneva, 1996, ISBN: 9221071081 | ISBN-13: 9789221071082
2. Enrick N. L., "Time study manual for Textile industry", Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., "Industrial Engineering and Management", Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

### REFERENCES

1. Norberd Lloyd Enrick., "Industrial Engineering Manual for Textile Industry", Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., "Introduction to Clothing Production Management", Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., "Ergonomics in the garment industry", Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, "Managing Productivity in Apparel Industry "CBS Publishers & Distributors, 2008

### COURSE ARTICULATION MATRIX:

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
<b>Overall CO</b>		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

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

**OBJECTIVES:**

- To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES 9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES 9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING 9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING 9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

**UNIT V BASICS OF KNITTING AND NONWOVEN 9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

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

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres

CO2: Regenerated and synthetic fibres

CO3: Yarn spinning

CO4: Weaving

CO5: Knitting and nonwoven

**TEXTBOOKS**

- Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
- Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
- Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

**REFERENCES:**

- 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.
- Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
- Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter

Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.

4. Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

#### COURSE ARTICULATION MATRIX:

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<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

PROGRESSTHROUGH KNOWLEDGE



**OBJECTIVE:**

The course is aimed to

- Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL****9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING****9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING****9**

Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS****9**

Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS****9**

Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

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

On the completion of the course students are expected to

- CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.
- CO2:** Understand the insights of primary treatment processes to produce the precursors.
- CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.
- CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.
- CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.
- CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS**

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition., McGraw Hill, New York, 1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons, 1986.

**REFERENCES**

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

**OBJECTIVES:**

At the end of the course, the student is expected to

- Understand and analyse the energy data of industries
- Carryout energy accounting and balancing
- Conduct energy audit and suggest methodologies for energy savings and
- Utilise the available resources in optimal ways

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

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS****9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS****9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES****9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

**UNIT V ECONOMICS****9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

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

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com). a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.  
Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

**COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

**UNIT I INTRODUCTION TO PLASTICS PROCESSING 9**

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

**UNIT II EXTRUSION 9**

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, 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 HOURS: 45**

## COURSE OUTCOMES

- Ability to find out the correlation between various processing techniques with product properties.
- Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- Acquire knowledge on additives for plastic compounding and methods employed for the same
- Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- Select an appropriate processing technique for the production of a plastic product

## REFERENCES

1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

OEC351

**SIGNALS AND SYSTEMS**

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

### COURSE OBJECTIVES :

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

### UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS

**9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

### UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS

**9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

### UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS

**9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

### UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS

**9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS****9**

Impulse response–Difference equations–Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:****At the end of the course, the student will be able to:**

CO1:Determine if a given system is linear/causal/stable

CO2: Determine the frequency components present in a deterministic signal

CO3:Characterize continuous LTI systems in the time domain and frequency domain

CO4:Characterize discrete LTI systems in the time domain and frequency domain

CO5:Compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

**REFERENCES :**

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2<sup>nd</sup> Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	-	3	-	3	2	-	-	-	-		3	-	-	1
2	3	-	3	-	-	2	-	-	-	-		3	-	3	-
3	3	3	-	-	3	2	-	-	-	-		3	2	-	-
4	3	3	-	-	3	2	-	-	-	-		3	-	3	1
5	3	3	-	3	3	2	-	-	-	-		3	-	3	1
<b>C</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>

**OEC352 FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS****L T P C  
3 0 0 3****COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES****9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS****9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9**  
 Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9**  
 Advantages of negative feedback – Analysis of Voltage / Current, Series, Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9**  
 Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Explain the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Analyze frequency response of BJT and MOSFET amplifiers

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Design and analyze power amplifiers and supply circuits

**TEXT BOOKS :**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

**REFERENCES :**

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1

**OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

**TEXT BOOKS:**

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

**REFERENCES:**

1. 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, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

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

**OMA352**

**OPERATIONS RESEARCH**

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

**OBJECTIVES:**

This course will help the students to

- Determine the optimum solution for Linear programming problems.
- Study the Transportation and assignment models and various techniques to solve them.
- Acquire the knowledge of optimality, formulation and computation of integer programming problems.
- Acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- Determine the optimum solution for non-linear programming problems.

**UNIT I LINEAR PROGRAMMING**

9

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

<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.		
		<b>TOTAL:45 PERIODS</b>

**OUTCOMES :**

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

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- Solve the integer programming problems using various methods.
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- Determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

**REFERENCES :**

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum’s Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

**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 –  $2 \times 2$  linear systems.

**UNIT V            CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS****9**

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

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

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5<sup>th</sup> Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.

**REFERENCES:**

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2<sup>nd</sup> Edition , 2006.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
CO1	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
CO2	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
CO3	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
CO4	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
CO5	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
Avg	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

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 01	PS 02	PS 03
<b>CO1</b>	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
<b>CO2</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO3</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO4</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>CO5</b>	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
<b>Avg</b>	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

## 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	-	-	-
<b>AVg.</b>	<b>2.4</b>	<b>2.2</b>	<b>2.4</b>	<b>2.2</b>	<b>2</b>	<b>2.6</b>	<b>2.4</b>	<b>2.2</b>	<b>2.6</b>	<b>3</b>	<b>2.6</b>	<b>3</b>	-	-	-

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

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

**REFERENCES**

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)  
Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

**OCE354****BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT****L T P C****3 0 0 3****OBJECTIVES**

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

**UNIT I OVERVIEW OF IWRM****9**

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

**UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION****9**

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

**UNIT III WATER ECONOMICS****9**

Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

**UNIT IV RECENT TRENDS 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%20iwrwm/Tutorial\\_text.pdf](http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrwm/Tutorial_text.pdf)
4. Pramod R. Bhawe, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

**OMA355 ADVANCED NUMERICAL METHODS L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

**UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9**  
System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

**UNIT II INTERPOLATION 9**  
Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

**UNIT III                    NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS                    9**

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor - Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

**UNIT IV                    FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS                    9**

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

**UNIT V                    FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS                    9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;

CO2: understand the interpolation theory;

CO3: understand the concepts of numerical methods for ordinary differential equations;

CO4: demonstrate the understandings of common numerical methods for elliptic equations;

CO5: understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS :**

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

**REFERENCES:**

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers", 4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

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



**OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I      RANDOM VARIABLES****9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II      RANDOM PROCESSES****9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III      SPECIAL RANDOM PROCESSES****9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV      CORRELATION AND SPECTRAL DENSITIES****9**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V      LINEAR SYSTEMS WITH RANDOM INPUTS****9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

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

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

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

**TEXT BOOKS**

1. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes ", 1<sup>st</sup> Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.

**REFERENCES**

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.

4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3<sup>rd</sup> Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

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

**OMA357**

**QUEUEING AND RELIABILITY MODELLING**

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

**OBJECTIVES:**

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

**UNIT I RANDOM PROCESSES**

**9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

**UNIT II MARKOVIAN QUEUEING MODELS**

**9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little’s formula - Queues with finite waiting rooms.

**UNIT III ADVANCED QUEUEING MODELS**

**9**

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E<sub>K</sub>/1 as special cases – Series queues – Open Jackson networks.

**UNIT IV SYSTEM RELIABILITY**

**9**

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

**UNIT V MAINTAINABILITY AND AVAILABILITY**

**9**

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS**

**OUTCOMES**

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

- Enable the students to apply the concept of random processes in engineering disciplines.
- Students acquire skills in analyzing various queueing models.

- Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- Students can analyze reliability of the systems for various probability distributions.
- Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

**TEXT BOOKS**

1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018.
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

**REFERENCES**

1. Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9<sup>th</sup> Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2<sup>nd</sup> Edition, John Wiley and Sons, 2002.
4. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
<b>CO1</b>	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO2</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO3</b>	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
<b>CO4</b>	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
<b>CO5</b>	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
<b>Avg</b>	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

**OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS**

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

**OBJECTIVES:**

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

**UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9**

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

**UNIT II PRODUCTION & OPERATION SYSTEMS 9**

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

**UNIT III PRODUCTION & OPERATIONS PLANNING 9**  
 Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

**UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9**  
 Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

**UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9**  
 Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45 : PERIODS**

**OUTCOMES:**

Upon completion of this course the learners will be able :

- CO 1 To understand the basics and functions of Production and Operation Management for business owners.
- CO 2 To learn about the Production & Operation Systems.
- CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
- CO 4 To know about the Production & Operations Management Processes in organisations.
- CO 5 To comprehend the techniques of controlling , Production and Operations in industries.

**REFERENCES**

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

**OMG355 MULTIVARIATE DATA ANALYSIS L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- To know various multivariate data analysis techniques for business research.

**UNIT I INTRODUCTION 9**  
 Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

**UNIT II PREPARING FOR MULTIVARIATE ANALYSIS 9**  
 Conceptualization of research model with variables, collection of data –Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

**UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS 9**  
 Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

**UNIT IV LATENT VARIABLE TECHNIQUES 9**  
 Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

**UNIT V ADVANCED MULTIVARIATE TECHNIQUES 9**  
 Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS**

**OUTCOMES :**

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

**REFERENCES :**

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

**OME352 ADDITIVE MANUFACTURING L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

**UNIT I INTRODUCTION 9**  
 Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

<b>UNIT II</b>	<b>VAT POLYMERIZATION AND MATERIAL EXTRUSION</b>	<b>9</b>
Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.		
<b>UNIT III</b>	<b>POWDER BED FUSION AND BINDER JETTING</b>	<b>9</b>
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.		
<b>UNIT IV</b>	<b>MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION</b>	<b>9</b>
Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.		
<b>UNIT V</b>	<b>SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY</b>	<b>9</b>
Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.		
		<b>TOTAL: 45 PERIODS</b>

**COURSE OUTCOMES:**

**At the end of this course students shall be able to:**

- CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.
- CO3: Elaborate the process and applications of powder bed fusion and binder jetting.
- CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.
- CO5: Acquire knowledge on sheet lamination and direct write technology.

**TEXT BOOKS:**

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3<sup>rd</sup> edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

**REFERENCES:**

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1<sup>st</sup> Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

**COURSE OBJECTIVES**

- 1 To introduce the fundamental concepts of the new product development
- 2 To develop material specifications, analysis and process.
- 3 To Learn the Feasibility Studies & reporting of new product development.
- 4 To study the New product qualification and Market Survey on similar products of new product development  
To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT – I FUNDAMENTALS OF NPD****9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS****9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT – III ESSENTIALS OF NPD****9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programming. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

**UNIT – IV CRITERIONS OF NPD****9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

**UNIT – V REPORTING & FORWARD-THINKING OF NPD****9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS**

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

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar

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

**OME355 INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES****L T P C  
3 0 0 3****OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX****9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT****9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN****9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING****9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing



**UNIT V ELECTRONIC RAPID PROTOTYPING****9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

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

**At the end of the course, learners will be able to:**

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS:**

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

**REFERENCES:**

1. <https://www.adobe.com/products/xd/learn/get-started.html>
2. <https://developer.android.com/guide>
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>
4. [https://help.prusa3d.com/en/category/prusaslicer\\_204](https://help.prusa3d.com/en/category/prusaslicer_204)

**MF3010****MICRO AND PRECISION ENGINEERING****L T 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 Battery Model or Simulation.
4. Estimate State-of-Charges in a Battery Pack.
5. Approach different BMS architectures during real world usage.

**TEXT BOOKS**

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
2. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

**REFERENCE BOOKS**

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

**AU3008**

**SENSORS AND ACTUATORS**

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

**COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

**UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

**UNIT II VARIABLE RESISTANCE AND 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**

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

**OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS 9**  
 Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**  
 Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**  
 Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**  
 TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**  
 Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design

**OIM352**

**MANAGEMENT SCIENCE**



L	T	P	C
3	0	0	3

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental concepts of management and organization to students.
2. To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y- Hertzberg Two Factor Theory of Motivation- Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

**UNIT II OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production),Work Study - Basic procedure involved in Method Study and Work Measurement - BusinessProcessReengineering(BPR)- StatisticalQualityControl:controlchartsforVariablesandAttributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ,ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System,Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on ProductLifeCycle.

**UNIT III HUMAN RESOURCES MANAGEMENT 9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager:Manpower planning, Recruitment, Selection, TrainingandDevelopment,WageandSalaryAdministration,Promotion,Transfer,PerformanceAppraisal, 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 Cardsas Contemporary Business Strategies.

**TOTAL: 45 PERIODS**

**COURSEOUTCOMES:**

Upon completion of the course, Students will be able to

CO1:Plananorganizationalstructureforagivencontextintheorganisationtocarryoutproductionoperatio nsthroughWork-study.

CO2:Surveythemarkets,customersandcompetitionbetterandpricethegivenproductsappropriately

CO3:Ensurequalityforagivenproduct or service.

CO4:Plan, schedule and control projects through PERTandCPM.

CO5:Evaluate strategyforabusiness orserviceorganisation.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
AVg.	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

**TEXTBOOKS:**

1. Kanishka Bedi, Production and Operations Management, Oxford University Press,2007.
2. Stoner,Freeman,Gilbert, Management,6<sup>th</sup> Ed, Pearson Education, 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.

<b>OIM353</b>	<b>PRODUCTION PLANNING AND CONTROL</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		3	0	0	3

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT I INTRODUCTION 9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNITII 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.

**UNITIII 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.

**UNITIV PRODUCTION SCHEDULING 9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,

- CO1:The students can able to prepare production planning and control act work study,
- CO2:The students can able to prepare product planning,



CO3: The students can able to prepare production scheduling,

CO4: The students can able to prepare Inventory Control.

CO5: They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

**REFERENCES**

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S. Buffa, and Rakesh K. Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, "Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn. 1984
8. Upendra Kachru, "Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

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

OIE353

**OPERATIONS MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT**

**9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy – Strategic fit, framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN 9**  
 Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**  
 Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**  
 Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**  
 Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.
- CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
- CO3:** The students will be able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
- CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
- CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**CO’s- PO’s & PSO’s MAPPING**

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

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 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.

**OSF352**

**INDUSTRIAL HYGIENE**

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

**COURSE OBJECTIVES:**

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I INTRODUCTION AND SCOPE 9**

Occupational Health and Environmental Safety Management - Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT 9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9**

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT-V INDUSTRIAL HAZARDS 9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)

2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication

2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,

3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India

4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London

5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

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

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

PROGRESSTHROUGH KNOWLEDGE

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 BOOKS:**

- 1 David A Crowl& Joseph F Louvar,"Chemical Process safety", Pearson publication, 3<sup>rd</sup> Edition,2014
- 2 Maurice Jones .A,"Fire Protection Systems,2<sup>nd</sup> edition, Jones & Bartlett Publishers,2015

**REFERENCES:**

1. Ralph King and Ron Hirst,"King's safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council," Accident prevention manual for industrial operations". Chicago, 1982.

4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety", 3<sup>rd</sup> Edition, Gulf professional publishing, 2006

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
AVg.	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

### OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS

L T P C  
3 0 0 3

#### COURSE OBJECTIVES:

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

- Understanding the importance of various materials used in electrical, electronics and magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

#### UNIT- I DIELECTRIC MATERIALS

9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

#### UNIT – II MAGNETIC MATERIALS

9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

#### UNIT – III SEMICONDUCTOR MATERIALS

9

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

#### UNIT – IV MATERIALS FOR ELECTRICAL APPLICATIONS

9

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetal fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

**UNIT – V OPTICAL AND OPTOELECTRONIC MATERIALS****9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

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

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

1. Understand various types of dielectric materials, their properties in various conditions.
2. Evaluate magnetic materials and their behavior.
3. Evaluate semiconductor materials and technologies.
4. Select suitable materials for electrical engineering applications.
5. Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

**REFERENCE BOOKS:**

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3	2	2	3								2	2	2	1
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	1
CO4	3	2	1	2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	3	1.8	1.6	2.2								2	2	2	1.2

**OML353****NANOMATERIALS AND APPLICATIONS****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

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

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

<b>UNIT I</b>	<b>NANOMATERIALS</b>	<b>9</b>
Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.		
<b>UNIT II</b>	<b>THERMODYNAMICS &amp; KINETICS OF NANOSTRUCTURED MATERIALS</b>	<b>9</b>
Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.		
<b>UNIT III</b>	<b>PROCESSING</b>	<b>9</b>
Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.		
<b>UNIT IV</b>	<b>STRUCTURAL CHARACTERISTICS</b>	<b>9</b>
Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis		
<b>UNIT V</b>	<b>APPLICATIONS</b>	<b>9</b>
Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries		
		<b>TOTAL: 45 PERIODS</b>

**COURSE OUTCOMES:**

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

1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties
3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

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

**REFERENCES:**

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
CO4	3	1		2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3



**COURSE OBJECTIVES:**

1. To knowledge on fluid power principles and working of hydraulic pumps
2. To obtain the knowledge in hydraulic actuators and control components
3. To understand the basics in hydraulic circuits and systems
4. To obtain the knowledge in pneumatic and electro pneumatic systems
5. To apply the concepts to solve the trouble shooting

**UNIT – I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal’s Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

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

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

- CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps
- CO 2: Recognize the concepts in hydraulic actuators and control components
- CO 3: Obtain the knowledge in basics of hydraulic circuits and systems
- CO 4: Know about the basics concept in pneumatic and electro pneumatic systems
- CO 5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

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

**TEXT BOOKS**

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997.

**REFERENCES**

1. Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, Tata McG Raw Hill, 2001.
3. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987
5. Srinivasan. R, “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008
6. Joshi.P, Pneumatic Control”, Wiley India, 2008.
7. Jagadeesha T, “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.

**OMR353**

**SENSORS**

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

**COURSE OBJECTIVES:**

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT – I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT – II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT – III FORCE, MAGNETIC AND HEADING SENSORS****9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT – IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS****9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT – V SIGNAL CONDITIONING****9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

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

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

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

**TEXT BOOKS**

1. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

**REFERENCES**

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Hstand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

**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.

**TEXTBOOK**

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.



**TEXT BOOKS:**

1. GP. Ghose, "Basic Ship propulsion",2015
2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5,2010
3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers",4<sup>th</sup> Edition,2009

**REFERENCES BOOKS:**

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

**MAPPING OF COS AND POS:**

C O	PO												PSO			
	PO 1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
Av g	1	1	1	1	1				1	1	1	1	1	1		1

**OMV351****MARINE MERCHANT VESSELS****LT P C  
3 0 0 3****OBJECTIVES:****At the end of the course, students are expected to acquire**

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

**UNIT I INTRODUCTION TO HYDROSTATICS****9**

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

**UNIT II TYPES OF SHIP****10**

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

**UNIT III SHIPBUILDING MATERIALS****9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV MARINE PROPELLER AND RUDDER****8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY****9**

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships), **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

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

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

**TEXT BOOKS:**

1. D.J.Eyres, "Ship Constructions", Seventh Edition, Butter Worth Heinemann Publishing, USA, 2015
2. Dr.DA Taylor, "Merchant Ship Naval Architecture" I. Mar EST publications, 2006
3. EA Stokoe, E.A, "Naval Architecture for Marine Engineers", Vol.4, Reeds Publications, 2000

**REFERENCES:**

1. Kemp & Young "Ship Construction Sketches & Notes", Butter Worth Heinemann Publishing, USA, 2011
2. MARPOL Consolidated Edition, Bhandakar Publications, 2018
3. SOLAS Consolidated Edition, Bhandakar Publications, 2016

**OMV352****ELEMENTS OF MARINE ENGINEERING****L T P C  
3 0 0 3****OBJECTIVES:****At the end of the course, students are expected to**

1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. Be aware of ship propellers and steering system

**UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS****9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II MARINE PROPULSION MACHINERY SYSTEM****9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III MARINE AUXILIARY MACHINERY SYSTEM****9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV MARINE BOILER SYSTEM****9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V SHIP PROPELLERS AND STEERING MECHANISM****9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

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

**At the end of the course, students should able to,**

1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system
4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellers and steering system

**TEXT BOOKS:**

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, "Text book on Marine Engineering", Eswar Press, Chennai, 2018

**REFERENCES:**

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

**CRA332****DRONE TECHNOLOGIES**

L	T	P	C
3	0	0	3

**COURSE OBJECTIVES:**

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

**UNIT – I INTRODUCTION TO DRONE TECHNOLOGY****9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING****9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program -



Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT – III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

**UNIT – IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT – V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

- CO1: Know about a various type of drone technology, drone fabrication and programming.
- CO2: Execute the suitable operating procedures for functioning a drone
- CO3: Select appropriate sensors and actuators for Drones
- CO4: Develop a drone mechanism for specific applications
- CO5: 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. Zavrnsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

**OBJECTIVES:**

To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

**UNIT I FUNDAMENTALS OF GIS****9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS****9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

**UNIT III DATA INPUT AND TOPOLOGY****9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS****9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT****9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

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

- On completion of the course, the student is expected to
- CO1** Have basic idea about the fundamentals of GIS.
- CO2** Understand the types of data models.
- CO3** Get knowledge about data input and topology
- CO4** Gain knowledge on data quality and standards
- CO5** Understand data management functions and data output

**TEXTBOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCES:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM**

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

**OAI352****AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT****L T P C  
3 0 0 3****OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT****9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE****9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE****9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control- Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-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.

**UNITV ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT**

**9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

1. Judge about agricultural finance, banking and cooperation
2. Evaluate basic concepts, principles and functions of financial management
3. Improve the skills on basic banking and insurance schemes available to customers
4. Analyze various financial data for efficient farm management
5. Identify the financial institutions

**TEXT BOOKS**

1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

**REFERENCES**

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO-PO MAPPING**

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1

PO10	Communication	1	1	1	1	2	1
PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1

**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.

**TEXTBOOKS**

1. Farid Golnarghi, Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5<sup>th</sup> Edition 2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

**REFERENCES**

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5<sup>th</sup> Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.

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

**OCH353**

**ENERGY TECHNOLOGY**

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

**UNIT I INTRODUCTION**

**8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY**

**8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY**

**10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY**

**10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

**UNIT V ENERGY CONSERVATION****9**

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

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

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

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

**TEXT BOOKS**

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

**REFERENCES**

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

Course articulation matrix

Course Outcomes	Statements	Program Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	Students will excel as professionals in the various fields of energy engineering	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	Explain the technological basis for harnessing renewable energy sources.	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3

understanding of energy problems at an advanced level																
OVERALL CO	2	2	1	3	3	2	2	1	1	1	1	3	2	1	3	

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

**OCH354**

**SURFACE SCIENCE**

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

**OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, adsorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fischer-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

- K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

- Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.



**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, New Delhi, "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", Cengage Learning, 3rd Edition, 2005.

#### List of Open Source Software/ Learning website:

1. <https://archive.nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/108105063>
3. <https://www.electrical4u.com/industrial-automation/>
4. <https://realpars.com/what-is-industrial-automation/>
5. <https://automationforum.co/what-is-industrial-automation-2/>

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

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
CO2	3	1	1	-	1	-	-	1	-	1	-	-	1	-	1
CO3	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
CO4	3	3	3	3	1			1		1			1		1
CO5	3	3	3	3	1	1		1		1			1		1
AVg.	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

OPY353

NUTRACEUTICALS

LTPC  
3003

#### OBJECTIVES:

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

#### UNIT I INTRODUCTION AND SIGNIFICANCE

6

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

#### UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS

11

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, carotenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

#### UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY

11

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant



CO 1	3											1
CO 2	3											1
CO 3	3					2						
CO 4	3											
CO 5	3					2						1
CO 6	3							2				1

OTT354

**BASICS OF DYEING AND PRINTING**

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

**OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

**UNIT I INTRODUCTION 9**  
Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT 9**  
Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring- Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING 9**  
Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING 9**  
Definition of printing – Difference between printing and 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:**

- Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
- Shenai V.A. "Technology of Textile Processing Vol. IV" 1998, Sevak Publications, Mumbai.

**REFERENCES:**

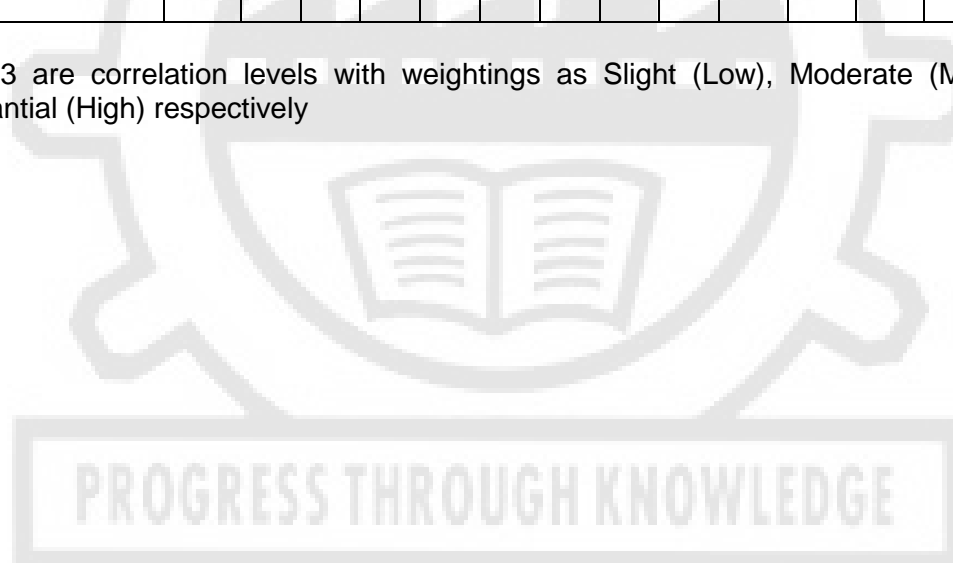
- Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
- Dr. N N Mahapatra., "Textile dyeing", Wood head publishing India, 2018

3. Mathews Kolanjikombil., "Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics", Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

**COURSE ARTICULATION MATRIX:**

Course Outcomes	Statement	Program Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
<b>Overall CO</b>		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

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



**COURSE OBJECTIVES**

- To enable the students to learn about the types of fibre and its properties

**UNIT I INTRODUCTION TO TEXTILE FIBRES 9**

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

**UNIT II REGENERATED FIBRES 9**

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

**UNIT III SYNTHETIC FIBRES 9**

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

**UNIT IV SPECIALITY FIBRES 9**

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

**UNIT V FUNCTIONAL SPECIALITY FIBRES 9**

**Properties and end uses** : Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

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

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

**TEXT BOOKS:**

- Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
- Meredith R., and Hearle J. W. S., "Physical Methods of Investigation of Textiles", Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
- Mukhopadhyay S. K., "Advances in Fibre Science", The Textile Institute,1992, ISBN: 1870812379

**REFERENCES:**

- Meredith R., "Mechanical Properties of Textile Fibres", North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
- Hearle J. W. S., Lomas B., and Cooke W. D., "Atlas of Fibre Fracture and Damage to Textiles", The Textile Institute, 2<sup>nd</sup> Edition, 1998, ISBN: 1855733196.
- Raheel M. (ed.), "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737
- Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
- Hearle J.W.S., "Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1", Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36



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

9

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

### UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS

9

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

### UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER

9

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

### UNIT IV BASICS OF MASS TRANSFER

9

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

### UNIT V MASS TRANSFER OPERATIONS

9

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

## **COURSE OUTCOMES:**

At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

## **TEXTBOOK(S)**

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchemo, J.T., Tata McGraw Hill New York 1997

## **REFERENCE BOOKS**

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352**

**PLASTIC MATERIALS FOR ENGINEERS**

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

## **COURSE OBJECTIVES**

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

### **UNIT I INTRODUCTION TO PLASTIC MATERIALS**

**9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

### **UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS**

**9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

### **UNIT III THERMOSETTING PLASTICS**

**9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

**UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanooates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL HOURS: 45**

**COURSE OUTCOMES**

- To study the importance, advantages and classification of plastic materials
- Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
- To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
- Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
- To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

**REFERENCES**

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8<sup>th</sup> Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7<sup>th</sup> Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4<sup>th</sup> Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3<sup>rd</sup> Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2<sup>nd</sup> Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

**OPT353 PROPERTIES AND TESTING OF PLASTICS**

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

**COURSE OBJECTIVES**

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

**UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9**

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

**UNIT II MECHANICAL PROPERTIES 9**

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

**UNIT III THERMAL RHEOLOGICAL PROPERTIES 9**

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

**UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9**

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.
- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

**REFERENCES**

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2<sup>nd</sup> Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3<sup>rd</sup> Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

**OEC353**

**VLSI DESIGN**

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

**OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

**UNIT I MOS TRANSISTOR PRINCIPLES 9**  
 MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

**UNIT II COMBINATIONAL LOGIC CIRCUITS 9**  
 Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore’s constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

**UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9**  
 Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

**UNIT IV INTERCONNECT, MEMORY ARCHITECTURE 9**  
 Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

**UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS 9**  
 Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**Upon successful completion of the course the student will be able to**

- CO1:** Understand the working principle and characteristics of MOSFET
- CO2:** Design Combinational Logic Circuits
- CO3:** Design Sequential Logic Circuits and Clocking systems
- CO4:** Understand Memory architecture and interconnects
- CO5:** Design of arithmetic building blocks.

**TEXTBOOKS**

1. Jan D Rabaey, Anantha Chandrakasan, “Digital Integrated Circuits: A Design Perspective”, PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, “Principles of CMOS VLSI Design: A System Perspective,” Addison Wesley, 2009.( Units - I).

**REFERENCES**

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, “Principles of Testing Electronic Systems”, Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
<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>

**OBJECTIVES:**

The student should be made to:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**TOTAL PERIODS:45**

**OUTCOMES:**

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

CO1: Describe the concepts of wearable system.

CO2: Explain the energy harvestings in wearable device.

CO3: Use the concepts of BAN in health care.

CO4: Illustrate the concept of smart textile

CO5: Compare the various wearable devices in healthcare system

**TEXT BOOKS**

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and Jamil Y. Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte.Ltd, Singapore, 2012

**REFERENCES**

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

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

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

**CBM356**

**MEDICAL INFORMATICS**

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

### PREAMBLE:

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

### UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

### UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

### UNIT III COMPUTERISED PATIENT RECORD 9

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

### UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer-assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

### UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

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

1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill, 2005

**REFERENCES:**

1. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 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
<b>AVg.</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>			<b>1</b>					<b>1</b>	<b>1</b>	<b>1</b>

**VERTICAL 1: FINTECH AND BLOCK CHAIN****CMG331****FINANCIAL MANAGEMENT****LTPC  
3003****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**

**LTPC  
3003**

**OBJECTIVES:**

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT 9**

The investment decision process, Types of Investments – Commodities, Real Estate and financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

**UNIT II FIXED INCOME SECURITIES 9**

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

**UNIT III APPROACHES TO EQUITY ANALYSIS 9**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION 9**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism

**TOTAL : 45 PERIODS**

**REFERENCES:**

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

**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

**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**

**REFERENCES:**

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2<sup>nd</sup> Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madiseti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.

**CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS LT P C 3 0 0 3**

**UNIT I CURRENCY EXCHANGE AND PAYMENT 9**  
 Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

**UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9**  
 A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

**UNIT III INSURETECH 9**  
 InsurTech Introduction , Business model disruption AI/ML in InsurTech IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

**UNIT IV PEER TO PEER LENDING 9**  
 P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES****9**

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

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

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

**CMG336****INTRODUCTION TO FINTECH****LT P C  
3 0 0 3****OBJECTIVES:**

1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

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

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY****9**

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY****9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE****9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT V FUTURE OF FINTECH 9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Arner D., 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 V EMERGING TRENDS IN ENTREPRENEURSHIP

9

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.

**TOTAL : 45 PERIODS**

### OUTCOMES:

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

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship

CO 4 Learn about applications of technopreneurship and successful technopreneurs

CO 5 Acquaint with the recent and emerging trends in entrepreneurship

### TEXT BOOKS:

- 1) S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
- 2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

### REFERENCES :

- 1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
- 2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5) HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>
- 6) JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
- 7) Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8) Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS** L T P C  
3 0 0 3

### COURSE OBJECTIVES

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

## UNIT I INTRODUCTION TO MANAGING TEAMS

9

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

## UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS

9

Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building

High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

**UNIT III INTRODUCTION TO LEADERSHIP 9**

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

**UNIT IV LEADERSHIP IN ORGANISATIONS 9**

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

**UNIT V LEADERSHIP EFFECTIVENESS 9**

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL 45 : PERIODS**

**OUTCOMES:**

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

- CO 1 Learn the basics of managing teams for business.
- CO 2 Understand developing effective teams for business management.
- CO 3 Understand the fundamentals of leadership for running a business.
- CO 4 Learn about the importance of leadership for business development.
- CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

**REFERENCES :**

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5th ed, Jossey-Bass, (2013).

**CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

**UNIT I CREATIVITY 9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE 9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our

creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION**

**9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP**

**9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS**

**9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

**TOTAL 45 : PERIODS**

**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:**

Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand

Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.

Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.

A. Dale Timpe, Creativity, Jaico Publishing House, 2003.

Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.

Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS**

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

**COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.



<b>UNIT I</b>	<b>INTRODUCTION TO MARKETING MANAGEMENT</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>MARKETING ENVIRONMENT</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>PRODUCT AND PRICING MANAGEMENT</b>	<b>9</b>
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.		
<b>UNIT IV</b>	<b>PROMOTION AND DISTRIBUTION MANAGEMENT</b>	<b>9</b>
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.		
<b>UNIT V</b>	<b>CONTEMPORARY ISSUES IN MARKETING MANAGEMENT</b>	<b>9</b>
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:**

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

**UNIT I INTRODUCTION TO HRM** **9**  
 Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

**UNIT II HUMAN RESOURCE PLANNING** **9**  
 HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

**UNIT III RECRUITMENT AND SELECTION** **9**  
 Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

**UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT** **9**  
 Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

**UNIT V CONTROLLING HUMAN RESOURCES** **9**  
 Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

**TOTAL 45 : PERIODS**

**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; Hardymon, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

### VERTICAL 3: PUBLIC ADMINISTRATION

<b>CMG343</b>	<b>PRINCIPLES OF PUBLIC ADMINISTRATION</b>	<b>L T P C</b>
		<b>3 0 0 3</b>
<b>UNIT-I</b>		<b>(9)</b>
1. Meaning, Nature and Scope of Public Administration		
2. Importance of Public Administration		
3. Evolution of Public Administration		
<b>UNIT-II</b>		<b>(9)</b>
1. New Public Administration		
2. New Public Management		
3. Public and Private Administration		
<b>UNIT-III</b>		<b>(9)</b>
1. Relationships with Political Science, History and Sociology		
2. Classical Approach		
3. Scientific Management Approach		
<b>UNIT-IV</b>		<b>(9)</b>
1. Bureaucratic Approach: Max Weber		
2. Human Relations Approach : Elton Mayo		
3. Ecological Approach : Riggs		
<b>UNIT-V</b>		<b>(9)</b>
1. Leadership: Leadership - Styles - Approaches		
2. Communication: Communication Types - Process - Barriers		
3. Decision Making: Decision Making - Types, Techniques and Processes.		
	<b>TOTAL: 45 PERIODS</b>	
<b>REFERENCES:</b>		
1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.		
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.		
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.		
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.		
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.		

<b>CMG344</b>	<b>CONSTITUTION OF INDIA</b>	<b>L T P C</b>
		<b>3 0 0 3</b>
<b>UNIT-I</b>		<b>(9)</b>
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**  
**(9)**

**UNIT-I**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT-II**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT-III**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

**UNIT-IV**

1. All India Services
2. Service Conditions
3. State Public Service Commission

**UNIT-V**

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 - PARAMETRIC TESTS**

**9**

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS**

**9**

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION**

**9**

Correlation – Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS**

**OUTCOMES:**

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

**REFERENCES:**

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**CMG350**

**DATAMINING FOR BUSINESS INTELLIGENCE**

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

**OBJECTIVES :**

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION**

**9**

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



<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 Chiriach C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. Galit Shmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**CMG351**

**HUMAN RESOURCE ANALYTICS**

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

**OBJECTIVE:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

<b>UNIT I -</b>	<b>INTRODUCTION TO HR ANALYTICS</b>	<b>9</b>
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.

**CMG352**

**MARKETING AND SOCIAL MEDIA WEB ANALYTICS**

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

**OBJECTIVE:**

- To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I MARKETING ANALYTICS 9**  
Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

<b>UNIT II</b>	<b>COMMUNITY BUILDING AND MANAGEMENT</b>	<b>9</b>
History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages-Linking Social Media Accounts-The Viral Impact of Social Media.		
<b>UNIT III</b>	<b>SOCIAL MEDIA POLICIES AND MEASUREMENTS</b>	<b>9</b>
Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.		
<b>UNIT IV</b>	<b>WEB ANALYTICS</b>	<b>9</b>
Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.		
<b>UNIT V</b>	<b>SEARCH ANALYTICS</b>	<b>9</b>
Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.		
		<b>TOTAL: 45 PERIODS</b>

**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

<b>CMG353</b>	<b>OPERATION AND SUPPLY CHAIN ANALYTICS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVE:**

➤ To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
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Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

<b>UNIT II</b>	<b>WAREHOUSING DECISIONS</b>	<b>9</b>
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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>
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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>
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Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

**UNIT V MCDM MODELS****9**

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

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

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

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

**CMG354****FINANCIAL ANALYTICS****L T P C  
3 0 0 3****OBJECTIVE:**

➤ This course introduces a core set of modern analytical tools that specifically target finance applications.

**UNIT I CORPORATE FINANCE ANALYSIS****9**

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

**UNIT II FINANCIAL MARKET ANALYSIS****9**

Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III PORTFOLIO ANALYSIS****9**

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

**UNIT IV TECHNICAL ANALYSIS****9**

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS****9**

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

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

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.



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	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

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

CES333

SUSTAINABLE BIOMATERIALS

L T P C  
3 0 0 3

**OBJECTIVES**

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

**UNIT I INTRODUCTION TO BIOMATERIALS**

9

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials



**UNIT II BIO POLYMERS 9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

**UNIT III BIO CERAMICS AND BIOCOMPOSITES 9**

General properties- Bio ceramics -Silicate glass - Alumina (Al<sub>2</sub>O<sub>3</sub>) -Zirconia (ZrO<sub>2</sub>)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

**UNIT IV METALS AS BIOMATERIALS 9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

**UNIT V NANOBIOMATERIALS 9**

Meatlllicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics-BioNEMs -Biosensor-Bioimaging/Molecular Imaging- challenges and future perspective.

**TOTAL : 45 PERIODS**

**OUTCOMES**

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

**REFERENCES**

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopoldo Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

**OBJECTIVES**

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

**UNIT I SUSTAINABLE ENERGY SOURCES 9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

**UNIT II ELECTROCHEMICAL DEVICES 9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O<sub>2</sub> battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, 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 - benzine – fullerenes - boron subphthalocyanine-tin (II) phthalocyanine)

**UNIT V SUPERCAPACITORS 9**

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon-carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**



## UNIT V GREEN NANOTECHNOLOGY

9

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES

CO1: To understand the principles of green engineering and technology

CO2: To learn about pollution using hazardous chemicals and solvents

CO3: To modify processes and products to make them green and safe.

CO4: To design processes and products using green technology

CO5 – To understand advanced technology in green synthesis

### TEXT BOOKS

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and David Constable (Eds) , Wiley publications,2008

### REFERENCE BOOKS

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

## CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS

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

### OBJECTIVES:

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

## UNIT I ENVIRONMENTAL MONITORING AND STANDARDS

9

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

## UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS

9

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

## UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING

9

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

## UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT

9

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

**UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING****9**

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

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

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability of the environment.
CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

**TEXTBOOKS**

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and solid wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

**REFERENCES**

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

**COURSE ARTICULATION MATRIX**

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

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

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

<b>UNIT I</b>	<b>ENERGY SCENARIO</b>	<b>9</b>
Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security		
<b>UNIT II</b>	<b>ENERGY AND ENVIRONMENT</b>	<b>9</b>
Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls		
<b>UNIT III</b>	<b>SUSTAINABLE DEVELOPMENT</b>	<b>9</b>
Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.		
<b>UNIT IV</b>	<b>RENEWABLE ENERGY TECHNOLOGY</b>	<b>9</b>
Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits		
<b>UNIT V</b>	<b>ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT</b>	<b>9</b>
National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix		

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

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](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, “Energy and the environment”, Willey, 2005.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar, Bhawana Pathak, R K Kale, “Environment and Sustainable Development” Springer, 2016
7. <https://www.niti.gov.in/verticals/energy>

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

**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:**

1. Energy Manager Training Manual (4Volumes) available at [http://www.em-  
ea.org/gbook1.asp](http://www.em-<br/>ea.org/gbook1.asp), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
4. Pratap Bhattacharyya, “Climate Change and Greenhouse Gas Emission”, New India Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul “Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies” CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.