GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)
Coimbatore - 641 013

Curriculum For

M. E. ENGINEERING DESIGN

2023

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
THADAGAM ROAD, COIMBATORE - 641 013
PHONE 0422 - 2433355
E.mail: gctcoe@gct.ac.in

VISION

To create outstanding Mechanical Engineers with strong domain knowledge and skills capable of working in an Interdisciplinary environment with exemplary ethical values contributing to society through Innovation, Entrepreneurship and Leadership.

MISSION

- To develop in each student, a strong theoretical and practical knowledge, a global outlook for a sustainable future and problem solving skills.
- To make productive members of interdisciplinary teams, capable of adapting to changing environments of Engineering, technology and society.
- To inculcate critical thinking abilities among students to enhance innovative ideas and entrepreneurial skills, leadership qualities.
- To imbibe moral and ethical values along with leadership qualities in students.

PROGRAMME OUTCOMES (POs):

The students of M.E- Engineering Design will be able to

PO1:- Independently conduct investigation and develop methodology to solve practical problems.

PO2:- Prepare, write and present comprehensive technical reports / documents.

PO3:- Demonstrate the degree of mastery and expertise in Engineering Design.

PO4:- Develop the sustainable research attitude through lifelong learning to full fill the Global needs.

PO5:- Acquire the competency for resolving the societal issues in Product design/ Environment/ Recyclable/ Disposal through Inter disciplinary activities.

PROGRAMME EDUCATIONAL OUTCOMES (PEOs):

The students of M.E- Engineering Design will be able to

PEO1:- Develop an aptitude to use engineering principles and concepts to create, test and evaluate designs for local and global needs.

PEO2:- Become effective and excellent need based engineer, participating in efforts to provide solutions to social and technical challenges.

PEO3:- Develop innovative technologies and find solutions to contemporary issues in Engineering Design using basic principles in combination with latest tools and concepts.

PEO4:- Pursue advanced research and development and other innovative efforts in their career.

FIRST SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY COURSES										
1.	23EDFCZ1	RESEARCH METHODOLOGY AND IPR	FC	40	60	100	3	0	0	3
2.	23EDFC02	APPLIED MATHEMATICS FOR ENGINEERING DESIGN	FC	40	60	100	3	1	0	4
3.	23EDPC01	APPLIED MECHANICS OF MATERIAL	PC	40	60	100	3	1	0	4
4.	23EDPC02	VIBRATION ANALYSIS AND CONTROL	PC	40	60	100	3	1	0	4
5.	23EDPC03	GEOMETRIC DIMENSIONING AND TOLERANCING	PC	40	60	100	3	0	0	3
6.	23EDPEXX	PROFESSIONAL ELECTIVE I	PE	40	60	100	3	0	0	3
7.	23EDACXX	AUDIT COURSE – I	AC	40	60	100	2*	0	0	0
PRACTICAL COURSES										
8.	23EDPC04	VIBRATION LAB	PC	60	40	100	0	0	4	2
TOTAL				**340**	**460**	**800**	**20**	**3**	**4**	**23**

SECOND SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY COURSES										
1.	23EDPC05	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	PC	40	60	100	3	1	0	4
2	23EDPC06	COMPUTER APPLICATIONS IN DESIGN	PC	40	60	100	3	0	0	3
3.	23EDPC07	TRIBOLOGY IN DESIGN	PC	40	60	100	3	1	0	4
4.	23EDPEXX	PROFESSIONAL ELECTIVE II	PE	40	60	100	3	0	0	3
5.	23EDPEXX	PROFESSIONAL ELECTIVE III	PE	40	60	100	3	0	0	3
6.	23EDACXX	AUDIT COURSE – II	AC	40	60	100	2	0	0	0
PRACTICAL COURSES										
7.	23EDPC08	SIMULATION LAB	PC	60	40	100	0	0	4	2
8.	23EDEE01	MINI PROJECT	EEC	40	60	100	0	0	4	2
TOTAL				**340**	**460**	**800**	**17**	**2**	**8**	**21**

THIRD SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY COURSES										
1	23EDPEXX	PROFESSIONAL ELECTIVE IV	PE	40	60	100	3	0	0	3
2	23EDOEXX	OPEN ELECTIVE	OE	40	60	100	3	0	0	3
PRACTICAL COURSES										
3	23EDEE02	INTERNSHIP / INDUSTRIAL TRAINING	EEC	100	-	100	-	-	*	2
4	23EDEE03	PROJECT PHASE I	EEC	100	100	200	0	0	12	6
TOTAL				**280**	**220**	**500**	**6**	**0**	**12**	**14**

* - FOUR WEEKS OF INTERNSHIP / INDUSTRIAL TRAINING

FOURTH SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PRACTICAL COURSES										
1	23EDEE04	PROJECT PHASE II	EEC	200	200	400	0	0	24	12
TOTAL				**200**	**200**	**400**	**0**	**0**	**24**	**12**

Note:* No Credit Courses **TOTAL CREDITS : 70**

LIST OF PROFESSIONAL ELECTIVES										
S. No	**Course Code**	**Course Title**	**Category**	**CA Marks**	**End Sem Marks**	**Total Marks**	**L**	**T**	**P**	**C**
PROFESSIONAL ELECTIVE I										
1.	23EDPE01	DESIGN FOR SUSTAINABILITY	PE	40	60	100	3	0	0	3
2.	23EDPE02	COMPOSITE MATERIALS AND MECHANICS	PE	40	60	100	3	0	0	3
3.	23EDPE03	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	PE	40	60	100	3	0	0	3
4.	23EDPE04	QUALITY CONCEPTS IN DESIGN	PE	40	60	100	3	0	0	3
5.	23EDPE05	SURFACE ENGINEERING	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE II										
6.	23EDPE06	DESIGN FOR X	PE	40	60	100	3	0	0	3
7.	23EDPE07	DESIGN OF MACHINE TOOL	PE	40	60	100	3	0	0	3
8.	23EDPE08	PRODUCT LIFE CYCLE MANAGEMENT	PE	40	60	100	3	0	0	3
9	23EDPE09	OPTIMIZATION TECHNIQUES IN DESIGN	PE	40	60	100	3	0	0	3
10	23EDPE10	BIO MATERIALS	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE III										
11	23EDPE11	MECHANICAL MEASUREMENTS AND ANALYSIS	PE	40	60	100	3	0	0	3
12	23EDPE12	VIBRATION CONDITION MONITORING AND CONTROL	PE	40	60	100	3	0	0	3
13	23EDPE13	VEHICLE DYNAMICS	PE	40	60	100	3	0	0	3
14	23EDPE14	ENGINEERING FRACTURE MECHANICS FOR DESIGN	PE	40	60	100	3	0	0	3
15	23EDPE15	WEARABLE DEVICES AND TECHNOLOGIES	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE IV										
16	23EDPE16	MATERIAL HANDLING SYSTEMS AND DESIGN	PE	40	60	100	3	0	0	3
17	23EDPE17	BEARING DESIGN AND ROTOR DYNAMICS	PE	40	60	100	3	0	0	3
18	23EDPE18	DESIGN OF HYBRID AND ELECTRIC VEHICLES	PE	40	60	100	3	0	0	3
19	23EDPE19	CREATIVITY AND INNOVATION	PE	40	60	100	3	0	0	3
20	23EDPE20	DESIGN OF PRESSURE VESSELS AND PIPING	PE	40	60	100	3	0	0	3

LIST OF OPEN ELECTIVE COURSES

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEOE01	BUILDING BYE-LAW AND CODES OF PRACTICE	OE	40	60	100	3	0	0	3
2	23SEOE02	PLANNING OF SMART CITIES	OE	40	60	100	3	0	0	3
3	23SEOE03	GREEN BUILDING	OE	40	60	100	3	0	0	3
4	23EEOE04	ENVIRONMENT HEALTH AND SAFETY MANAGEMENT	OE	40	60	100	3	0	0	3
5	23EEOE05	CLIMATE CHANGE AND ADAPTATION	OE	40	60	100	3	0	0	3
6	23EEOE06	WASTE TO ENERGY	OE	40	60	100	3	0	0	3
7	23GEOE07	ENERGY IN BUILT ENVIRONMENT	OE	40	60	100	3	0	0	3
8	23GEOE08	EARTH AND ITS ENVIRONMENT	OE	40	60	100	3	0	0	3
9	23GEOE09	NATURAL HAZARD AND MITIGATION	OE	40	60	100	3	0	0	3
10	23EDOE10	BUSINESS ANALYTICS	OE	40	60	100	3	0	0	3
11	23EDOE11	INTRODUCTION TO INDUSTRIAL SAFETY	OE	40	60	100	3	0	0	3
12	23EDOE12	OPERATIONS RESEARCH	OE	40	60	100	3	0	0	3
13	23MFOE13	OCCUPATIONAL HEALTH AND SAFETY	OE	40	60	100	3	0	0	3
14	23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS	OE	40	60	100	3	0	0	3
15	23MFOE15	COMPOSITE MATERIALS	OE	40	60	100	3	0	0	3
16	23TEOE16	GLOBAL WARMING SCIENCE	OE	40	60	100	3	0	0	3
17	23TEOE17	INTRODUCTION TO NANO ELECTRONICS	OE	40	60	100	3	0	0	3
18	23TEOE18	GREEN SUPPLY CHAIN MANAGEMENT	OE	40	60	100	3	0	0	3
19	23PSOE19	DISTRIBUTION AUTOMATION SYSTEM	OE	40	60	100	3	0	0	3
20	23PSOE20	ELECTRICITY TRADING AND ELECTRICITY ACTS	OE	40	60	100	3	0	0	3
21	23PSOE21	MODERN AUTOMOTIVE SYSTEMS	OE	40	60	100	3	0	0	3
22	23PEOE22	VIRTUAL INSTRUMENTATION	OE	40	60	100	3	0	0	3
23	23PEOE23	ENERGY MANAGEMENT SYSTEMS	OE	40	60	100	3	0	0	3
24	23PEOE24	ADVANCED ENERGY STORAGE TECHNOLOGY	OE	40	60	100	3	0	0	3
25	23AEOE25	DESIGN OF DIGITAL SYSTEMS	OE	40	60	100	3	0	0	3
26	23AEOE26	BASICS OF NANO ELECTRONICS	OE	40	60	100	3	0	0	3

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
27	23AEOE27	ADVANCED PROCESSOR	OE	40	60	100	3	0	0	3
28	23VLOE28	HDL PROGRAMMING LANGUAGES	OE	40	60	100	3	0	0	3
29	23VLOE29	CMOS VLSI DESIGN	OE	40	60	100	3	0	0	3
30	23VLOE30	HIGH LEVEL SYNTHESIS	OE	40	60	100	3	0	0	3
31	23CSOE31	ARTIFICIAL INTELLIGENCE	OE	40	60	100	3	0	0	3
32	23CSOE32	COMPUTER NETWORK MANAGEMENT	OE	40	60	100	3	0	0	3
33	23CSOE33	BLOCKCHAIN TECHNOLOGIES	OE	40	60	100	3	0	0	3

LIST OF AUDIT COURSES

(Common to all branches)

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	HOURS			
							L	T	P	C
1	23EDACZ1	ENGLISH FOR RESEARCH PAPER WRITING	AC	40	60	100	2	0	0	0
2	23EDACZ2	DISASTER MANAGEMENT	AC	40	60	100	2	0	0	0
3	23EDACZ3	VALUE EDUCATION	AC	40	60	100	2	0	0	0
4	23EDACZ4	CONSTITUTION OF INDIA	AC	40	60	100	2	0	0	0
5	23EDACZ5	PEDAGOGY STUDIES	AC	40	60	100	2	0	0	0
6	23EDACZ6	STRESS MANAGEMENT BY YOGA	AC	40	60	100	2	0	0	0
7	23EDACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	AC	40	60	100	2	0	0	0
8	23EDACZ8	SANSKRIT FOR TECHNICAL KNOWLEDGE	AC	40	60	100	2	0	0	0

SUMMARY OF CREDIT DISTRIBUTION

S.No	Course / Subject Area	Credits					Percentage
		I SEM	II SEM	III SEM	IV SEM	Total	
1.	FC	7	-	-	-	07	**10 %**
2.	PC	13	13	-	-	26	**37.14%**
3.	PE	3	6	3	-	12	**17.14 %**
4.	OE	-	-	3	-	03	**4.29 %**
5.	AC	0	0	-	-	(Non Credit)	**0%**
6.	EEC	-	2	8	12	22	**31.43 %**
Total Credits		**23**	**21**	**14**	**12**	**70**	**100.00%**

CATEGORY-WISE CREDIT DISTRIBUTION

FUNDAMENTAL COURSE (FC)

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	23EDFCZ1	RESEARCH METHODOLOGY AND IPR	FC	40	60	100	3	0	0	3
2.	23EDFC02	APPLIED MATHEMATICS FOR ENGINEERING DESIGN	FC	40	60	100	3	1	0	4
Total				**80**	**120**	**200**	**6**	**1**	**0**	**7**

PROFESSIONAL CORE (PC)

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	23EDPC01	APPLIED MECHANICS OF MATERIAL	PC	40	60	100	3	1	0	4
2.	23EDPC02	VIBRATION ANALYSIS AND CONTROL	PC	40	60	100	3	1	0	4
3.	23EDPC03	GEOMETRIC DIMENSIONING AND TOLERANCING	PC	40	60	100	3	0	0	3
4.	23EDPC04	VIBRATION LAB	PC	60	40	100	0	0	4	2
5.	23EDPC05	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	PC	40	60	100	3	1	0	4
6.	23EDPC06	COMPUTER APPLICATIONS IN DESIGN	PC	40	60	100	3	0	0	3
7.	23EDPC07	TRIBOLOGY IN DESIGN	PC	40	60	100	3	1	0	4
8.	23EDPC08	SIMULATION LAB	PC	60	40	100	0	0	4	2
Total				**360**	**440**	**800**	**18**	**4**	**8**	**26**

PROFESSIONAL ELECTIVE (PE)

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	23EDPEXX	PROFESSIONAL ELECTIVE I	PE	40	60	100	3	0	0	3
2.	23EDPEXX	PROFESSIONAL ELECTIVE II	PE	40	60	100	3	0	0	3
3.	23EDPEXX	PROFESSIONAL ELECTIVE III	PE	40	60	100	3	0	0	3
4.	23EDPEXX	PROFESSIONAL ELECTIVE IV	PE	40	60	100	3	0	0	3
Total				**160**	**240**	**400**	**12**	**0**	**0**	**12**

OPEN ELECTIVE (OE)

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	23EDOEXX	OPEN ELECTIVE	OE	40	60	100	3	0	0	3
Total				**40**	**60**	**100**	**3**	**0**	**0**	**3**

AUDIT COURSE (AC)

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	23EDACXX	AUDIT COURSE - I	AC	40	60	100	2	0	0	0
2.	23EDACXX	AUDIT COURSE - II	AC	40	60	100	2	0	0	0
Total				**80**	**120**	**200**	**4**	**0**	**0**	**0**

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

S. No	Subject Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23EDEE01	MINI PROJECT	EEC	40	60	100	0	0	4	2
2	23EDEE02	INTERNSHIP / INDUSTRIAL TRAINING	EEC	100	0	100	0	0	**	2
3	23EDEE03	PROJECT PHASE - I	EEC	100	100	200	0	0	12	6
4	23EDEE04	PROJECT PHASE - II	EEC	200	200	400	0	0	24	12
				440	**360**	**800**	**0**	**0**	**40**	**22**

**4 WEEKS OF INTERNSHIP / INDUSTRIAL TRAINING

23EDFCZ1	RESEARCH METHODOLOGY AND IPR (Common to all branches)	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	0	0	3

Course Objectives	1.To impart knowledge on research methodology ,Quantitative methods for problem solving, data interpretation and report writing 2. To know the importance of IPR and patent rights.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.		
UNIT – II	**QUANTITATIVE METHODS FOR PROBLEM SOLVING**	**9 Periods**
Statistical Modelling and Analysis, Time Series Analysis Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis.		
UNIT – III	**DATA DESCRIPTION AND REPORT WRITING**	**9 Periods**
Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables , Relation between frequency distributions and other graphs, preparing data for analysis. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.		
UNIT – IV	**INTELLECTUAL PROPERTY**	**9 Periods**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
UNIT – V	**PATENT RIGHTS**	**9 Periods**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES

1	*Stuart Melville and Wayne Goddard,* ***"Research methodology: an introduction for science & engineering students",*** *Juta Academic, 1996.*
2	*Donald H.McBurney and Theresa White,* ***"Research Methods",*** *9th Edition, engageLearning, 2013.*
3	*RanjitKumar,* ***"Research Methodology: A Step by Step Guide for Beginners",*** *5th Edition, 2014.*
4	*Dr. C. R. Kotharia and GauravGarg,* ***"Research Methodology: Methods and Trends",*** *New age international publishers, Fourth Edition, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate research question for conducting research.	K4
CO2	Analyze qualitative and quantitative data.	K4
CO3	Interpret research findings and give appropriate conclusions.	K4
CO4	Develop a structured content to write technical report.	K4
CO5	Summarize the importance of IPR and protect their research work through intellectual property.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	2
CO2	2	-	-	-	-
CO3	3	3	3	2	2
CO4	2	2	2	2	2
CO5	1	1	1	1	1
23EDFCZ1	2	2	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	30	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	30	20	-	-	100
ESE	30	30	20	20	-	-	100

23EDFC02	APPLIED MATHEMATICS FOR ENGINEERING DESIGN	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	1	0	4

Course Objectives	1. To gain the concepts of Correlation and Regression. 2. To gain the knowledge of test of hypothesis applicable to small and large samples. 3. To be familiar with numerical solutions of algebraic, transcendental equation and system of linear equations. 4. To acquire knowledge of numerical solution to first order ordinary differential equations using single and multi-step techniques. 5.To gain the knowledge of numerical solution to second order partial differential equations using explicit and implicit methods.	
UNIT – I	**CORRELATION AND REGRESSION**	**9+3 Periods**
Correlation coefficients- Equation of the lines of regression, Regression coefficients, Regression curves- Multiple and Partial correlation, Partial regression.		
UNIT – II	**TESTING OF HYPOTHESIS**	**9+3 Periods**
Large samples: Tests for Mean and proportions, Small samples: Tests for Mean, Variance and Attributes using t, F, Chi–Square distribution.		
UNIT – III	**NUMERICAL SOLUTION OF EQUATIONS, LINEAR SYSTEM AND INVERSE OF MATRIX**	**9+3 Periods**
Newton-Raphson method for single variable and simultaneous equations with two variables- Solution of linear system by Gauss elimination, Gauss-Jordan, Crout's and Gauss Seidal Methods – Matrix inversion: Gauss elimination and Gauss-Jordan methods.		
UNIT – IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Single step methods: Taylor's series method – Euler's method – Modified Euler's method – Runge - Kutta method of fourth order - Multi step methods: Miline's Predictor and Corrector methods: Adam Bashforth predictor and corrector method. Numerical solution of ordinary differential equation by finite difference method.		
UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Finite difference solution for two-dimensional Laplace equation: Gauss Jacobi and Gauss Seidal methods – Poisson equation. Finite difference method for one dimensional heat equation: Parabolic equation – Hyperbolic Equation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES

1	*VeerarajanT.*, ***Probability and Statistics, Random Processes and Queuing Theory (First edition)****, Graw Hill Education(India) Pvt Ltd., New Delhi, Fourth Edition,2018.*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***Numerical Methods****, S. Chand & Company, 3nd Edition, Reprint 2013.*
3	*Trivedi K.S,* ***Probability and Statistics with Reliability, Queuing and Computer Science Applications****, Prentice Hall of India, New Delhi.*

4.	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***Numerical Methods****, S. Chand & Company, 3nd Edition, Reprint 2013.*
5.	*S.S. Sastry,* ***Introductory methods of numerical analysis****, PHI, New Delhi, 5th Edition, 2015.* *Ward Cheney.*
6.	*S. Larsson, V. Thomee,* ***Partial Differential Equations with Numerical Methods****, Springer, 2003.*
7.	*B.S.Grewal,* ***Higher Engineering Mathematics****, Khanna Publishers, New Delhi, 44thEdition, 2018.*
8.	*Gupta S.C and Kapoor V.K.,* ***Fundamentals of Mathematical Statistics****, Sultan Chand & Sons, New Delhi, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe how correlation is used to identify relationships between variables and how regression analysis is used to predict outcomes.	K5
CO2	Test for significance of hypothesis connected to small and large samples using different parameters.	K5
CO3	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to polynomial and transcendental equations, the solution of system linear equations.	K5
CO4	Construct one-step and multistep methods for the numerical solution of initial-value problems for ordinary differential equations and systems of such equations.	K5
CO5	To acquire the knowledge of principles for designing numerical schemes for PDEs in particular finite difference schemes, interpret solutions in a physical context of wave and heat equation in specified techniques.	K5

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1		
CO2	3	2	1		
CO3	3	2	1		
CO4	3	2	1		
CO5	3	2	1		
23EDFC02	3	2	1		
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	20	15	15		100
CAT2	20	30	15	15	20		100
Assignment 1		30	25	20	25		100
Assignment 2		30	20	30	20		100
ESE	10	30	20	10	30		100

23EDPC01	APPLIED MECHANICS OF MATERIALS	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	1. To learn the concepts of theory of elasticity in three-dimensional stress system. 2. To study the shear center of various cross-sections and deflections in beams subjected to unsymmetrical bending. 3. To learn the stresses in flat plates and curved members. 4. To study torsional stress of non-circular sections. 5. To learn the stresses in rotating members, contact stresses in point and line contact applications.	
UNIT – I	**ELASTICITY**	**9+3 Periods**
Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - plane stress - Airy's stress function. Energy methods.		
UNIT – II	**SHEAR CENTER AND UNSYMMETRICAL BENDING**	**9+3 Periods**
Location of shear center for various sections - shear flows. Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section		
UNIT – III	**CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES**	**9+3 Periods**
Circumference and radial stresses - deflections-curved beam with restrained ends-closed ring subjected to concentrated load and uniform load-chain links and crane hooks. Stresses in circular and rectangular plates due to various types of loading and end conditions, buckling of plates.		
UNIT – IV	**TORSION OF NON-CIRCULAR SECTIONS**	**9+3 Periods**
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy Prandtl's stress function.		
UNIT – V	**STRESSES DUE TO ROTARY SECTIONS AND CONTACT STRESSES**	**9+3 Periods**
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness. Methods of computing contact stress-deflection of bodies in point and line contact applications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total:60 Periods**		

REFERENCES

1	*Seely and Smith,"**Advanced Mechanics of Materials**", John Wiley International Edn.*
2	*Sadhusingh, "**Theory of Elasticity**",Khanna Publishers, 2003.*
3	*Timoshenko and Goodier, "**Theory of Elasticity**", McGraw Hill, 2010*
4	*Wang, "**Applied Elasticity**", McGraw Hill, 2007*
5	*J.Case,L.Chilver and Carl T.F "**Strength of Materials and structures**", Arnold publisher 1999.*
6	*Robert D. Cook, Warren C. Young, "**Advanced Mechanics of Materials**", Mc-millan pub. Co., 1985.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of theory of elasticity in three-dimensional stress system.	K4
CO2	Determine the shear centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.	K4
CO3	Evaluate the stresses in flat plates and curved members.	K4
CO4	Calculate torsional stress of non-circular sections.	K4
CO5	Determine the stresses in rotating members, contact stresses in point and line contact applications.	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	-	-
CO2	-	2	2	-	-
CO3	1	2	2	1	1
CO4	1	2	2	-	-
CO5	-	2	2	1	1
23EDPC01	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPC02	VIBRATION ANALYSIS AND CONTROL	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	1. To appreciate the basic concepts of vibration in damped and undamped systems. 2. To calculate the natural frequencies and mode shapes of the two-degree freedom systems. 3. To determine the natural frequencies and mode shapes of the multi degree freedom and continuous systems. 4. To learn the fundamentals of control techniques of vibration and noise levels. 5. To use the instruments for the measuring and analyzing the vibration levels in a body.	
UNIT – I	**FUNDAMENTALS OF VIBRATION**	**9+3 Periods**
Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration- Review of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response to Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads -Critical Speed of Shaft-Rotor systems.		
UNIT – II	**TWO DEGREE OF FREEDOM SYSTEM**	**9+3 Periods**
Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert's principle, Energy methods. Free vibrations, free damped vibrations, and forced vibrations with and without damping, base excitation.		
UNIT – III	**MULTI-DEGREES OF FREEDOM SYSTEMS**	**9 Periods**
Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton's Principle, Lagrangian equation and their applications.		
UNIT – IV	**VIBRATION CONTROL**	**9+3 Periods**
Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool - Vibration Isolation methods - Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber, Damped Vibration absorbers - Static and Dynamic Balancing-Balancing machines - Field balancing – Vibration Control by Design Modification- - Active Vibration Control		
UNIT – V	**EXPERIMENTAL METHODS IN VIBRATION ANALYSIS**	**9+3 Periods**
Vibration Analysis Overview - Experimental Methods in Vibration Analysis - Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings. Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments - System Identification from Frequency Response - Testing for resonance and mode shapes.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total:60 Periods**		

REFERENCES:

1	*Timoshenko, S. **"Vibration Problems in Engineering**", John Wiley & Sons, Inc., 1987.*
2	*Meirovitch, L. "**Elements of Vibration Analysis**", McGraw-Hill Inc., 1986.*
3	*Thomson W.T, Marie Dillon Dahleh, "**Theory of Vibrations with Applications**", Prentice Hall, 1997.*
4	*F.S. Tse., I.F. Morse and R.T. Hinkle, "**Mechanical Vibrations**", Prentice-Hall of India, 1985.*
5	*Rao.J.S. and Gupta.K. "**Theory and Practice of Mechanical Vibrations**", Wiley Eastern Ltd., New Delhi, 1999.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basics of vibration and its importance in engineering field.	K4
CO2	Apply the basic concepts of vibration in damped and undamped systems.	K4
CO3	Identify the reasons for vibrations in engineering systems.	K4
CO4	Design and analyze two and multi-degree vibratory systems.	K4
CO5	Apply vibration measuring instruments, vibration control and analysis techniques in the engineering field.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	-	-
CO2	1	2	2	-	-
CO3	2	2	-	-	-
CO4	1	2	2	2	-
CO5	1	2	2	1	-
23EDPC02	1	2	2	2	-
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPC03	GEOMETRIC DIMENSIONING AND TOLERANCING	I

PREREQUISITES	CATEGORY	L	T	P	C
Machine Drawing	PC	3	0	0	3

Course Objectives	1. GD&T, as well as selecting the appropriate symbols and applying general design principles for manufacturability. 2. Datum concept in the field of GD&T. 3.Determining the material conditions and material boundary. 4.Knowledge of the various tolerance types. 5.Knowledge of profile and run out tolerances.	
UNIT – I	**DIMENSIONING, TOLERANCING AND INTRODUCTION TO SYMBOLS, TERMS**	**9 Periods**
Dimensioning Units, Fundamental Dimensioning Rules, Definitions Related to Tolerancing, Single Limits, Maximum Material Condition (MMC), Least Material Condition (LMC), Extreme Form Variation, Basic Fits of Mating Parts, Clearance Fit, Allowance, Clearance, Force Fit, Chain Dimensioning, Baseline Dimensioning, Direct Dimensioning, Alternate Dimensioning Practices. Geometric Dimensioning and Tolerancing for CADD/CAM. Dimensioning Symbols-Dimensioning and Tolerancing Templates. Datum Feature Symbols, Datum Target Symbols, Geometric Characteristic Symbols, Material Boundary Symbols. Feature Control Frame Basic Dimensions Additional Symbols.		
UNIT – II	**DATUMS**	**9 Periods**
Datum Feature Symbol, Reference Frame Concept, Datum Target Symbols, Partial Datum Surface, Coplanar Surface Datums, Datum Axis, Movable Datum Target Symbols and Datum Target Points, Movable Datum Target Symbols and Datum Target Spheres, Datum Center Plane, The Center of a Pattern of Features as the Datum Axis, applying a Translation Modifier to a Datum Reference Using a Contoured Surface as a Datum Feature.		
UNIT – III	**MATERIAL CONDITION AND MATERIAL BOUNDARY**	**9 Periods**
Features of Size, Conventional Tolerance. Limits of Size, Perfect Form Boundary. Regardless of Feature Size (RFS) and Regardless of Material Boundary (RMB). Maximum Material Condition (MMC). Least Material Condition (LMC). Primary Datum Feature, Secondary and Tertiary Datum Feature. Datum Precedence and Material Condition. Placing the MMB value in the Feature Control Frame Material Condition Analysis and Applications Material Boundary Calculation Examples.		
UNIT – IV	**FORM, ORIENTATION AND LOCATION TOLERANCES**	**10 Periods**
Straightness, Flatness, Circularity. Free State Variation. Cylindricity, Applying Form Control to a Datum Feature. Orientation Tolerances -Parallelism, Perpendicularity Tolerance. Combination of Parallelism and Perpendicularity Tolerances. Angularity Tolerance. Application of Orientation Tolerances at RFS, MMC, and Zero Tolerance at MMC. Location Tolerances-Positional Tolerance. Locating Multiple Features, Positional Tolerancing of Coaxial Features, Positional Tolerancing of Nonparallel Holes. Locating Slotted Features, Positional Tolerancing of Spherical Features. Location Tolerances and Virtual Condition. Fasteners, Projected Tolerance Zone, Virtual Condition, Concentricity Tolerance, Positional Tolerancing for Coaxially.		
UNIT – V	**PROFILE TOLERANCES AND RUNOUT TOLERANCES**	**8 Periods**
Profile Tolerances -Non-Uniform Profile Tolerance Zone, Specifying Basic Dimensions in a Note, Combination of Geometric Tolerances. Runout Tolerances-Combination of Geometric Tolerances, Specifying Independency.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0Periods Total: 45 Periods**		

REFERENCES:

1	*Alex Krulikowski,* ***"Fundamentals of Geometric Dimensioning and Tolerancing",*** *Delmar Cengage Learning, 2012.*
2	*P.S.Gill,* ***"Geometric Dimensioning and Tolerancing",****S.K.Kataria& sons, 2013*
3	*Bruce A.Wilson,****"GD&T- Application and Interpretation",****Goodeheart-Willcox, 2019*
4	*James D Meadows,****"Geometric Dimensioning and Tolerancing Handbook",*** *JamesD. Meadows & Associates, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select relevant process; apply the general design principles for manufacturability; GD&T	K4
CO2	Applying the concept of datums in GD&T	K4
CO3	Understanding about the material condition and material boundary	K4
CO4	Know the various types of tolerances	K4
CO5	Know about the profile and runout tolerances	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	-	2	-
CO2	2	-	2	-	-
CO3	2	2	2	1	2
CO4	-	2	-	2	2
CO5	2	2	-	-	2
23EDPC03	2	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPC04	VIBRATION LAB	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	To supplement the principles learnt in vibration and dynamics of machinery and expose to various measuring devices for vibration analysis.
1	Modal analysis of Simply Supported beam
2	Modal analysis of Cantilever beam
3	Natural frequency and modal analysis of Disc.
4	Amplitude and frequency of simple harmonic motion.
5	Verify the laws of gyroscopic and determination of gyroscopic couple.
6	Find the Whirling speed of given shaft.
7	Governors – determination of sensitivity, effort for Watt, Porter, Proell, governors
8	Determination of Cam jump and generation of Cam profile.
9	Vibrating system – spring mass system analysis.
10	Determination of damping co-efficient of rotary system.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total:60 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Use signal analyzers for vibrating systems.	K6
CO2	Demonstrate the use of gyroscope and governors.	K6
CO3	Use the knowledge for balancing of machine components.	K6
CO4	Depict the results of experiments in written and graphical format.	K6
CO5	Respond as instructed while working in groups.	K6

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	-	1
CO2	1	2	2	1	-
CO3	1	2	2	-	1
CO4	1	2	2	1	-
CO5	1	2	2	-	1
23EDPC04	1	2	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

23EDPC05	FINITE ELEMENT METHOD IN MECHANICAL DESIGN	II

PREREQUISITES	CATEGORY	L	T	P	C
Solid Mechanics/Numerical methods in Engineering	PC	3	1	0	4

Course Objectives	1.To develop a thorough understanding of the basic principles of finite element analysis 2.To develop techniques for solving practical design problems in engineering 3.To understand the basic concepts of application to Heat conduction and torsion problems 4. To study the Implementation issues, locking, reduced integration, B-Bar method 5.To acquire knowledge in application of FEA in structural analysis.	
UNIT – I	**INTRODUCTION**	**6+3 Periods**
Introduction, Boundary value problems and solution methods, Direct approach – example, advantage and limitations.		
UNIT – II	**RELEVANCE OF FINITE ELEMENT ANALYSIS IN DESIGN**	**9+3 Periods**
Elements of calculus of variation, Strong form and weak form, equivalence between strong and weak forms, Rayleigh-Ritz method. Method of weighted residuals – Galerkin and Petrov -Galerkin approach; Axially loaded bar, governing equations, discretization, derivation of element equation, assembly, imposition of boundary condition and solutions.		
UNIT – III	**FINITE ELEMENT FORMULATION FOR ONE-DIMENSIONAL PROBLEMS**	**10+3 Periods**
Finite element formulation for Euler-Bernoulli beams, Timoshenko beams, plane trusses and frames		
UNIT – IV	**FINITE ELEMENT FORMULATION FOR TWO-DIMENSIONAL PROBLEMS**	**10+3 Periods**
Finite element formulation for two-dimensional problems - completeness and continuity, different elements (triangular, rectangular, quadrilateral etc.), shape functions, Gauss quadrature technique for numerical integration. Scalar field problems; Iso-parametric formulation, Application to Heat conduction and torsion problems. Linear elasticity; Formulation.		
UNIT – V	**FINITE ELEMENT FORMULATION FOR THREE-DIMENSIONAL PROBLEMS**	**10+3 Periods**
Implementation issues, locking, reduced integration, B-Bar method; Finite element formulation for three-dimensional problems-Different elements, shape functions, Gauss quadrature in three dimensions.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total:60 Periods**		

REFERENCES:

1	*J. N. Reddy.,"**Introduction to Finite Element Method**",McGraw-Hill Education (2019).*
2	*Jacob Fish and Ted Belytschko .," **First Course in Finite Elements**" .John Wiley & Sons, Ltd(2007).*
3	*Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt .,"**Concept and Applications of Finite Element Analysis** ",Willy publication(2007).*
4	*Thomas J. R. Hughes .,"**The Finite Element Method: Linear Static and Dynamic Finite Element Analysis**", Courier Corporation, (2012).*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Distinguish different numerical methods involved in Finite Element Analysis	K4
CO2	Apply equations in finite element methods for 1D, 2D and 3D problems.	K4
CO3	Apply shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation	K4
CO4	Formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics.	K4
CO5	Analyze beams and truss, frames using finite element analysis	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	-	-
CO2	-	2	2	-	-
CO3	1	2	2	1	1
CO4	1	2	2	-	-
CO5	-	2	2	1	1
23EDPC05	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPC06	COMPUTER APPLICATIONS IN DESIGN	II

PREREQUISITES	CATEGORY	L	T	P	C
• Student required the knowledge of drafting principles and basic PC (Windows) computer skills.	PC	3	0	0	3

Course Objectives	1. Impart knowledge on computer graphics on various engineering, medicine and scientific areas. 2. Demonstrate basics of CAD concepts. 3. Explain computer graphics and solid modelling techniques. 4. Demonstrate part programs and group technology techniques. 5. Explain Optimization in CAD aspect.	
UNIT – I	**INTRODUCTION TO CAD APPLICATIONS**	**9 Periods**
CAD Applications: Engineering Products, analogy: documentation, Design Representation, FEM, Optimization, Software/AutoCAD/Mechanical Desktop/I-DEAS		
UNIT – II	**SOLID MODELING**	**9 Periods**
Representation of Solids, Topology, wireframe modelling, Boundary Representation, CSG, Operations: extrude, revolve, examples.		
UNIT – III	**DESIGN OF CURVES,SURFACES, SURFACE PATCHES**	**10 Periods**
Representation, piecewise continuous, differential geometry of curves, Ferguson, segments, Bezier segments, B-Splines, Rational Curves/NURBS. Design of Surfaces-Piecewise continuous, differential geometry. Design of Surface patches: Fersugon,16 point form, Bezier, B-spline.		
UNIT – IV	**DESIGN OF COMPOSITE SURFACES**	**9 Periods**
Design of Composite Surfaces: Ferguson and Bezier surfaces, Computational geometry, Mesh generation.		
UNIT – V	**OPTIMIZATION IN CAD**	**8 Periods**
Optimization: Single variable methods, KKT conditions, Stochastic Methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES

1	*J. Srinivas," **CAD/CAM - Principles and Applications**", Oxford HED, 2016.*
2	*Saxena, A., and Sahay., B "**Computer Aided Engineering Design**," Anamaya and Springer,2006.*
3	*Faux I. D. and Pratt M. J., "**Computational Geometry for Design and Manufacture**", Ellis Harwood Limited, West Sussex, England, 1979.*
4	*Mortenson M. E., "**Geometric Modeling**", John Wiley and Sons, New York., 1985.*
5	*P.N.Rao, "**CAD/CAM: Principles and Applications**"-3rd Edition, Tata McGraw Hill, India, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply design concepts	K4
CO2	Appreciate visual realism through modelling techniques	K4
CO3	Develop the idea to design the composite surfaces	K4
CO4	Develop part programs for solid models	K4
CO5	Make use of FEM concept for analysis	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	-	-
CO2	-	2	2	-	-
CO3	1	2	2	1	1
CO4	1	2	2	-	-
CO5	-	2	2	1	1
23EDPC06	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPC07	TRIBOLOGY IN DESIGN	II

PREREQUISITES	CATEGORY	L	T	P	C
Fluid mechanics	PC	3	1	0	4

Course Objectives	1. Learn the principles of friction and wear 2. Understand the standard procedure available for tribology using standard data and catalogues 3. Design the fluid film bearings, rolling element bearings etc., 4. Study the Tribological aspects of rolling motion 5.Understand the concept of finite bearing	
UNIT – I	**INTRODUCTION,FRICTION AND WEAR**	**8+3 Periods**
Tribology in Design - Mechanical design of oil seals and gasket - Tribological design of oil seals and gasket. Tribology in Industry (Maintenance). Lubrication-Basic Modes of Lubrication, Properties of Lubricants, Lubricant Additives. Bearing -Terminology, sliding contact bearings, Rolling contact bearings. Comparison between Sliding and Rolling Contact Bearings.Friction - Laws of friction, classification, Causes of friction. Theories of Dry Friction, Friction Measurement, Stick-Slip Motion and Friction Instabilities. Wear – classification, Wear between solids, Wear between solid and liquid, Factors affecting wear, Measurement of wear. Theories of Wear, Approaches to Friction Control and Wear Prevention, Boundary Lubrication, Bearing Materials and Bearing Construction.		
UNIT – II	**LUBRICATION OF BEARINGS**	**10+3 Periods**
Mechanics of Fluid Flow - Theory of hydrodynamic lubrication -Mechanism of pressure development in oil film. Two-Dimensional Reynolds's Equation and its Limitations. Idealized Bearings. Infinitely Long Plane Fixed Sliders, Infinitely Long Plane Pivoted Sliders, Infinitely Long Journal Bearings, Infinitely Short Journal Bearings. Designing Journal Bearing - Sommerfeld number – Raimondi and Boyd method - Petroff's Solution - Parameters of bearing design - Unit pressure - Temperature rise - Length to diameter ratio - Radial clearance - Minimum oil-film thickness.		
UNIT – III	**HYDRODYNAMIC THRUST BEARING**	**8+3 Periods**
Introduction, Pressure Equation, Load, Center of Pressure, Friction- Flat plate thrust bearing, tilting pad thrust bearing.		
UNIT – IV	**HYDROSTATIC, ELASTO-HYDRODYNAMIC AND GAS (AIR-) LUBRICATED BEARINGS**	**11+3 Periods**
Hydrostatic Lubrication - Basic concept, Advantages and limitations, Viscous flow through rectangular slot, Load carrying capacity and flow requirement, Energy losses, Optimum design, Application to journal bearings, Piston Pin Lubrications.Elasto-Hydrodynamic Lubrication-Principles and Applications, Pressure viscosity term in Reynolds's equation, Hertz's Theory, Ertel-Grubin equation, Lubrication of spheres, Gear teeth bearings, Rolling element bearings.Gas (Air-) Lubricated Bearings-Introduction, Merits, Demerits and Applications, tilting pad bearings, Magnetic recording discs with flying head, Hydrostatic bearings with air lubrication, Hydrodynamic bearings with air lubrication, Thrust bearings with air lubrication.		
UNIT – V	**TRIBOLOGICAL ASPECTS OF ROLLING MOTION AND FINITE BEARINGS**	**7+3 Periods**
Tribological aspects of rolling motion-The mechanics of tyre-road interactions, Road grip and rolling resistance, Tribological aspects of wheel on rail contact. Finite Bearings-Hydrostatic bearings, Hydrodynamic bearings, Thrust oil bearings, Porous Bearings, Foil bearings, Heat in bearings.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total:60 Periods**		

REFERENCES:

1	*Harish Hirani., "**Fundamentals of Engineering Tribology with Applications**", Cambridge University Press (2016).*
2	*Ajayi, Layo; Ludema, K. C., "**Friction, wear, lubrication: a textbook in tribology** [Second edition"], Taylor & Francis (2019).*
3	*Martin Dienwiebel, Maria-Isabel De Barros Bouchet., "**Advanced Analytical Methods in Tribology** [1st ed.]",Springer International Publishing (2018).*
4	*Catalin I. Pruncu (editor), AmitAherwar (editor), StanislavGorb (editor).," **Tribology and Surface Engineering for Industrial Applications** [1 ed.]",CRC Press (2021).*
5	*G W Stachowiak; A W Batchelor., "**Engineering tribology** "[4th ed.],Butterworth-Heinemann (2013).*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply knowledge of friction and wear in engineering applications.	K4
CO2	Design hydrostatic and hydrodynamic bearings for machineries and equipments.	K4
CO3	Design bearings of various types.	K4
CO4	Perform the various measurements on surfaces and bearings.	K4
CO5	Apply knowledge of lubrication in engineering applications.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	-	-
CO2	-	2	2	-	-
CO3	1	2	2	1	1
CO4	1	2	2	-	-
CO5	-	2	2	1	1
23EDPC07	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPC08	SIMULATION LAB	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	1. To impart practical training on simulation and analysis of mechanical systems using advanced software tools. 2. To give exposure to software tools needed to analyze engineering problems.
LIST OF EXPERIMENTS Analysis of Mechanical Components – Use of FEA Packages like ANSYS and CFD. Exercises shall include analysis of	
1	Introduction to ANSYS and FEA software.
2	Static structural analysis of truss.
3	Static structural analysis of cantilever beam with point load (3D)
4	Static structural analysis of simply supported beam with uniformly varying load.
5	Indirect coupled field analysis
6	Modal analysis of two mass spring system.
7	Harmonic analysis of cantilever beam
8	Transient thermal analysis
9	Thermal stress of a cylinder using axi-symmetric elements (thermal to structural)
10	Simulation of four bar mechanism.
11	Simulation of pipe flow.
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total:60 Periods**	

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use the software tool for analyzing structural systems.	K6
CO2	Demonstrate the use of simulation tool.	K6
CO3	Use the knowledge of mechanism of synthesis or modelling.	K6
CO4	Depict the results of simulation in graphical format.	K6
C05	Respond as instructed while working in groups.	K6

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	-	1
CO2	1	2	2	1	-
CO3	1	2	2	-	1
CO4	1	2	2	1	-
CO5	1	2	2	-	1
23EDPC08	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

23EDEE01	MINI PROJECT	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	4	2

Course Objectives	To make the student to feel/understand the magnitude of engineering design and then apply.

SYLLABUS

Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total:60 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Get an opportunity to work in actual industrial environment if they opt for internship.	K6
CO2	Solve a live problem using software/analytical/computational tools.	K6
CO3	Write technical reports.	K6
CO4	Develop skills to present and defend their work in front of technically qualified audience.	K6
CO5	execute the Project experimental Work	K6

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	2	3	2	1
CO3	3	2	3	3	3
CO4	1	1	2	1	2
CO5	1	2	1	1	1
23EDEE01	3	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23EDEE02	INTERNSHIP / INDUSTRIAL TRAINING	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	*	2

Course Objectives	1.To make students get ready to become an entrepreneur or an effective administrator. 2. To acquire the knowledge about industrial programs.
CONTENTS	
Four week continuously industrial training of any industry, the report of the training must have a literature survey of selected company product and training certificate.	
Total Periods: 4 Weeks	

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify gaps in published literatures and find scope of improvement.	K6
CO2	Write technical report about any industrial activity.	K6
CO3	Perform the differential analysis between theory and practical.	K6
CO4	Innovate new mechanism design and estimate cost for a product or process.	K6
CO5	analyze tolerances and engineering drawings.	K6

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	1	1	1
CO2	1	3	2	1	-
CO3	2	1	1	2	1
CO4	1	1	3	1	2
CO5	1	2	1	1	1
23EDEE02	1	2	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

23EDEE03	PROJECT PHASE I	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	12	6

Course Objectives	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature and to develop the methodology to solve the identified problem then publish paper at least in conference.
SYLLABUS	
1. The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. 2. The student can select any topic which is relevant to the area of Engineering Design. The topic may be theoretical or case studies. 3. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work and report on the preliminary study conducted. 4. The students will be evaluated through a viva-voce examination.	
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 180 Periods Total: 180 Periods**	

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the project work scientifically in a systematic way	K6
CO2	Analyze the problem and data of literatures clearly to explore the ideas and methods.	K6
CO3	Formulate the objectives and methodology to solve the identified problem.	K6

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	3
CO2	3	2	3	3	2
CO3	3	2	3	3	3
23EDEE03	3	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial					

23EDEE04	PROJECT PHASE II	IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	24	12

Course Objectives	To solve the identified problem based on the formulated methodology and to develop skills to analyze and discuss the test results and make conclusions.

SYLLABUS	
1. The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. 2. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. 3. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner	
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 360 Periods Total:360 Periods**	

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Execute the project work on challenging practical problem in a structured manner.	K6
CO2	Investigate the findings and infer observations logically.	K6
CO3	Evaluate the results and confirm the solution to the practical application and social benefit.	K6

COURSE ARTICULATION MATRIX					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	3
CO3	3	3	3	3	3
23EDEE04	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial					

23EDPE01	DESIGN FOR SUSTAINABILITY	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

REFERENCES:

Course Objectives	1. GD&T, as well as selecting the appropriate process and applying general design principles for manufacturability. 2. Designing cast and welded components with design concerns in mind. 3. Designing formed and machined components with design concerns in mind. 4. Consider design factors when putting together a system. 5. Consider environmental factors when designing.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning &Tolerance (GD&T) – Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – run out tolerancing: circular and total – Supplementary symbols.		
UNIT – II	**CAST & WELDED COMPONENTS DESIGN**	**9 Periods**
Design considerations for: Sand cast – Die cast – Permanent mold parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash &Upset weldment.		
UNIT – III	**FORMED & MACHINED COMPONENTS DESIGN**	**9 Periods**
Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts. Design considerations for: Turned parts – Drilled parts – Milled, planned, shaped and slotted parts– Ground parts.		
UNIT – IV	**DESIGN FOR ASSEMBLY**	**9 Periods**
Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly – Computer Application for DFMA		
UNIT – V	**DESIGN FOR ENVIRONMENT**	**9 Periods**
Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Boothroyd, G, Heartz and Nike,* ***"Product Design for Manufacture",*** *Marcel Dekker, 1994*
2	*Bralla,* ***"Design for Manufacture handbook",*** *McGraw hill, 1999*
3	*Dickson, John. R, and Corroda Poly,* ***"Engineering Design and Design for Manufacture and Structural Approach",*** *Field Stone Publisher, USA, 1995*
4	*Fixel,* ***"J. Design for the Environment",*** *McGraw Hill., 1996*
5	*Kevin Otto and Kristin Wood,* ***"Product Design. Pearson Publication",*** *2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select relevant process; apply the general design principles for manufacturability; GD&T	K4
CO2	Apply design considerations while designing the cast and welded components	K4
CO3	Apply design considerations while designing the formed and machined components	K4
CO4	Apply design considerations for assembled systems.	K4
CO5	Apply design considerations for environmental issues	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	2	1
CO2	1	2	2	2	1
CO3	1	2	2	1	1
CO4	2	1	3	2	1
CO5	1	1	1	2	3
23EDPE01	1	1	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE02	COMPOSITE MATERIALS AND MECHANICS	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. The study of various composite materials and the determination of their mechanical strength. 2. Different manufacturing technologies are used to fabricate FRP and other composites. 3. Fiber reinforced stress analysis Laminates for various combinations of plies with various fiber orientations. 4. Stresses in the laminate's lamina calculated using various failure theories 5. The Classical Laminate Theory was used to calculate residual stresses in various types of laminates under thermo-mechanical load.	
UNIT – I	**INTRODUCTION TO COMPOSITE MATERIALS**	**9 Periods**
Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute -Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites,		
UNIT – II	**MANUFACTURING OF COMPOSITES**	**9 Periods**
Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state, vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) –hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces		
UNIT – III	**LAMINA CONSTITUTIVE EQUATIONS**	**9 Periods**
Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix, Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.		
UNIT – IV	**LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES**	**9 Periods**
Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies		
UNIT – V	**THERMO-STRUCURAL ANALYSIS**	**9 Periods**
Fabrication stresses/Residual stresses in FRP laminated composites- Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's -Stress and Moment Resultants due cooling of the laminates during fabrication-Calculations for thermo-mechanical stresses in FRP laminates Case studies: Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Agarwal BD and Broutman LJ,* ***"Analysis and Performance of Fiber Composites"****, John Wiley and Sons, New York, 1990.*
2	*Gibson R F,* ***Principles of Composite Material Mechanics****, McGraw-Hill, 1994.CRC press, 4th Edition, 2016.*
3	*Hyer MW and Scott R White,* ***"Stress Analysis of Fiber – Reinforced Composite Materials"****, McGraw-Hill, 1998.*
4	*Issac M Daniel and Orilshai,* ***"Engineering Mechanics of Composite Materials",*** *Oxford University Press-2006, First Indian Edition - 2007*
5	*MadhujitMukhopadhyay,* ***"Mechanics of Composite Materials and Structures",*** *University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)*
6	*Mallick PK,* ***Fiber – Reinforced Composites: Materials, Manufacturing and Design****, CRC Press, 3rd Edition,2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Calculate for mechanical strength of the composite material	K4
CO2	Fabricate the FRP and other composites by different manufacturing methods	K4
CO3	Analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.	K4
CO4	Evaluate the stresses in the lamina of the laminate using different failure theories	K4
CO5	Analyze thermo-mechanical behavior and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	1	1	-
CO2	-	-	-	1	-
CO3	-	1	-	2	3
CO4	1	2	1	-	-
CO5	-	1	3	-	-
23EDPE02	1	1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE03	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. To provide an overview of the various components of hydraulic systems, as well as their design and selection techniques. 2. To develop a comprehensive grasp of the necessity for and use of different control and regulating components in hydraulic systems. 3. To allow them to construct hydraulic circuits for industrial applications on their own. 4. To familiarize them with the various components of pneumatic systems and to teach them how to construct basic pneumatic systems. 5. To persuade them of the need of integrating electronics, developing low-cost systems, and developing solutions for basic industrial applications.	
UNIT – I	**OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS**	**9 Periods**
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics, Hydrostatic drives, types, selection.		
UNIT – II	**CONTROL AND REGULATION ELEMENTS**	**9 Periods**
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems, Proportional Electro hydraulic servo valves.		
UNIT – III	**HYDRAULIC CIRCUITS**	**9 Periods**
Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits design methodology- design and selection of components - safety and emergency mandrels – Cascade method.		
UNIT – IV	**PNEUMATIC SYSTEMS AND CIRCUITS**	**9 Periods**
Pneumatic fundamentals - control elements, position and pressure sensing, Pneumatic equipment's-selection of components - design calculations - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design- Karnaugh - Veitch map.		
UNIT – V	**ELECTROMAGNETIC & ELECTRONIC CONTROL OF HYDRAULICS & PNEUMATIC CIRCUIT**	**9 Periods**
Electrical control of pneumatic circuits – use of relays, counters, timers, ladder diagrams, use of microprocessor in circuit design – use of PLC in hydraulic and pneumatic circuits – Fault finding– application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Lowcost automation - Robotic circuits.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Jagadeesha T,* ***"Pneumatics Concepts, Design and Applications ",*** *Universities Press, 2015*
2	*Majumdar, S.R.,* ***"Oil Hydraulics Systems – Principles and Maintenance",*** *Tata McGraw Hill, 2001.*
3	*ShanmugaSundaram.K,* ***"Hydraulic and Pneumatic Controls",****Chand& Co, 2006.*
4	*Anthony Esposito,* ***"Fluid Power with Applications",*** *Prentice Hall, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design and select appropriate pumps in industries based on need.	K4
CO2	Select correct sizing and rating of control elements in hydraulics.	K4
CO3	Design basic circuits (hydraulic) for industrial applications.	K4
CO4	Design basic pneumatic circuits for industrial applications.	K4
CO5	Identify and provide solution for troubleshooting and design low cost automation for industrial application.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	1	1	-	-
CO2	-	1	2	1	-
CO3	-	-	1	-	-
CO4	1	-	2	1	1
CO5	-	-	1	-	1
23EDPE03	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE04	QUALITY CONCEPTS IN DESIGN	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. To teach diverse engineering design ideas, material choices, and production procedures. 2. To study the fundamentals of employing various tools to implement quality in a product or service. 3. To employ failure mode effect analysis to improve product quality and apply ways to maintain the six-sigma status 4. Using multiple design-of-experiment principles to create a solid product or services 5. Maintaining product quality through the use of statistical tools and enforcing measures to increase product reliability.	
UNIT – I	**DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION**	**9 Periods**
Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.		
UNIT – II	**DESIGN FOR QUALITY**	**9 Periods**
Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.		
UNIT – III	**FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIX SIGMA**	**9 Periods**
Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method-linking fault states to systems modeling - Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.		
UNIT – IV	**DESIGN OF EXPERIMENTS**	**9 Periods**
Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios		
UNIT – V	**STATISTICAL CONSIDERATION AND RELIABILITY**	**9 Periods**
Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto Diagrams-Cause and Effect Diagrams-Box plots- Probability Distribution-Statistical Process control–Scatter diagrams – Multivariable charts –Matrix plots and 3-D plots. -Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distributions.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*AmitavaMitra,* ***"Fundamentals of Quality control and improvement",*** *John Wiley & Sons, 2016.*
2	*George E. Dieter, Linda C. Schmidt,* ***"Engineering Design",*** *McGraw Hill Education Pvt. Ltd., 2013*
3	*Karl T. Ulrich, Steven D. Eppinger,* ***"Product Design And Development",*** *Tata Mcgraw-Hill Education, 2015*
4	*Montgomery, D.C.,* ***"Design and Analysis of experiments",*** *John Wiley and Sons, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply fundamentals of design process and material selection for developing a quality product	K4
CO2	Apply the quality concepts to develop a robust product	K4
CO3	Perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality	K4
CO4	Apply different experimental design methods in product development	K4
CO5	Implement various statistical tools to improve its quality and reliability	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	3	3	2	2
CO2	1	2	2	1	2
CO3	2	1	1	-	1
CO4	1	1	2	-	1
CO5	2	2	3	1	2
23EDPE04	1	2	2	1	2
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE05	SURFACE ENGINEERING	I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. The goal of this course is to learn about the fundamentals of surface characteristics and different forms of friction in metals and non-metals. 2. To investigate the various types of wear mechanisms and the worldwide standards for measuring friction and wear. 3. To investigate the various forms of corrosion and the steps that may be taken to avoid it. 4. To investigate the many forms of surface treatments and surface modification methods. 5. To investigate the various materials utilized in friction and wear applications.	
UNIT – I	**FRICTION**	**9 Periods**
Topography of Surfaces – Surface features – Properties and measurement – Surface interaction –Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and nonmetallic materials – Friction in extreme conditions – Thermal considerations in sliding contact.		
UNIT – II	**WEAR**	**9 Periods**
Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear Laws of wear – Theoretical wear models – Wear of metals and non-metals – International standards in friction and wear measurement.		
UNIT – III	**CORROSION**	**9 Periods**
Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.		
UNIT – IV	**SURFACE TREATMENTS**	**9 Periods**
Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, laser re-melting, and laser cladding. Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coating.		
UNIT – V	**ENGINEERING MATERIALS**	**9 Periods**
Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*G.W.Stachowiak& A.W .Batchelor , **"Engineering Tribology",** Butterworth-Heinemann, UK,2005*
2	*Rabinowicz.E, **"Friction and Wear of materials",** John Willey &Sons,UK,1995*
3	*Halling, J. , **"Principles of Tribology ",**Macmillian – 1984*
4	*Williams J.A. **"Engineering Tribology",** Oxford Univ. Press, 1994*
5	*S.K.Basu, S.N.Sengupta&B.B.Ahuja, **"Fundamentals of Tribology",** Prentice –Hall of India Pvt. Ltd , New Delhi, 2005*
6	*Fontana G., **"Corrosion Engineering",** McGraw Hill, 1985.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basics of surface features, laws of friction, and different types of friction.	K4
CO2	Develop the knowledge of various wear mechanism and its measurement.	K4
CO3	Understand the types of corrosion and its preventive measures.	K4
CO4	Familiarize the types of surface properties and various surface modification techniques.	K4
CO5	Ability to understand the different types of materials used in the friction and wear applications.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	2
CO2	-	1	2	1	-
CO3	1	2	3	-	1
CO4	-	1	2	1	1
CO5	-	-	1	-	-
23EDPE05	1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE06	DESIGN FOR X	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. To study the concept of design for manufacturing, assembly and environment. 2. To know about the value analysis in design. 3. To study the product development economics. 4. To study the concepts of reliability. 5. To acquire the knowledge about maintainability techniques.	
UNIT – I	**DESIGN FOR MANUFACTURE & ASSEMBLY**	**9 Periods**
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks. Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines		
UNIT – II	**VALUE ENGINEERING**	**9 Periods**
Value –types –functional –operational –aesthetic –cost- –material – Design process – value and worthiness –procedure -brainstorming sessions –evaluation – case studies – value estimation-Value analysis - Design for value - Selection of alternatives - optimization – Implementation		
UNIT – III	**PRODUCT DEVELOPMENT ECONOMICS**	**9 Periods**
Elements of Economics Analysis-Quantitative and qualitative analysis-Economic Analysis Process-Estimating magnitude and time of future cash inflows and out flows- Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis- Influence of qualitative factors on project success		
UNIT – IV	**CONCEPT OF RELIABILITY**	**9 Periods**
Introduction: The study of Reliability and Maintainability, Concepts, Terms and Definitions, Applications, The Failure Distribution: The reliability Function, Mean Time to Failure, Hazard Rate Function, Bath-tub Curve, Conditional Reliability.		
UNIT – V	**ENGINEERING MATERIALS**	**9 Periods**
Analysis of down time, Report Time Distribution, Stochastic Point Processes, Reliability under Preventive Maintenance, State-Dependent System with Repair, Design for Maintainability.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Harry Peck, **"Designing for Manufacture",** Pitman Publications, 1983.*
2	*George E Dieter, **"Engineering Design",** McGraw-Hill Int Editions, 2017.*
3	*S.S.Iyer, **"Value Engineering",** New Age International, 2019.*
4	*Charles E. Ebeling, **"An Introduction to Reliability and Maintainability Engineering**", TMH 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply design concepts for manufacturing, assembly and environment.	K4
CO2	Understand the basic principles and limitations of common manufacturing processes and how they affect the manufacturability of a design.	K4
CO3	Evaluate the influence of economics in product development.	K4
CO4	Understand the reliability aspects in design	K4
CO5	Gain the knowledge about maintainability analysis.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	2
CO2	-	1	2	1	-
CO3	1	2	3	-	1
CO4	-	1	2	1	1
CO5	-	-	1	-	-
23EDPE06	1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE07	DESIGN OF MACHINE TOOL	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Selecting the different machine tool mechanisms. 2. Designing the Multi speed Gear Box and feed drives. 3. Designing the machine tool structures. 4. Designing the guideways and power screws. 5. Designing the spindles and bearings.	
UNIT – I	**INTRODUCTION TO MACHINE TOOL DESIGN**	**9 Periods**
Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.		
UNIT – II	**REGULATION OF SPEEDS AND FEEDS**	**9 Periods**
Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.		
UNIT – III	**DESIGN OF MACHINE TOOL STRUCTURES**	**9 Periods**
Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.		
UNIT – IV	**DESIGN OF GUIDEWAYS AND POWER SCREWS**	**9 Periods**
Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.		
UNIT – V	**DESIGN OF SPINDLES AND SPINDLE SUPPORT**	**9 Periods**
Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*N.K. Mehta, "**Machine Tool Design and Numerical Control"** TMH, New Delhi, 2010.*
2	*G.C. Sen and A. Bhattacharya, **"Principles of Machine Tools"** New Central Book Agency, 2009.*
3	*D. K Pal, S. K. Basu, **"Design of Machine Tools**" 5th Edition. Oxford IBH, 2008.*
4	*Acherkan.N.,**"Machine Tool Design"** Vol. 3 & 4, MIR Publishers, Moscow, 1968.*
5	*F. Koenigsberger, **"Machine Tool Structures"** Pergamon Press,1970.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Select the different machine tool mechanisms.	K4
CO2	Design the Multi speed Gear Box and feed drives.	K4
CO3	Design the machine tool structures.	K4
CO4	Design the guideways and power screws.	K4
CO5	Design the spindles and bearings.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	2	1
CO2	1	2	3	2	1
CO3	1	3	-	1	1
CO4	-	1	2	-	1
CO5	-	-	3	1	-
23EDPE07	1	3	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE08	PRODUCT LIFECYCLE MANAGEMENT	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. PLM's history, principles, and vocabulary will be studied. 2. To have a better understanding of PLM/functionality PDM's and features 3. To comprehend the many modules available in commercial PLM/PDM products 4. To show how PLM/PDM may be used in industrial settings. 5. PLM/PDM may be used with legacy data bases, CAx, and ERP systems.	
UNIT – I	**HISTORY, CONCEPTS AND TERMINOLOGY OF PLM**	**9 Periods**
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications		
UNIT – II	**PLM/PDM FUNCTIONS AND FEATURES**	**9 Periods**
User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration		
UNIT – III	**DETAILS OF MODULES IN A PDM/PLM SOFTWARE**	**9 Periods**
Case studies based on top few commercial PLM/PDM tools – Teamcenter, Windchill, ENOVIA, Aras PLM, SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault.		
UNIT – IV	**ROLE OF PLM IN INDUSTRIES**	**9 Periods**
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance		
UNIT – V	**BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE**	**9 Periods**
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Max Giordano, Luc Mathieu, Francois Villeneuve, **"Product Lifecycle Management", Wiley".***
2	*John Stark, **"Product Lifecycle Management, Vol.1",** 2015.*
3	*John Stark, **"Product Lifecycle Management, Vol.2",** 2015.*
4	*Michael Grieves, "**Product Lifecycle Management",** McGraw Hill, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Summarize the history, concepts and terminology of PLM.	K4
CO2	Use the functions and features of PLM/PDM.	K4
CO3	Use different modules offered in commercial PLM/PDM tools.	K4
CO4	Implement PLM/PDM approaches for industrial applications.	K4
CO5	Integrate PLM/PDM with legacy data bases, CAx& ERP systems.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	1
CO2	-	1	1	-	-
CO3	1	1	2	1	1
CO4	-	-	1	2	1
CO5	-	-	2	1	-
23EDPE08	1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE09	OPTIMIZATION TECHNIQUES IN DESIGN	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. To understand the basic concepts of unconstrained optimization techniques. 2. To understand the basic concepts of constrained optimization techniques. 3. To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems. 4. To implement optimization approaches and to select appropriate solution for design application. 5. To demonstrate selected optimization algorithms commonly used in static and dynamic applications.	
UNIT – I	**UNCONSTRAINED OPTIMIZATION TECHNIQUES**	**9 Periods**
Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.		
UNIT – II	**CONSTRAINED OPTIMIZATION TECHNIQUES**	**9 Periods**
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.		
UNIT – III	**ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE**	**9 Periods**
Introduction – Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multilayer feed forward network, Neural network applications. Swarm intelligence - Various animal behaviors, Ant Colony optimization, Particle Swarm optimization.		
UNIT – IV	**ADVANCED OPTIMIZATION TECHNIQUES**	**9 Periods**
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing technique.		
UNIT – V	**STATIC AND DYNAMIC APPLICATIONS**	**9 Periods**
Structural applications – Design of simple truss members – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsional loaded members – Design of springs. Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Goldberg, David.E, "**Genetic Algorithms in Search, Optimization and Machine Learning**", Pearson, 2009.*
2	*Jang, J.S.R, Sun, C.T and Mizutani E., "**Neuro-Fuzzy and Soft Computing**", Pearson Education.2015.*
3	*Johnson Ray, C., "**Optimum design of mechanical elements**", Wiley, 2nd Edition 1980.*
4	*Kalyanmoy Deb, "**Optimization for Engineering Design: Algorithms and Examples**", PHI Learning Private Limited, 2nd Edition, 2012.*
5	*RaoSingiresu S., "**Engineering Optimization - Theory and Practice**", New Age International Limited, New Delhi, 3rd Edition, 2013.*
6	*Rajasekaran S and VijayalakshmiPai, G.A, "**Neural Networks, Fuzzy Logic and Genetic Algorithms**", PHI, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate unconstrained optimization techniques in engineering design application.	K4
CO2	Formulate constrained optimization techniques for various application.	K4
CO3	Implement neural network technique to real world design problems.	K4
CO4	Apply genetic algorithms to combinatorial optimization problems.	K4
CO5	Evaluate solutions by various optimization approaches for a design problem.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	3	1	1
CO2	-	1	2	-	-
CO3	1	1	1	2	1
CO4	1	-	-	-	-
CO5	1	1	2	1	-
23EDPE09	1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE10	BIO MATERIALS	II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1.Learn characteristics and classification of Biomaterials 2.Understand different metals, ceramics and its nano materials characteristics as biomaterials 3.Learn polymeric materials and its combinations that could be used as a tissue replacement implants 4.Get familiarized with the concepts of Nano Science and Technology 5.Understand the concept of biocompatibility and the methods for biomaterials testing.	
UNIT – I	**INTRODUCTION**	**8 Periods**
Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.		
UNIT – II	**METALLIC IMPLANT MATERIALS**	**7 Periods**
Metallic implants – Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.		
UNIT – III	**POLYMERIC IMPLANT MATERIALS**	**10 Periods**
Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach.		
UNIT – IV	**CERAMIC IMPLANT MATERIALS**	**10 Periods**
Definition of bio ceramics. Common types of bio ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction. Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g., hydroxyapatite). Host tissue reactions.		
UNIT – V	**TESTING OF BIOMATERIALS**	**10 Periods**
Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and In vivo testing; Sterilization of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES

1	*Biomaterials Science:* ***An Introduction to Materials in Medicine****, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.*
2	*Sujata V. Bhat,* ***Biomaterials****, Narosa Publishing House, 2002.*
3	*J B Park,* ***Biomaterials – Science and Engineering, Plenum*** *Press, 1984.*
4	*Sree ram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo,* ***Biomaterials: A Nano Approach****, CRC Press, 2010*
5	*Myer Kutz,* ***Standard Handbookof Biomedical Engineering and Design****, McGraw Hill,2003.*
6	*Joseph J.Carr and John M Brown****, Introduction To Biomedical Equipment Technology****, 4/E, pearson education India, 2001.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.	K4
CO2	Identify significant gap required to overcome challenges and further development in metallic and ceramic materials.	K4
CO3	Create combinations of materials that could be used as a tissue replacement implant.	K4
CO4	apply the testing standards for biomaterials.	K4
CO5	Identify significant gap required to overcome challenges and further development in polymeric materials.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	2	1	-
CO2	-	1	1	2	1
CO3	1	1	-	2	1
CO4	2	1	1	1	-
CO5	2	1	1	2	1
23EDPE10	2	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE11	MECHANICAL MEASUREMENTS AND ANALYSIS	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. The student will understand the principle of force and strain measurement. 2. The student will understand the vibration measurement and their applications. 3. To impart knowledge on the principle behind acoustics and wind flow measurements. 4. To familiarize with the distress measurements. 5. To realize the non-destructive testing principle and application.	
UNIT – I	**FORCES AND STRAIN MEASUREMENT**	**9 Periods**
Strain gauge, principle, types, performance and uses. Photo elasticity – Principle and applications - Moire Fringe - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines.		
UNIT – II	**VIBRATION MEASUREMENTS**	**9 Periods**
Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.		
UNIT –III	**ACOUSTICS AND WIND FLOW MEASUREMENTS**	**9 Periods**
Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modelling – direct and indirect model analysis.		
UNIT –IV	**DISTRESS MEASUREMENTS**	**9 Periods**
Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.		
UNIT – V	**NON-DESTRUCTIVE TESTING METHODS**	**9 Periods**
Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing –Brittle coating.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Bray Don E and Stanley, R. K.,* ***"Non-destructive Evaluation",*** *McGraw Hill Publishing Company,N.Y.1989*
2	*Garas, F.K., Clarke, J.L and Armer GST,* ***"Structural assessment",****Butterworths, London, 1987*
3	*James W. Dally and William Franklin Riley,* ***"Experimental Stress Analysis",*** *McGraw Hill , 3rd Edition, 1991*
4	*Sadhu Singh,* ***"Experimental Stress Analysis",*** *Khanna Publishers, New Delhi, 2009.*
5	*Srinath LS, Raghavan Mr, Lingaiah K, Gargesha G, Pant B and Ramachandra, K,* ***" Experimental Stress Analysis",*** *Tata McGraw Hill Company, New Delhi, 1984 .*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Measure physical quantities such as forces and strains.	K4
CO2	Apply different vibration measurements techniques.	K4
CO3	Measure physical quantities such as pressure and flow.	K4
CO4	Apply techniques involved in crack measurement.	K4
CO5	Select the appropriate non-destructive testing methods for various engineering applications.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	-	1	1	-
CO2	1	1	2	-	-
CO3	1	-	2	1	-
CO4	1	1	1	-	1
CO5	1	1	2	1	-
23EDPE11	1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE12	VIBRATION CONDITION MONITORING AND CONTROL	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge in vibration control and use condition monitoring techniques for machineries.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Review of fundamentals of single degree freedom systems – Two-degree freedom systems, Multi Degree Freedom systems, Continuous systems, Determination of Natural frequencies and mode shapes, Numerical methods in vibration Analysis.		
UNIT – II	**VIBRATION CONTROL**	**9 Periods**
Introduction – Reduction of vibration at the source – control of vibration – by structural design – Material selection – Localized additions – Artificial damping – Resilient isolation, Vibration isolation, Vibration absorbers.		
UNIT – III	**ACTIVE VIBRATION CONTROL**	**9 Periods**
Introductions – Concepts and applications, Review of smart materials – Types and characteristic review of smart structures – Characteristic Active vibration control in smart structures.		
UNIT – IV	**CONDITION BASED MAINTENANCE PRINCIPLES AND APPLICATIONS**	**9 Periods**
Introduction – condition monitoring methods – The design of Information system, Selecting method of monitoring, Machine condition monitoring and diagnosis – Vibration severity criteria – Machine Maintenance Techniques – Machine condition monitoring techniques – Vibration monitoring techniques – Instrumentation systems – choice of monitoring parameter.		
UNIT – V	**DYNAMIC BALANCING AND ALLIGNMENT OF MACHINERY**	**9 Periods**
Introduction-Dynamic balancing of Rotors-Field Balancing in one plane-Two planes and in several planes-Machinery alignment-Rough alignment methods-The face peripheral dial indicator method- Reverse indicator method-shaft-to coupling spool method.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES:

1	*S S. Rao. "**MechanicalVibration**" Sixth Edition, Pearson Education-2018*
2	*Rao J.S. "**Vibratory Condition Monitoring of Machines**" CRC Press. 2000.*
3	*A. Davies, **"Hand book of Condition Monitoring"** Springer - 2012*
4	*Daniel J. Inman, **"Vibration with Control"**, Willey Publication - 2017*
5	*Thomson W.T, Marie Dillon Dahleh, **"Theory of Vibrations with Applications",** Prentice Hall,*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Obtain vibration characteristics of mechanical systems	K4
CO2	Control vibration using active and passive control techniques	K4
CO3	Design and develop dynamically balanced systems with condition monitoring setup.	K4
CO4	Evaluate the maintenance and applications of vibration control	K4
CO5	Obtain the techniques of dynamic balancing of vibration	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	1	1	2	-	-
CO3	-	1	1	1	-
CO4	1	-	-	2	1
CO5	-	-	-	-	1
23EDPE12	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE13	VEHICLE DYNAMICS	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Apply and develop mathematical model of a system. 2. Applying vehicular vibrations and response of vehicle. 3. Applying a tire model based on required performance. 4. Applying the various vehicle performances, control methodologies to ensure stability and ride comfort. 5.Applying the principles vertical, longitudinal and lateral dynamics vehicle design	
UNIT – I	**BASIS OF VIBRATION**	**9 Periods**
Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.		
UNIT – II	**TYRES**	**9 Periods**
Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Test On Various Road surfaces. Tyre vibration.		
UNIT – III	**VERTICAL DYNAMICS**	**9 Periods**
Human response to vibration, Sources of Vibration. Design, analysis and computer simulation of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H Infinite, Skyhook damping. Air suspension system and their properties		
UNIT – IV	**LONGITUDINAL DYNAMICS AND CONTROL**	**9 Periods**
Aerodynamic forces and moments. Equation of motion. Tyre forces, rolling resistance, Load distribution for three-wheeler and four-wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control. Case Studies		
UNIT – V	**LATERAL DYNAMICS**	**9 Periods**
Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Roll axis, Vehicle under side forces. Stability of vehicle on banked road and during turn. Effect of suspension on cornering.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES:

1	*Singiresu S. Rao, **"Mechanical Vibrations (5th Edition)"**, Prentice Hall, 2012.*
2	*G. NakhaieJazar, **"Vehicle Dynamics: Theory and Application",** Springer, 2008*
3	*Rajesh Rajamani, **"Vehicle Dynamics and Control",** Springer, 2005*
4	*J. Y. Wong, **"Theory of Ground Vehicles",** 4th Edition, Wiley-Interscience, 2008*
5	*Thomas D. Gillespie, **"Fundamentals of Vehicle Dynamics",**Society of Automotive Engineers Inc, 1992.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate and develop mathematical model of a system.	K4
CO2	Apply vehicular vibrations and response of vehicle.	K4
CO3	Create a tire model based on required performance.	K4
CO4	Predict vehicle performance, control methodologies to ensure stability and ride comfort.	K4
CO5	Apply vertical, longitudinal and lateral dynamics vehicle design.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	2	1	-
CO2	-	1	1	2	1
CO3	1	1	-	2	1
CO4	2	1	1	1	-
CO5	2	1	1	2	1
23EDPE13	2	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE14	ENGINEERING FRACTURE MECHANICS FOR DESIGN	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1.Formulation of governing equations for elastic problems 2.Stresses calculations/displacements around the crack tip for different modes of fracture 3.Estimation of K1c/SIF/critical flaws/failure stresses for different crack geometries 4. Life assessment of the cracked components under different types of repeated/variable fatigue loads and design for its life extension. 5. Analysis of failed engineering components under different modes of fracture.

UNIT – I	**ELEMENTS OF SOLID MECHANICS**	**9 Periods**

Introduction to Failure and Fracture- Spectacular Failures-Basics Principles-Governing equations for the deformable body-Stress-Strain relations and general equations of elasticity in Cartesian and Polar Coordinates-vectors and tensors-differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress system - generalized hook's law– plane stress and stain problems - Airy's stress function. Methods of formulation of Governing. Differential equations for plane elasticity-Naviers Equation-Biharmonic equation in Cartesian and polar coordinates.

UNIT – II	**STRESS AND DISPLACEMENT AROUND THE CRACK TIP FOR DIFFERENT MODES OF FRACTURE**	**9 Periods**

Brittle and Ductile Fracture-Modes of Fracture-Weakness of the components due to Flaws-Need for Linear Elastic Fracture Mechanics (LEFM) – Evaluation of Structural Design-Stress and displacement around the crack tip in K-annulus for Mode-I and Mode-II plane crack problems – Stress and displacement around the crack tip in K-annulus for Mode III crack problems.

UNIT – III	**STATIONARY CRACK UNDER STATIC LOADING**	**9 Periods**

Griffith analysis- Irwin's approximation-CTOD and stress ahead of the crack tip- Westergaard solutions: Analytical Calculations for SIF for different crack geometries-Critical crack length and fracture stress calculations. Two dimensional elastic fields – Analytical solutions for small scale yielding near a crack front -plastic zone size -Specimen size calculations: K1c Testing for Fracture toughness of the Material.

UNIT – IV	**FATIGUE FAILURE AND ENVIRONMENTAL-ASSISTED FRACTURE**	**9 Periods**

Introduction To fatigue failure-S-N Curve-Crack Initiation-Crack propagation- Effect Of an Overload-Variable amplitude Fatigue load-Crack closure- Characteristics of fatigue crack-Paris Law- Fatigue Crack Growth Test to evaluate Paris constants- life calculations for a given load amplitude –effects of changing the load spectrum Environmental-assisted Fracture-Micro mechanisms-factors influencing Environmental-assisted fracture-Environment-assisted Fatigue Failure affecting fatigue performance, fatigue loading, constant and variable amplitude loading.

UNIT – V	**APPLICATIONS OF FRACTURE MECHANICS**	**9 Periods**

J-integral, Mixed-mode fracture, Crack arrest methodologies- Case studies: Analysis on failed components and design for the extension of its life.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods

REFERENCES:

1	*Ted L. Anderson, **"Fracture Mechanics: Fundamentals and Applications",** CRC Taylor and Francis, 4th Edition, 2017.*
2	*TribikramKundu, **"Fundamentals of Fracture Mechanics",**Ane Books Pvt. Ltd. New Delhi/CRC Press, 1st Indian Reprint, 2012.*
3	*John M.Barson And StanelyT.Rolfe, **"Fatigue And fracture control in structures",**Butterworth-Heinemann; 3rd edition. 1999.*

4	*Prashant Kumar*, ***"Elements Of Fracture Mechanics",*** *Tata McGraw-Hill Publishing Company Ltd, 2014.*
5	*KareHellan,* ***"Introduction of Fracture Mechanics",*** *McGraw-Hill Book Company, 1985.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate governing equation for elastic problems	K4
CO2	Calculate stresses/displacements around the crack tip for different modes of fracture	K4
CO3	Estimate K1c/SIF/critical flaws/failure stresses for different crack geometries	K4
CO4	Assess the life of the cracked components under different types of repeated/variable fatigue loads and design for its life extension.	K4
CO5	Analyze failed engineering components under different modes of fracture.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	1	-	1	1
CO2	2	2	1	-	-
CO3	-	1	2	1	-
CO4	1	1	1	-	-
CO5	1	-	2	1	1
23EDPE14	1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE15	WEARABLE DEVICES AND TECHNOLOGIES	III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1 Identify the need for development of wearable devices and its implications on various sectors. 2. Comprehend the design and development of various wearable inertial sensors and wearable bioelectrode and physiological activity monitoring devices for use in healthcare applications. 3. To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life. 4. To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life. 5. To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life.

UNIT – I	**INTRODUCTION TO WEARABLE DEVICES**	**9 Periods**
Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors:Invasive, Non-invasive;Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.		
UNIT – II	**WEARABLE INERTIAL SENSORS**	**9 Periods**
Wearable Inertial Sensors - Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection, Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's, Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.		
UNIT – III	**SCOPE OF WEARABLE DEVICES**	**9 Periods**
Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.		
UNIT – IV	**INTRODUCTION TO MEASUREMENTS AND SENSORS**	**9 Periods**
Functional Elements of a Measurement System and Instruments, Applications and Classification of Instruments, Types of measured Quantities, Measures of Dispersion, Sample deviation and sample mean, Units and standards, Calibration and errors. General concepts and terminology of Sensor systems, Transducers classification-sensors and actuators, General input-output configurations, Static and dynamic characteristics of measurement system.		
UNIT – V	**RESISTIVE AND REACTIVE SENSORS**	**9 Periods**
Resistive sensors- Potentiometers, strain gages (piezo-resistive effect), resistive temperature detectors (RTD), thermistors, magneto resistors, light dependent resistor (LDR), resistive hygrometers, resistive gas sensors. Inductive sensors - variable reluctance sensors, Hall effect, Eddy current sensors, Linear variable differential transformers (LVDT), variable transformers, magneto-elastic, magneto-resistive, and magneto strictive sensors. Capacitive sensors- variable capacitor, differential capacitor.		

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods

REFERENCES:

1	*M. Mardonova and Y. Choi,* ***"Review of Wearable Device Technology and Its Applications to the Mining Industry,"*** *Energies, vol. 11, p. 547, 2018.*
2	***"Wearable Sensors -Fundamentals, Implementation and Applications",*** *by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.*

3	*B. C. Nakra, K.K. Choudhury,* ***"Instrumentation, Measurement and Analysis"****, -3rd Edition, Tata McGraw, 2009.*
4	*Edward Sazonov, Michael R Neuman,* ***"Wearable Sensors: Fundamentals, Implementation and Applications",*** *Elsevier, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify and understand the need for development of wearable devices and its influence on various sectors.	K4
CO2	Discus the applications of various wearable inertial sensors for biomedical applications.	K4
CO3	Able to design and perform experiments on the sensors and develop the projects based on the customer needs	K4
CO4	Gain the basic idea of measurements, characteristics and the errors associated with measurements.	K4
CO5	Demonstrate the concept of resistive and reactive sensors which can be employed for real life applications	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	1	1	-	-	2
CO3	1	1	2	1	-
CO4	-	1	1	1	1
CO5	1	-	-	2	1
23EDPE15	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE16	MATERIAL HANDLING SYSTEM AND DESIGN	IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Fundamental concepts related to material handling. 2. Design of various hoisting gears for different material handling applications 3. Development of conveyer systems for material flow in different industrial production systems. 4. Design of elevators for various manufacturing and service applications. 5. Integrated mechanical system design for machine tools, power transmission and engine parts.	
UNIT – I	**INTRODUCTIONS AND DESIGN OF HOISTS**	**9 Periods**
Types, selection and applications, Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.		
UNIT – II	**DRIVES OF HOISTING GEAR**	**9 Periods**
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.		
UNIT – III	**CONVEYORS**	**9 Periods**
Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.		
UNIT – IV	**ELEVATORS**	**9 Periods**
Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.		
UNIT – V	**INTEGRATED DESIGN**	**9 Periods**
Integrated Design of systems - Valve Gear Mechanisms, Portable Air Compressor, Hay-Bale lifter, Cam Testing Machine, Power Screws, Gear Box Design more than six speed.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES:

1	*Alexandrov, M., **"Materials Handling Equipments",** MIR Publishers, 1981.*
2	*Boltzharol, A., **"Materials Handling Handbook",** The Ronald Press Company, 1958*
3	*Norton. L Robert. **"Machine Design – An Integrated Approach",** Pearson Education, 2nd Edition, 2005.*
4	*Rudenko, N., **"Materials handling equipment",** ELnvee Publishers, 1970.*
5	*Spivakovsy, A.O. and Dyachkov, V.K., **"Conveying Machines",** Volumes I and II, MIR Publishers, 1985.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Design hoists and brakes used in any handling applications.	K4
CO2	Design drive mechanisms and hoisting gear for different handling applications.	K4
CO3	Design different conveyor systems for material handling applications.	K4
CO4	Design of integrated mechanical system for machine tools, power transmission and engine parts.	K4
CO5	Design bucket, cage and fork lift elevators for to and for transportation of .materials in vertical direction..	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	1	1	1
CO2	1	-	2	1	-
CO3	-	1	1	-	-
CO4	1	-	1	1	-
CO5	-	1	-	-	-
23EDPE16	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE17	BEARING DESIGN AND ROTOR DYNAMICS	IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1.Understand the mathematical model of a system 2.Understand the design and suggest bearings for specific applications 3.Understand a fatigue life calculation for various types of bearings 4. Understand the bearing behavior. 5.Study the dynamics of rotors mounted on Hydrodynamic Bearings	
UNIT – I	**CLASSIFICATION AND SELECTION OF BEARINGS**	**9 Periods**
Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic And Hydrostatic bearings-Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision. Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials – Metallic and Nonmetallic Bearings-Materials for rolling bearings.		
UNIT – II	**DESIGN OF FLUID FILM BEARINGS**	**9 Periods**
Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations- Design based on Charts & Tables Design of Hydrostatic, Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design in hydrostatic bearings- Foil Bearings-Air Bearings.		
UNIT – III	**ROLLING CONTACTS SELECTION OF ROLLING BEARINGS**	**9 Periods**
Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication-Fatigue life calculations- Bearing operating temperature- Lubrication- Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements. Manufacturing methods-Ceramic bearings-Rolling bearing cages-bearing seals selection		
UNIT – IV	**ROTOR DYNAMICS**	**9 Periods**
Motion of the shaft in the bearing- Rotor supported on rigid and flexible supports-Campbell diagram, Rotor Dynamic Analyses- Undamped critical speed - Unbalance response- Damped eigenvalue analysis- Bearing stiffness and damping coefficients- Mechanics of Hydro dynamic Instability-Half Frequency whirl and Resonance whip- bearing instability and Oil Whirl Technologies to Improve the Stability of Rotor-bearing Systems--Design configurations of stable journal bearings		
UNIT – V	**DYNAMICS OF ROTORSMOUNTED ON HYDRODYNAMIC BEARINGS**	**9 Periods**
Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads, alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES:

1	*S.K.Basu, S.N.Sengupta&B.B.Ahuja,* ***"Fundamentals of Tribology",*** *Prentice –Hall of India Pvt Ltd, New Delhi, 2005.*
2	*G.W.Stachowiak& A.W .Batchelor ,* ***"Engineering Tribology" ,*** *Butterworth-Heinemann, UK,2005.*
3	*Neale, M.J.* ***"Tribology Hand Book",*** *Butterworth Heinemann, United Kingdom 2001.*
4	*Williams J.A.* ***"Engineering Tribology",*** *Oxford Univ. Press, 1994.*
5	*Halling, J. (Editor),* ***"Principles of Tribology",*** *Macmillian – 1984.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	applythe various types of bearings and their operating principles	K4
CO2	Design and suggest bearings for specific applications	K4
CO3	Perform fatigue life calculations for various types of bearings,	K4
CO4	analyze the bearing behavior	K4
CO5	Identify the dynamics of rotors mounted on Hydrodynamic Bearings	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	2	1	1
CO2	1	1	2	-	-
CO3	1	2	1	1	-
CO4	2	-	-	1	1
CO5	1	-	1	-	-
23EDPE17	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE18	DESIGN OF HYBRID AND ELECTRIC VEHICLES	IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Fundamental concepts of electric and hybrid vehicle operation and architectures. 2. Understand the properties of batteries and its types. 3. Provide knowledge about design of series hybrid electric vehicles. 4. Provide knowledge about design of parallel hybrid electric vehicles. 5. Understand of electric vehicle drive train.

UNIT – I	**INTRODUCTION TO ELECTRIC VEHICLES**	**9 Periods**
Electric Vehicles (EV) system- EV History – EV advantages – EV market – vehicle mechanics: roadway fundamentals- law of motion-vehicle kinetics- dynamics of vehicle motion – propulsion power –velocity and acceleration- propulsion system design.		
UNIT – II	**ENERGY SOURCE**	**9 Periods**
Battery basics- lead acid battery – alternative batteries – battery parameters- technical characteristics – battery power – alternative energy sources: Fuel cells - Fuel Cell characteristics- Fuel cell types.		
UNIT – III	**SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN**	**9 Periods**
Operation Patterns- Control Strategies-Sizing of the Major Components -Design of peaking power source - Traction Motor Size - Design of the Gear Ratio-Verification of Acceleration Performance. Verification of gradeability-- Design of Engine/Generator Size - Design of the Power Capacity - Design of the Energy Capacity -Fuel Consumption.		
UNIT – IV	**PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN**	**9 Periods**
Control Strategies of Parallel Hybrid Drive Train- Drive Train Parameters- Engine Power Capacity- Electric Motor Drive Power Capacity- Transmission Design- Energy Storage Design		
UNIT – V	**ELECTRIC VEHICLE DRIVETRAIN**	**9 Periods**
EV Transmission configurations – Transmission components –Ideal gear box –Gear ratio- torque –speed characteristics - EV motor sizing –initial acceleration-rated vehicle velocity –maximum velocity – maximum gradability.		

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total:45 Periods

REFERENCES:

1	*Ehsani, M,* ***"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design",*** *CRC Press, 3rd edition -2018*
2	***"Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results,"*** *Center for Transportation Research Argonne National Laboratory, United States Department of Energy.*
3	*Iqbal Hussain,* ***"Electric & Hybrid Vehicles – Design Fundamentals",*** *Third Edition, CRC Press, 2021.*
4	*James Larminie,* ***"Electric Vehicle Technology Explained",*** *John Wiley & Sons, 2012.*
5	*SandeepDhameja,* ***"Electric Vehicle Battery Systems",****Newnes, 2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the conceptof hybrid vehicle and their function.	K4
CO2	Choose proper energy storage systems for vehicle applications	K4
CO3	Design series hybrid electric vehicles.	K4
CO4	Design parallel hybrid electric vehicles.	K4
CO5	apply the transmission components and their configurations for electric vehicles.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	-	2	1	-
CO2	1	-	-	1	1
CO3	-	1	1	-	1
CO4	-	1	1	-	-
CO5	-	-	-	1	-
23EDPE18	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE19	CREATIVITY AND INNOVATION	IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Understand the principles of essential theory of creativity in new product design and development. 2. Understand the principles of various methods and tools for creativity in new product design and development. 3. Understand the design principles of creativity in new product design and development. 4. Understand the various innovation principles and practices in new product design and development. 5. Understand the principles of innovation management in new product design and development.

UNIT – I	**INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY**	**9 Periods**
Directed creativity: The Need for Creative Thinking in the Pursuit of Quality - Essential Theory for Directed Creativity: Definitions and the Theory of the Mechanics of Mind; Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking		
UNIT – II	**METHODS AND TOOLS FOR CREATIVITY**	**9 Periods**
Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation.		
UNIT – III	**DESIGN AND APPLICATION OF CREATIVITY**	**9 Periods**
Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement		
UNIT – IV	**INNOVATION PRINCIPLES & PRACTICES**	**9 Periods**
Methods of Creativity Activation: Morphological Box – Requirements for Inventive Problem Solving – Altshuller's Engineering Parameters – Altshuller's Inventive Principles – Altshuller's Contradiction Matrix Algorithm.		
UNIT – V	**INNOVATION MANAGEMENT**	**9 Periods**
Disruptive Innovation Model – Two Types of Disruption – Three Approaches to Creating New-Growth Businesses – New Market Disruptions: Three Case Histories – Product Architectures and Integration – Process of commoditation and de-commoditation – Two Processes of Strategy Formulation – Role of senior executive in leading new growth: The Disruptive Growth Engine.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES:

1	*Clayton M. Christensen and Michael E. Raynor,* ***"The Innovator's Solution",*** *Harvard Business School Press, Boston, USA, 2003.*
2	*Donald A. Norman,* ***"Emotional Design",*** *Perseus Books Group, New York, 2004.*
3	*Geoffrey Petty,* ***"How to be better at Creativity",*** *The Industrial Society, 1999.*
4	*Paul E. Plsek,* ***"Creativity, Innovation and Quality",*** *ASQ Quality Press, Milwaukee, Wisconsin, 2000.*
5	*Semyon D. Savransky,* ***"Engineering of Creativity – TRIZ",*** *CRC Press, New York, USA, 2000.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the principles of essential theory of creativity in new product design and development.	K4
CO2	Apply the principles of various methods and tools for creativity in new product design and development.	K4
CO3	Apply the design principles of creativity in new product design and development.	K4
CO4	Apply the various innovation principles and practices in new product design and development.	K4
CO5	Apply the principles of innovation management in new product design and development.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	-
CO2	1	-	3	-	1
CO3	-	1	1	-	-
CO4	1	1	-	1	-
CO5	1	1	1	-	1
23EDPE19	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDPE20	DESIGN OF PRESSURE VESSELS AND PIPING	IV

PREREQUISITES	CATEGORY	L	T	P	C
Machine Design.	PE	3	0	0	3

Course Objectives	1.To give exposure to engineering problems involved in the design of pressure vessel. 2.To learn about the tests and analysis for various components of pressure vessels. 3.To know the procedure to design pressure vessels. 4. Ability to design and analyze supports and nozzle. 5.To acquire knowledge of piping, piping layout and designing of pipes.	
UNIT – I	**STRESSES IN PRESSURE VESSEL**	**9 Periods**
Introduction to stresses in pressure vessel and its application, stresses in circular plate, Stresses in cylinder, Thermal stresses, bending of circular plates of uniform thickness, bending of centrally loaded circular plates. Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.		
UNIT – II	**PRESSURE VESSEL DESIGN CODE**	**9 Periods**
Introduction to ASME standard for pressure vessel design, Pressure vessel and related components design using ASME standard;		
UNIT – III	**SUPPORT DESIGN FOR PRESSURE VESSEL**	**9 Periods**
Design of nozzle. Design of base plate and support lugs, Types of anchor bolt, its material and stresses, Design of saddle supports.		
UNIT – IV	**DESIGN CONSIDERATION IN PRESSURE VESSEL**	**10 Periods**
Buckling of pressure vessels: Elastic Buckling of circular ring and cylinders under external pressure, Failure of thick-walled cylinders or tubes under external pressure, buckling under combine External pressure and axial loading, Fatigue failure, high strength, light weight pressure vessels resistant to external high pressures found in undersea exploration.		
UNIT – V	**PIPING DESIGN**	**8 Periods**
Flow diagram, Piping layout and piping stress analysis, Flexibility factor and stress intensification factor, Design of piping as per B31.1 piping code, Piping components: bends, tees bellows and valve. Types of piping supports and the behavior, Introduction to piping Codes and Standards.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0Periods Total: 45 Periods**		

REFERENCES:

1	*Browenell L.E and Young E.D.* ***"Process equipment design",*** *Willey Esstern Ltd. India*
2	*John F. Harvey,* ***"Theory and Design of Pressure Vessels",*** *CBS Publishers and Distributors,1987.*
3	*Sam Kannapan,* ***"Introduction to Pipe Stress Analysis",*** *John Wiley and Sons, 1985.*
4	*Henry H Bednar,* ***"Pressure vessel Design Hand book",*** *CBS publishers and distributors.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	apply the design consideration of pressure vessel	K4
CO2	Apply the mathematical fundamental for the design of pressure vessels.	K4
CO3	Design the support of the pressure vessel	K4
CO4	Design pressure vessel under loading condition	K4
CO5	Design piping system for pressure vessel	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	-	2	-
CO2	1	-	2	-	-
CO3	2	2	2	1	2
CO4	-	2	-	2	3
CO5	2	2	-	-	2
23EDPE20	2	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23SEOE01	**BUILDING BYE-LAWS AND CODES OF PRACTICE** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To impart knowledge on the building bye –laws and to emphasize the significance of codes of practice in construction sector.	
UNIT – I	**INTRODUCTION TO BUILDING BYE-LAWS**	**9 Periods**
Introduction to Building Bye Laws and regulation, their need and relevance, General definitions such as building height, building line, FAR, Ground Coverage, set back line. Introduction to Master Plan and understanding various land uses like institutional, residential etc. - Terminologies of Building bye-laws.		
UNIT – II	**ROLE OF STATUTORY BODIES**	**9 Periods**
Role of various statutory bodies governing building works like development authorities, municipal corporations etc. Local Planning Authority, Town and Country planning organisation, Ministry of urban development.		
UNIT – III	**APPLICATION OF BUILDING BYE-LAWS**	**9 Periods**
Interpretation of information given in bye laws including ongoing changes as shown in various annexure and appendices. Application of Bye-laws like structural safety, fire safety, earthquake safety, basement, electricity, water, and communication lines in various building types.		
UNIT – IV	**INTRODUCTION TO CODES OF PRACTICE**	**9 Periods**
Introduction to various building codes in professional practice - Codes, regulations to protect public health, safety and welfare - Codes , regulations to ensure compliance with the local authority.		
UNIT – V	**APPLICATION OF CODES OF PRACTICE**	**9 Periods**
Applications of various codes as per various building types. Bureau of Indian Standards, Eurocode – Introduction to other international codes.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	***"National Building Code of India 2016 – SP 7",*** *NBC 2016, Bureau of Indian Standards.*
2	***"Model Building Bye-Laws (MBBL) – 2016",*** *Town and Country Planning Organization, Ministry of Housing and Urban Affairs, Government of India.*
3	***"Unified Building Bye-laws for Delhi 2016",*** *Nabhi Publications, 2017.*
4	Mukesh *Mittal,* ***"Building Bye Laws",*** *Graphicart publishers, Jaipur, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the building bye-laws in planning, design and construction works.	K3
CO2	Familiarize with the role of various statutory bodies.	K2
CO3	Execute safety related work practices in the construction sector.	K3
CO4	Ensure compliance with the rules and regulations in design and construction practices.	K3
CO5	Perform design and construction practices based on national and international codal provisions.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	1	1	2	3
CO2	1	3	1	1	2	3
CO3	1	3	1	1	2	3
CO4	2	3	1	1	2	3
CO5	2	3	1	1	2	3
23SEOE01	2	3	1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23SEOE02	**PLANNING OF SMART CITIES** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To have an exposure on planning of smart cities with consideration of the recent challenges and to address the importance of sustainable development of urban area.	
UNIT – I	**SMART CITIES DEVELOPMENT POTENTIALS AND CHALLENGES**	**9 Periods**
Perspectives of Smart Cities: Introduction and Overview - Implementation Challenges - Methodological issues - Spatial distribution of startup cities – Re imagining postindustrial cities - Implementation Challenges for Establishing Smart Urban Information and Knowledge Management System.		
UNIT – II	**SUSTAINABLE URBAN PLANNING**	**9 Periods**
Optimising Green Spaces for Sustainable Urban Planning - 3D City Models for Extracting Urban Environmental Quality Indicators - Assessing the Rainwater Harvesting Potential - The Strategic Role of Green Spaces - Monitoring Urban Expansion.		
UNIT – III	**ENERGY MANAGEMENT AND SUSTAINABLE DEVELOPMENT**	**9 Periods**
Alternatives for Energy Stressed Cities - Social Acceptability of Energy - Efficient Lighting - Energy Management - Urban Dynamics and Resource Consumption - Issues and Challenges of Sustainable Tourism - Green Buildings: Eco-friendly Technique for Modern Cities.		
UNIT – IV	**MULTIFARIOUS MANAGEMENT FOR SMART CITIES**	**9 Periods**
Assessment of Domestic Water Use Practices - Issue of Governance in Urban Water Supply - Assessment of Water Consumption at Urban Household Level - Water Sustainability - Socio-economic Determinants and Reproductive Healthcare System - Problems and Development of Slums.		
UNIT – V	**INTELLIGENT TRANSPORT SYSTEM**	**9 Periods**
Introduction to Intelligent Transport Systems (ITS) - The Range of ITS Applications -Network Optimization - Sensing Traffic using Virtual Detectors - Vehicle Routing and Personal route information - The Smart Car - Commercial Routing and Delivery - Electronic Toll Collection - The Smart Card - Dynamic Assignment - Traffic Enforcement. Urban Mobility and Economic Development.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Poonam Sharma, Swati Rajput,* ***"Sustainable Smart Cities In India Challenges And Future Perspectives"****, Springer 2017 Co.(P) Ltd. 2013.*
2	*Ivan Nunes Da Silva,* ***"Rogerio Andrade Flauzino-Smart Cities Technologies-Exli4eva"****, 2016.*
3	*Stan McClellan, Jesus A. Jimenez, George Koutitas* ***"Smart Cities_ Applications, Technologies, Standards"****, and Driving Factors-Springer International Publishing, 2018.*
4	*Stan Geertman, Joseph Ferreira, Jr., Robert Goodspeed, John Stillwell,* ***"Planning Support Systems And Smart Cities"****, Springer, 2015.*
5	*Pradip Kumar Sarkar and Amit Kumar Jain* ***"Intelligent Transport Systems"****, PHI Learning, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Indicate the potential challenges in smart city development.	K2
CO2	Select the different tools for sustainable urban planning.	K3
CO3	Choose appropriate energy conservation system for smart cities.	K3
CO4	Identify the proper method of water management system.	K3
CO5	Apply Intelligent Transport System concepts in planning of smart city.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	3	1	1
CO2	1	1	1	3	2	1
CO3	1	1		2	2	1
CO4	1	-	1	2	1	1
CO5	1	-	1	3	1	-
23SEOE02	1	1	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	45	30	-	-	-	100
CAT2	25	45	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	15	40	45	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	10	45	45	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEOE03	**GREEN BUILDING** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To introduce the different concepts of energy efficient buildings, indoor environmental quality management, green buildings and its design.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind – Solar radiation and solar temperature – Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Thermal properties of building materials.		
UNIT – II	**ENERGY EFFICIENT BUILDINGS**	**9 Periods**
Passive cooling and day lighting – Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards-Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency – Energy audit and energy targeting- Technological options for energy management.		
UNIT – III	**INDOOR ENVIRONMENTAL QUALITY MANAGEMENT**	**9 Periods**
Psychrometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement- Auditory requirement- Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines- Heat rejection equipment- Energy efficient motors- Insulation.		
UNIT – IV	**GREEN BUILDING CONCEPTS**	**9 Periods**
Green building concept- Green building rating tools- Leeds and IGBC codes. – Material selection Embodied energy- Operating energy- Façade systems- Ventilation systems-Transportation- Water treatment systems- Water efficiency- Building economics		
UNIT – V	**GREEN BUILDING DESIGN - CASE STUDY**	**9 Periods**
Case studies - Building form, orientation and site considerations; conservation measures; energy modeling; heating system and fuel choices; renewable energy systems; material choices - construction budget		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Sam Kubba* ***"Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes",*** *, Elsevier Science, 2012.*
2	*Yudelson, Jerry, McGraw-Hill,* ***"Greening existing buildings",*** *New York, 2010*
3	*Charles J. Kibert, John Wiley & Sons,* ***"Sustainable Construction: Green Building Design and Delivery****", 3rd Edition, 2012*
4	*R.S. Means, John Wiley & Sons,* ***"Green Building: Project Planning & Cost Estimating",*** *2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply the concepts of sustainable design in building construction.	K3
CO2	Execute green building techniques including energy efficiency management in the building design.	K3
CO3	Establish indoor environmental quality in green building.	K3
CO4	Perform the green building rating using various tools.	K3
CO5	Create drawings and models of green buildings.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	2	2	2	2	3	3
CO4	2	3	1	3	3	3
CO5	3	3	1	3	3	3
23SEOE03	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23EEOE04	**ENVIRONMENT HEALTH AND SAFETY MANAGEMENT** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To impart knowledge on occupational health hazards, safety measures at work place, accident prevention, safety management and safety measures in industries.	
UNIT – I	**OCCUPATIONAL HEALTH HAZARDS**	**9 Periods**
Occupation, Health and Hazards - Safety Health and Management: Occupational Health Hazards - Ergonomics - Importance of Industrial Safety - Radiation and Industrial Hazards: Types and effects - Vibration - Industrial Hygiene - Different air pollutants in industries and their effects - Electrical, fire and Other Hazards.		
UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**
Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance - Housekeeping, Industrial lighting, Vibration and Noise.		
UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**
Accident Prevention Techniques - Principles of accident prevention - Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid: Body structure and functions - Fracture and Dislocation, Injuries to various body parts.		
UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**
Safety Management System and Law - Legislative measures in Industrial Safety - Occupational safety, Health and Environment Management, Bureau of Indian Standards on Health and Safety, IS 14489 standards - OSHA, Process safety management (PSM) and its principles - EPA standards		
UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**
Plant Layout for Safety - design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System - Significance of Documentation - Case studies involving implementation of health and safety measures in Industries.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	***"Physical Hazards of the Workplace"****, Barry Spurlock, CRC Press, 2017.*
2	***"Handbook of Occupational Safety and Health",*** *S. Z. Mansdorf, Wiley Publications,2019*
3	***"Safety, Health, and Environment"****, NAPTA, 2nd Edition, Pearson Publications, 2019.*
4	*"**Occupational Health and Hygiene in Industries**", Raja Sekhar Mamillapalli, Visweswara Rao PharmaMed Press, 1st edition, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the occupational health hazards.	K3
CO2	Execute various safety measures at workplace.	K3
CO3	Analyze and execute accident prevention techniques.	K3
CO4	Implement safety management as per various standards.	K3
CO5	Develop awareness on safety measures in Industries.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	2	3	2
CO2	2	2	2	1	2	2
CO3	2	3	2	1	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	1	1	2
23EEOE04	1	2	2	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEOE05	**CLIMATE CHANGE AND ADAPTATION** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To understand the Earth's climate system, changes and their effects on the earth, identifying the impacts, adaptation, mitigation of climate change and for gaining knowledge on clean technology, carbon trading and alternate energy sources.	
UNIT – I	**EARTH'S CLIMATE SYSTEM**	**9 Periods**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification- Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies – Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.		
UNIT – II	**OBSERVED CHANGES AND ITS CAUSES**	**9 Periods**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large-Scale Variability –Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol –UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.		
UNIT – III	**IMPACTS OF CLIMATE CHANGE**	**9 Periods**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios –Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.		
UNIT – IV	**CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES**	**9 Periods**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry –Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) – Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.		
UNIT – V	**CLEAN TECHNOLOGY AND ENERGY**	**9 Periods**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology –Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Biofuels– Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES

1	***"Impacts of Climate Change and Climate Variability on Hydrological Regimes",*** *Jan C. Van Dam, Cambridge University Press, 2003.*
2	*IPCC fourth assessment report - The AR4 synthesis report, 2007*
3	*IPCC fourth assessment report –Working Group I Report****, "The physical sciencebasis",****2007*
4	*IPCC fourth assessment report - Working Group II Report,* ***"Impacts, Adaptation and Vulnerability"****, 2007*
5	*IPCC fourth assessment report – Working Group III Report****" Mitigation of Climate Change",*** *2007*

6	***"Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change,*** *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., IPCC Secretariat, Geneva, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the Earths climatic system and factors causing climate change and global warming.	K2
CO2	Relate the Changes in patterns of temperature, precipitation and sea level rise and Observed effects of Climate Changes	K2
CO3	Illustrate the uncertainty and impact of climate change and risk of reversible changes.	K3
CO4	Articulate the strategies for adaptation and mitigation of climatic changes.	K3
CO5	Discover clean technologies and alternate energy source for sustainable growth.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	3	1
CO2	3	2	2	2	3	2
CO3	2	2	2	2	3	2
CO4	3	2	2	2	2	2
CO5	3	3	2	3	3	3
23EEOE05	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEOE06	**WASTE TO ENERGY** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To classify waste as fuel, introduce conversion devices, gain knowledge about Biomass Pyrolysis, demonstrate methods, factors for biomass gasification, and acquire knowledge about biogas and its development in India.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, Gasifiers, Digestors.		
UNIT – II	**BIOMASS PYROLYSIS**	**9 Periods**
Biomass Pyrolysis: Pyrolysis -Types, Slow Pyrolysis, Fast Pyrolysis – Manufacture of charcoal – Methods – Yields and Applications – Manufacture of Pyrolytic oils and gases, Yields and Applications.		
UNIT – III	**BIOMASS GASIFICATION**	**9 Periods**
Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, Construction and Operation – Gasifier burner arrangement for thermal heating – Gasifier Engine arrangement and electrical power – Equilibrium and Kinetic Considerations in gasifier operation.		
UNIT – IV	**BIOMASS COMBUSTION**	**9 Periods**
Biomass Combustion – Biomass Stoves – Improved Chullahs, types, some exotic designs, Fixed bed combustors, types – Inclined grate combustors – Fluidized bed combustors, design, construction and operation of all the above biomass combustors.		
UNIT – V	**BIOENERGY SYSTEM**	**9 Periods**
Biogas: Properties of biogas (Calorific value and composition) – Biogas plant technology and status – Bio energy system – Design and constructional features – Biomass resources and their classification - Biomass conversion processes – Thermo chemical conversion – Direct combustion – biomass gasification – pyrolysis and liquefaction – biochemical conversion – anaerobic digestion – Types of biogas plants – Applications – Alcohol production from biomass – Bio diesel production – Urban waste to energy conversion – Biomass energy programme in India.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	***"Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies",*** *P Jayaram Reddy, Taylor and Francis Publications, 2016.*
2	***"Waste – to – Energy: Technologies and project Implementations",*** *Marc J Rogoff, Francois Screve,ELSEVIER Publications, Third Edition, 2019.*
3	***"Biogas Technology and Principles"****, Brad Hill, NY RESEARCH PRESS Publications, Illustrated Edition, 2015.*
4	***"Biomass Gasification and Pyrolysis Practical Design and Theory"***,Prabir*ELSEVIER Publications, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Investigate solid waste management techniques.	K2
CO2	Get knowledge about biomass pyrolysis.	K3
CO3	Demonstrate methods and factors considered for biomass gasification.	K3
CO4	Identify the features of different facilities available for biomass combustion.	K4
CO5	Analyze the potential of different Bioenergy systems with respect to Indian condition.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	3	1
CO2	3	2	2	2	3	1
CO3	3	3	2	3	2	1
CO4	3	2	2	3	3	1
CO5	2	3	3	3	2	1
23EEOE06	3	3	3	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	20	25	15	10	100
CAT2	10	25	20	10	25	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	15	35	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	10	40	50	-	-	100
ESE	10	25	25	20	10	10	100

23GEOE07	**ENERGY IN BUILT ENVIRONMENT** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	To understand constructional energy requirements of buildings, energy audit methods and conservation of energy.	
UNIT–I	**INTRODUCTION**	**9 Periods**
Indoor activities and environmental control - Internal and external factors on energy use – Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications –Thermal comfort-Ventilation and air quality-Air-conditioning requirement-Visual perception-Illumination requirement-Auditory requirement.		
UNIT–II	**LIGHTING REQUIREMENTS IN BUILDING**	**9 Periods**
The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces-Energy impact on the shape and orientation of buildings–Lighting and day lighting :Characteristics and estimation, methods of day-lighting–Architectural considerations for day-lighting.		
UNIT–III	**ENERGY REQUIREMENTS IN BUILDING**	**9 Periods**
Steady and unsteady heat transfer through wall and glazed window-Standards for thermal performance of building envelope- Evaluation of the overall thermal transfer- Thermal gain and net heat gain-End-Use energy requirements-Status of energy use in buildings-Estimation of energy use in a building.		
UNIT–IV	**ENERGY AUDIT**	**9 Periods**
Energy audit and energy targeting-Technological options for energy management-Natural and forced ventilation–Indoor environment and air quality-Air flow and air pressure on buildings-Flow due to Stack effect.		
UNIT–V	**COOLING IN BUILT ENVIRONMENT**	**9 Periods**
Passive building architecture–Radiative cooling-Solar cooling techniques-Solar desiccant dehumidification for ventilation-Natural and active cooling with adaptive comfort–Evaporative cooling –Zero energy building concept.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Period Practical: 0 Period Total: 45 Periods**		

REFERENCES

1	*J.Krieder and A.Rabl**, "Heating and Cooling of Buildings: Design for Efficiency"**, McGraw-Hill, 2000.*
2	*S.M.Guinnes and Reynolds, "**Mechanical and Electrical Equipment for Buildings"**,Wiley, 1989.*
3	*A.Shaw, "**Energy Design for Architects"**, AEE Energy Books, 1991.*
4	*ASHRAE,"**Hand book of Fundamentals"**,ASHRAE,Atlanta,GA.,2001.*
5	*Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University of Illinois ,USA.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand energy and its usage	K2
CO2	Know lighting to be given to a building	K1
CO3	Analyse the energy requirements in a building	K3
CO4	Apply the energy audit concepts.	K3
CO5	Study architectural specifications of a building	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	2	1
CO2	2	-	3	1	2	1
CO3	2	-	3	1	2	1
CO4	2	-	3	1	2	1
CO5	2	-	3	1	2	1
23GEOE07	2	-	3	1	2	1
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE08	EARTH AND ITS ENVIRONMENT *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	To know about the planet earth, the geosystems and the resources like ground water and air and to learn about the Environmental Assessment and sustainability.	
UNIT–I	**EVOLUTION OF EARTH**	**9 Periods**
Evolution of earth as habitable planet-Evolution of continents-oceans and landforms-evolution of life through geological times - Exploring the earth's interior - thermal and chemical structure - origin of gravitational and magnetic fields.		
UNIT–II	**GEOSYSTEMS**	**9 Periods**
Plate tectonics - working and shaping the earth - Internal geosystems – earthquakes – volcanoes - climatic excursions through time - Basic Geological processes - igneous, sedimentation – metamorphic processes.		
UNIT–III	**GROUND WATER GEOLOGY**	**9 Periods**
Geology of ground water occurrence –recharge process-Ground water movement-Ground water discharge and catchment hydrology – Ground water as a resource - Natural ground water quality and contamination-Modelling and managing ground water systems.		
UNIT–IV	**ENVIRONMENTAL ASSESMENT AND SUSTAINABILITY**	**9 Periods**
Engineering and sustainable development - population and urbanization - toxic chemicals and finite resources - water scarcity and conflict - Environmental risk - risk assessment and characterization – hazard assessment-exposure assessment.		
UNIT–V	**AIR AND SOLIDWASTE**	**9 Periods**
Air resources engineering-introduction to atmospheric composition–behaviour-atmospheric photo chemistry-Solid waste management–characterization-management concepts.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Period Practical: 0 Period Total: 45 Periods**		

REFERENCES

1	*John Grotzinger and Thomas H.Jordan, "**Understanding Earth",** Sixth Edition, W.H.Freeman, 2010.*
2	*Younger,P.L., "**Ground water in the Environment: An introduction"**, Blackwell Publishing,2007.*
3	*Mihelcic, J. R., Zimmerman, J. B., "**Environmental Engineering:Fundamentals, Sustainability and Design"**,Wiley,NJ, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To know about evolution of earth and the structure of the earth.	K2
CO2	To understand the internal geosystems like earthquakes and volcanoes and the Various geological processes.	K2
CO3	To able to find the geological process of occurrence and movement of Ground water and the modeling systems.	K3
CO4	To assess the Environmental risks and the sustainability developments.	K3
CO5	To learn about the photochemistry of atmosphere and the solid waste Management concepts.	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	2	2	-
CO2	3	-	3	3	-	3
CO3	2	-	-	-	-	-
CO4	-	2	-	-	1	-
CO5	2	2	-	1	-	-
23GEOE08	2	2	3	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE09	NATURAL HAZARDS AND MITIGATION *(Common to all Branches)*

PREREQUISITES:	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	To get idea on the causes, effects and mitigation measures of different types of hazards with case studies.	
UNIT–I	**EARTH QUAKES**	**9 Periods**
Definitions and basic concepts-different kinds of hazards–causes-Geologic Hazards–Earthquakes-causes of earthquakes–effects-plate tectonics-seismic waves-measures of size of earthquakes-earthquake resistant design concepts.		
UNIT–II	**SLOPE STABILITY**	**9 Periods**
Slope stability and landslides-causes of landslides–principles of stability analysis-remedial and corrective measures for slope stabilization.		
UNIT–III	**FLOODS**	**9 Periods**
Climatic Hazards–Floods-causes of flooding-regional flood frequency analysis–flood control measures-flood routing-flood forecasting-warning systems.		
UNIT–IV	**DROUGHTS**	**9 Periods**
Droughts –causes - types of droughts –effects of drought -hazard assessment – decision making-Use of GIS in natural hazard assessment–mitigation-management.		
UNIT–V	**TSUNAMI**	**9 Periods**
Tsunami–causes–effects–under sea earthquakes–landslides–volcanic eruptions–impact of sea meteorite–remedial measures–precautions–case studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Period Practical: 0 Period Total: 45 Periods**		

REFERENCES

1	*Donald Hyndman and David Hyndman,* ***"Natural Hazards and Disasters",*** *Brooks/Cole Cengage Learning, 2008.*
2	*Edward Bryant,* ***"Natural Hazards"****, Cambridge University Press,2005.*
3	*J Michael Duncan and Stephan G Wright,* ***"Soil Strength and Slope Stability"****, John Wiley & Sons, Inc,2005.*
4	*AmrS.Elnashai and Luigi Di Sarno,****"Fundamentals of Earthquake Engineering"****, John Wiley & Sons,Inc,2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Learn the basic concepts of earthquakes and the design concepts of earthquake Resistant buildings.	K2
CO2	Acquire knowledge on the causes and remedial measures of slope stabilization.	K3
CO3	As certain the causes and control measures of flood.	K3
CO4	Know the types, causes and mitigation of droughts.	K2
CO5	Study the causes, effects and precautionary measures of Tsunami.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	3	2	3
CO2	3	1	2	3	3	3
CO3	3	2	3	-	-	3
CO4	3	-	-	3	2	3
CO5	3	-	2	2	-	3
23GEOE09	3	1	2	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23EDOE10	**BUSINESS ANALYTICS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To apprehend the fundamentals of business analytics and its life cycle. 2. To gain knowledge about fundamental business analytics. 3. To study modeling for uncertainty and statistical inference. 4. To apprehend analytics the usage of Hadoop and Map Reduce frameworks. 5. To acquire insight on other analytical frameworks.	
UNIT – I	**BUSINESS ANALYTICS AND PROCESS**	**9 Periods**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.		
UNIT – II	**REGRESSION ANALYSIS**	**9 Periods**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.		
UNIT – III	**STRUCTURE OF BUSINESS ANALYTICS**	**9 Periods**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.		
UNIT – IV	**FORECASTING TECHNIQUES**	**9 Periods**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.		
UNIT – V	**DECISION ANALYSIS AND RECENT TRENDS IN BUSINESS ANALYTICS**	**9 Periods**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES

1	*VigneshPrajapati,* ***"Big Data Analytics with R and Hadoop",****Packt Publishing, 2013.*
2	*Umesh R Hodeghatta, UmeshaNayak,* ***"Business Analytics Using R – A Practical Approach",****Apress, 2017.*
3	*AnandRajaraman, Jeffrey David Ullman,* ***"Mining of Massive Datasets",*** *Cambridge University Press, 2012.*
4	*Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson,* ***"Essentials of Business Analytics",*** *Cengage Learning, second Edition, 2016.*
5	*U. Dinesh Kumar,* ***"Business Analytics: TheScience of Data-Driven Decision Making",*** *Wiley, 2017.*
6	*Rui Miguel Forte,* ***"Mastering Predictive Analytics with R",*** *Packt Publication, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the real world business problems and model with analytical solutions.	K4
CO2	Solve analytical problem with relevant mathematics background knowledge.	K4
CO3	Convert any real world decision making problem to hypothesis and apply suitable statistical testing.	K4
CO4	Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce	K4
CO5	Use open source frameworks for modeling and storing data.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	2	1
CO2	1	1	1	2	1
CO3	2	2	1	1	-
CO4	2	2	1	-	-
CO5	1	2	-	-	-
23EDOE10	1	2	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDOE11	INTRODUCTION TO INDUSTRIAL SAFETY *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. Summarize basics of industrial safety. 2. Describe fundamentals of maintenance engineering. 3. Explain wear and corrosion. 4. Illustrate fault tracing. 5. Identify preventive and periodic maintenance.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.		
UNIT – II	**FUNDAMENTALS OF MAINTENANCE ENGINEERING**	**9 Periods**
Definition and aim of maintenance engineering, Primary and secondary functions andresponsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.		
UNIT – III	**WEAR AND CORROSION AND THEIR PREVENTION**	**9 Periods**
Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.		
UNIT – IV	**FAULT TRACING**	**9 Periods**
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.		
UNIT – V	**PERIODIC AND PREVENTIVE MAINTENANCE**	**9 Periods**
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES

1	*Hans F. Winterkorn,* ***"Foundation Engineering Handbook",*** *Chapman & Hall London,2013.*
2	***"Maintenance Engineering"*** *by Dr. Siddhartha Ray, New Age International (P) Ltd., Publishers, 2017*
3	***"Industrial Safety Management",****McGraw Hill Education; New edition (1 July 2017)*
4	***"Industrial Engineering And Production Management",*** *S. Chand Publishing; Third edition ,2018*
5	***"Industrial Safety and Maintenance Engineering",****Parth B. Shah, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Ability to summarize basics of industrial safety	K4
CO2	Ability to describe fundamentals of maintenance engineering	K4
CO3	Ability to explain wear and corrosion	K4
CO4	Ability to illustrate fault tracing	K4
CO5	Ability to identify preventive and periodic maintenance	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23EDOE11	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDOE12	**OPERATIONS RESEARCH** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. Solve linear programming problem and solve using graphical method. 2. Solve LPP using simplex method. 3. Solve transportation, assignment problems. 4. Solve project management problems. 5. Solve scheduling problems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models		
UNIT – II	**LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming		
UNIT – III	**NON-LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT		
UNIT – IV	**SEQUENCING AND INVENTORY MODEL**	**9 Periods**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.		
UNIT – V	**GAME THEORY**	**9 Periods**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total:45 Periods**		

REFERENCES

1	*H.A. Taha**"Operations Research, An Introduction",** PHI, 2017.*
2	***"Industrial Engineering and Management",** O. P. Khanna, 2017.*
3	***"Operations Research",** S.K. Patel, 2017.*
4	***"Operation Research",** AnupGoel, RuchiAgarwal, Technical Publications, Jan 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate linear programming problem and solve using graphical method.	K4
CO2	Solve LPP using simplex method.	K4
CO3	Formulate and solve transportation, assignment problems.	K4
CO4	Solve project management problems.	K4
CO5	Solve scheduling problems	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	-
CO3	1	1	2	1	1
CO4	1	1	-	-	-
CO5	2	1	-	-	-
23EDOE12	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23MFOE13	OCCUPATIONAL HEATH AND SAFETY *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To gain knowledge about occupational health hazard and safety measures at work place. 2. To learn about accident prevention and safety management. 3. To learn about general safety measures in industries.	
UNIT – I	**OCCUPATIONAL HEALTH AND HAZARDS**	**9 Periods**
Safety- History and development, National Safety Policy- Occupational Health Hazards - Ergonomics - Importance of Industrial Safety Radiation and Industrial Hazards- Machine Guards and its types, Automation.		
UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**
Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance, Plant Design and Housekeeping, Industrial lighting, Vibration and Noise Case studies.		
UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**
Accident Prevention Techniques - Principles of accident prevention - Definitions, Theories, Principles – Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid : Body structure and functions - Fracture and Dislocation, Injuries to various body parts.		
UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**
Safety Management System and Law - Legislative measures in Industrial Safety: Various acts involved in Detail- Occupational safety, Health and Environment Management: Bureau of Indian Standards on Health and Safety, 14489, 15001 - OSHA, Process safety management (PSM) and its principles - EPA standards- Safety Management: Organisational & Safety Committee - its structure and functions.		
UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**
Plant Layout for Safety -design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System: Significance of Documentation Directing Safety, Leadership -Case studies involving implementation of health and safety measures in Industries.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total:45 Periods**		

REFERENCES:

1	*Benjamin O.Alli,* ***Fundamental Principles of Occupational Health and Safety*** *ILO 2008.*
2	*Danuta Koradecka,* ***Handbook of Occupational Health and Safety****, CRC, 2010.*
3	*Dr. Siddhartha Ray,* ***Maintenance Engineering,*** *New Age International (P) Ltd., Publishers, 2017*
4	*Deshmukh. L.M.,* ***Industrial Safety Management****, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.*
5	*https://nptel.ac.in/courses/110105094*

6	*https://archive.nptel.ac.in/courses/110/105/110105094/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain the knowledge about occupational health hazard and safety measures at work place.	K3
CO2	Learn about accident prevention and safety management.	K2
CO3	Understand occupational health hazards and general safety measures in industries.	K3
CO4	Know various laws, standards and legislations.	K2
CO5	Implement safety and proper management of industries.	K4

COURSE ARTICULATION MATRIX:					
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	2	2	1	1	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23MFOE13	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		50	50				100
CAT2		50	30	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	30	20			100
ESE		40	40	20			100

23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To understand the costing concepts and their role in decision making. 2. To acquire the project management concepts and their various aspects in selection. 3. To gain the knowledge in costing concepts with project execution. 4. To develop knowledge of costing techniques in service sector and various budgetary control techniques. 5. To familiarize with quantitative techniques in cost management.	
UNIT – I	**INTRODUCTION TO COSTING CONCEPTS**	**9 Periods**
Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision - Making.		
UNIT – II	**PROJECT PLANNING ACTIVITIES**	**9 Periods**
Project: meaning, Different types, why to manage, cost overruns centers, 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. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.		
UNIT – III	**COST ANALYSIS**	**9 Periods**
Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.		
UNIT – IV	**PRICING STRATEGIES AND BUDGETORY CONTROL**	**9 Periods**
Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing, Costing of service sector, Just-in -time approach, Material Requirement Planning, Enterprise Resource Planning. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.		
UNIT – V	**TQM AND OPERATIONS REASEARCH TOOLS**	**9 Periods**
Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charles T. Horngren and George Foster,* ***Advanced Management Accounting****, 2018.*
2	*John M. Nicholas,****Project Management for Engineering, Business and Technology****, Taylor &Francis, 2016*
3	*Nigel J,* ***Engineering Project Management****, John Wiley and Sons Ltd, Smith 2015.*
4	*Charles T. Horngren and George Foster* ***Cost Accounting a Managerial Emphasis****, Prentice Hall of India, New Delhi, 2011.*
5	*https://archive.nptel.ac.in/courses/110/104/110104073/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the costing concepts and their role in decision making.	K3
CO2	Apply the project management concepts and analyze their various aspects in selection.	K4
CO3	Interpret costing concepts with project execution.	K4
CO4	Gain knowledge of costing techniques in service sector and various budgetary control techniques.	K2
CO5	Become familiar with quantitative techniques in cost management.	K3

COURSE ARTICULATION MATRIX:

COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	1
CO2	2	1	1	1	-
CO3	2	2	2	-	-
CO4	1	1	1	1	1
CO5	1	2	1	1	-
23MFOE14	1	1	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1			40	60			100
CAT2		30	30	40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			40	60			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	30	40			100
ESE		20	40	40			100

23MFOE15	**COMPOSITE MATERIALS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To summarize the characteristics of composite materials and effect of reinforcement in composite materials. 2. To identify the various reinforcements used in composite materials. 3. To compare the manufacturing process of metal matrix composites. 4. To understand the manufacturing processes of polymer matrix composites. 5. To analyze the strength of composite materials.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement on overall composite performance.		
UNIT – II	**REINFORCEMENT**	**9 Periods**
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isosteresconditions.		
UNIT – III	**MANUFACTURING OF METAL MATRIX COMPOSITES**	**9 Periods**
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing- Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering–Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving- Properties and applications.		
UNIT – IV	**MANUFACTURING OF POLYMER MATRIX COMPOSITE**	**9 Periods**
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.		
UNIT – V	**STRENGTH ANALYSIS OF COMPOSITES**	**9 Periods**
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Chawla K.K., **Composite Materials**, Springer, 2013.*
2	*Lubin.G, **Hand Book of Composite Materials**, Springer New York, 2013.*
3	*Deborah D.L. Chung, **Composite Materials Science and Applications**, Springer, 2011.*
4	*uLektz, **Composite Materials and Mechanics**, uLektz Learning Solutions Private Limited, Lektz, 2013.*

5	*https://nptel.ac.in/courses/112104168*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the characteristics of composite materials and effect of reinforcement in composite materials.	K2
CO2	Know the various reinforcements used in composite materials.	K2
CO3	Understand and apply the manufacturing processes of metal matrix composites	K3
CO4	Understand and apply the manufacturing processes of polymer matrix composites.	K3
CO5	Analyze the strength of composite materials.	K4

COURSE ARTICULATION MATRIX:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	2	2	1	1	2
CO3	2	1	2	1	1
CO4	1	2	2	2	1
CO5	1	2	1	1	1
23MFOE15	**1**	**2**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		60	40				100
CAT2			60	40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		60	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			60	40			100
ESE		40	40	20			100

23TEOE16	**GLOBAL WARMING SCIENCE** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To make the students learn about the material consequences of climate change, sea level change due to increase in the emission of greenhouse gases and to examine the science behind mitigation and adaptation proposals.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Terminology relating to atmospheric particles – Aerosols - Types, characteristics, measurements – Particle mass spectrometry - Anthropogenic-sources, effects on humans.		
UNIT – II	**CLIMATE MODELS**	**9 Periods**
General climate modeling- Atmospheric general circulation model - Oceanic general circulation model, sea ice model, land model concept, paleo-climate - Weather prediction by numerical process. Impacts of climate change - Climate Sensitivity - Forcing and feedback.		
UNIT – III	**EARTH CARBON CYCLE AND FORECAST**	**9 Periods**
Carbon cycle-process, importance, advantages - Carbon on earth - Global carbon reservoirs - Interactions between human activities and carbon cycle - Geologic time scales - Fossil fuels and energy - Perturbed carbon cycle.		
UNIT – IV	**GREENHOUSE GASES**	**9 Periods**
Blackbody radiation - Layer model - Earth's atmospheric composition and Green house gases effects on weather and climate - Radioactive equilibrium - Earth's energy balance.		
UNIT – V	**GEO ENGINEERING**	**9 Periods**
Solar mitigation - Strategies – Carbon dioxide removal - Solar radiation management - Recent observed trends in global warming for sea level rise, drought, glacier extent.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Eli Tziperman, **"Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences"**, Princeton University Press, 1st Edition, 2022.*
2	*John Houghton, **"Global warming: The Complete Briefing"**, Cambridge University Press, 5th Edition, 2015.*
3	*David Archer, **"Global warming: Understanding the Forecast"**, Wiley, 2nd Edition, 2011.*
4	*David S.K. Ting, Jacqueline A Stagner, **"Climate Change Science: Causes, Effects and Solutions for Global Warming"**, Elsevier, 1st Edition, 2021.*
5	*Frances Drake, **"Global Warming: The Science of Climate Change"**,Routledge, 1st edition, 2000.*
6	*Dickinson, **"Climate Engineering-A review of aerosol approaches to changing the global energybalance"**, Springer, 1996.*
7	*Andreas Schmittner, **"Introduction to Climate Science"**, Oregon State University, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the global warming in relation to climate changes throughout the earth.	K2
CO2	Assess the best predictions of current climate models.	K4
CO3	Understand the importance of carbon cycle and its implication on fossil fuels.	K2
CO4	Know about current issues, including impact from society, environment, economy as well as ecology related to greenhouse gases.	K4
CO5	Know the safety measures and precautions regarding global warming.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	1	2
CO2	1	1	2	1	1	1
CO3	1	2	1	1	1	2
CO4	1	1	1	1	1	2
CO5	2	1	2	1	1	2
23TEOE16	1	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	35	10	-	-	100
CAT2	15	25	25	20	15	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	25	20	20	35	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	20	20	35	15	10	-	100
ESE	25	20	25	20	10	-	100

23TEOE17	**INTRODUCTION TO NANO ELECTRONICS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To make the students provide strong, essential, important methods and foundations of quantum mechanics and apply quantum mechanics on engineering fields.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Particles and Waves - Operators in quantum mechanics - The Postulates of quantum mechanics - The Schrodinger equation values and wave packet Solutions - Ehrenfest's Theorem.		
UNIT – II	**ELECTRONIC STRUCTURE AND MOTION**	**9 Periods**
Atoms- The Hydrogen Atom - Many-Electron Atoms – Pseudopotentials, Nuclear Structure, Molecules, Crystals - Translational motion – Penetration through barriers – Particle in a box - Two terminal quantum dot devices - Two terminal quantum wire devices.		
UNIT – III	**SCATTERING THEORY**	**9 Periods**
The formulation of scattering events - Scattering cross section - Stationary scattering state - Partial wave stationary scattering events - multi-channel scattering - Solution for Schrodinger equation-Radial and wave equation - Greens' function.		
UNIT – IV	**CLASSICAL STATISTICS**	**9 Periods**
Probabilities and microscopic behaviours - Kinetic theory and transport processes in gases - Magnetic properties of materials - The partition function.		
UNIT – V	**QUANTUM STATISTICS**	**9 Periods**
Statistical mechanics - Basic Concepts - Statistical models applied to metals and semiconductors - The thermal properties of solids- The electrical properties of materials - Black body radiation - Low temperatures and degenerate systems.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES:

1	*Vladimi V.Mitin, Viatcheslav A. Kochelap and Michael A.Stroscio,* ***"Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications"****, Cambridge University Press, 1st Edition, 2007.*
2	*Vinod Kumar Khanna,* ***"Introductory Nanoelectronics: Physical Theory and Device Analysis"****, Routledge, 1st Edition, 2020.*
3	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
4	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*

5	*Vladimi V.Mitin,* ***"Introduction to Nanoelectronics"****, Cambridge University Press, South Asian Edition, 2009.*
6	*Peter L. Hagelstein, Stephen D. Senturia and Terry P. Orlando, "****Introductory Applied Quantum Statistical Mechanics"****, Wiley, 2004.*
7	*A. F. J. Levi,* ***"Applied Quantum Mechanics"****, 2nd Edition, Cambridge, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the postulates of quantum mechanics.	K2
CO2	Know about nano electronic systems and building blocks.	K2
CO3	Solve the Schrodinger equation in 1D, 2D and 3Ddifferent applications.	K4
CO4	Learn the concepts involved in kinetic theory of gases.	K2
CO5	Know about statistical models applies to metals and semiconductor.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	1
CO2	2	2	1	1	1	1
CO3	2	2	2	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1
23TEOE17	1	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	30	30	20	20	-	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	35	25	20	20	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	30	25	20	25	-	-	100
ESE	20	30	30	20	-	-	100

22TEOE18	**GREEN SUPPLY CHAIN MANAGEMENT** *(Common to all Branches)*

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To make the students learn and focus on the fundamental strategies, tools and techniques required to analyze and design environmentally sustainable supply chain systems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Intro to SCM – complexity in SCM, Facility location - Logistics – Aim, activities, importance, progress, current trends - Integrating logistics with an organization.		
UNIT – II	**ESSENTIALS OF SUPPLY CHAIN MANAGEMENT**	**9 Periods**
Basic concepts of supply chain management - Supply chain operations – Planning and sourcing - Making and delivering - Supply chain coordination and use of technology - Developing supply chain systems.		
UNIT – III	**PLANNING THE SUPPLY CHAIN**	**9 Periods**
Types of decisions – strategic, tactical, operational - Logistics strategies, implementing the strategy - Planning resources – types, capacity, schedule, controlling material flow, measuring and improving performance.		
UNIT – IV	**ACTIVITIES IN THE SUPPLY CHAIN**	**9 Periods**
Procurement – cycle, types of purchase – Framework of e-procurement - Inventory management – EOQ, uncertain demand and safety stock, stock control - Material handling – Purpose of warehouse and ownership, layout, packaging - Transport – mode, ownership, vehicle routing and scheduling models- Travelling salesman problems - Exact and heuristic methods.		
UNIT – V	**SUPPLY CHAIN MANAGEMENT STRATEGIES**	**9 Periods**
Five key configuration components - Four criteria of good supply chain strategies - Next generation strategies- New roles for end-to-end supply chain management - Evolution of supply chain organization – International issues in SCM – Regional differences in logistics.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis and Dimitris Folinas,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2019.*
2	*Hsiao-Fan Wang and Surendra M.Gupta,* ***"Green Supply Chain Management: Product Life Cycle Approach"****,McGraw-Hill Education, 1st Edition, 2011.*

3	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2017.*
4	*Arunachalam Rajagopal,* ***"Green Supply Chain Management: A Practical Approach"****, Replica, 2021.*
5	*Mehmood Khan, Matloub Hussain and Mian M. Ajmal,* ***"Green Supply Chain Management for Sustainable Business Practice"****, IGI Global, 1st Edition, 2016.*
6	*S Emmett,* ***"Green Supply Chains: An Action Manifesto"****, John Wiley & Sons Inc, 2010.*
7	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 1st Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Integrate logistics with an organization.	K2
CO2	Evaluate complex qualitative and quantitative data to support strategic and operational decisions.	K5
CO3	Develop self-leadership strategies to enhance personal and professional effectiveness.	K3
CO4	Analyze inventory management models and dynamics of supply chain.	K4
CO5	Identify issues in international supply chain management and outsources strategies.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	3
CO2	2	2	1	1	1	1
CO3	2	1	2	1	1	1
CO4	2	2	1	1	2	2
CO5	1	1	2	1	1	3
23TEOE18	2	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	10	10	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	30	20	25	15	10	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	35	30	25	10	-	-	100
ESE	30	30	20	10	10	-	100

23PSOE19	**DISTRIBUTION AUTOMATION SYSTEM** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To study about the distributed automation and economic evaluation schemes of power network	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to Distribution Automation (DA) - Control system interfaces- Control and data requirements- Centralized (vs) decentralized control- DA system-DA hardware-DAS software.		
UNIT – II	**DISTRIBUTION AUTOMATION FUNCTIONS**	**9 Periods**
DA capabilities - Automation system computer facilities- Management processes- Information management- System reliability management- System efficiency management- Voltage management- Load management.		
UNIT – III	**COMMUNICATION SYSTEMS**	**9 Periods**
Communication requirements - reliability- Cost effectiveness- Data requirements- Two way capability- Communication during outages and faults - Ease of operation and maintenance- Conforming to the architecture of flow. Distribution line carrier- Ripple control-Zero crossing technique- Telephone, cableTV, radio, AM broadcast, FM SCA,VHF radio, microwave satellite, fiber optics-Hybrid communication systems used in field tests.		
UNIT – IV	**ECONOMIC EVALUATION METHODS**	**9 Periods**
Development and evaluation of alternate plans- select study area – Select study period- Project load growth-Develop alternatives- Calculate operating and maintenance costs-Evaluate alternatives.		
UNIT – V	**ECONOMIC COMPARISON**	**9 Periods**
Economic comparison of alternate plans-Classification of expenses - capital expenditures-Comparison of revenue requirements of alternative plans-Book life and continuing plant analysis- Year by year revenue requirement analysis, Short term analysis- End of study adjustment-Break even analysis, sensitivity analysis - Computational aids.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*M.K. Khedkar, G.M. Dhole, **"A Textbook of Electric Power Distribution Automation"**, Laxmi Publications, Ltd., 2010.*
2	*Maurizio Di Paolo Emilio, **"Data Acquisition Systems: From Fundamentals to Applied Design"**, Springer Science & Business Media, 21-Mar-2013*
3	*IEEE Tutorial course **"Distribution Automation"**, IEEE Working Group on Distribution Automation, IEEE Power Engineering Society. Power Engineering Education Committee, IEEE Power Engineering Society. Transmission and Distribution Committee, Institute of Electrical and Electronics Engineers, 1988*
4	*Taub, **"Principles Of Communication Systems",** Tata McGraw-Hill Education, 07-Sep-2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse the requirements of distributed automation	K1
CO2	Know the functions of distributed automation	K2
CO3	Perform detailed analysis of communication systems for distributed automation.	K3
CO4	Study the economic evaluation method	K4
CO5	Understand the comparison of alternate plans	K5

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	1
CO5	2	-	1	2
23PS0E19	3	-	3	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	10%	20%	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	20%	10%	30%	20%	20%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	30%	10%	20%	20%	-	100%
ESE	30%	20%	20%	20%	10%	-	100%

23PSOE20	**ELECTRICITY TRADING AND ELECTRICITY ACTS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To acquire expertise on Electric supply and demand of Indian Grid, gain exposure on energy trading in the Indian market and infer the electricity acts and regulatory authorities.	
UNIT – I	**ENERGY DEMAND**	**9 Periods**
Basic concepts in Economics - Descriptive Analysis of Energy Demand - Decomposition Analysis and Parametric Approach - Demand Side Management - Load Management - Demand Side Management - Energy Efficiency - Rebound Effect		
UNIT – II	**ENERGY SUPPLY**	**9 Periods**
Supply Behavior of a Producer - Energy Investment - Economics of Non-renewable Resources - Economics of Renewable Energy Supply Setting the context - Economics of Renewable Energy Supply - Economics of Electricity Supply		
UNIT – III	**ENERGY MARKET**	**9 Periods**
Perfect Competition as a Market Form - Why is the Energy Market not Perfectly Competitive? - Market Failure and Monopoly - Oil Market: Pre OPEC Era I - Oil Market: Pre OPEC Era II - Oil Market: OPEC		
UNIT – IV	**LAW ON ELECTRICITY**	**9 Periods**
Introduction of the Electricity Law; Constitutional Design - Evolution of Laws on Electricity Salient Features of Electricity Act, 2003 - Evolution of Laws on Electricity - Salient Features of the Electricity Act 2003		
UNIT – V	**REGULATORY COMMISSIONS FOR ELECTRICITY ACT**	**9 Periods**
Regulatory Commissions - Appellate Tribunal - Other Institutions under the Act - Electricity (Amendment) Bill 2020/2021. A Critical Comment - Renewable Energy - Role of Civil Society; Comments on Draft Renewable Energy Act, 2015		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Bhattacharyya, Subhes. C. (2011).* ***"Energy Economics: Concepts, Issues, Markets and Governance****". Springer.London, UK*
2	*Stevens, P. (2000).* ***"An Introduction to Energy Economics. In Stevens, P.(ed.) The Economics of Energy"****, Vol.1, Edward Elgar, Cheltenham, UK.*
3	*Nausir Bharucha,* ***"Guide to the Electricity Laws"****, LexisNexis, 2018*
4	*Mohammad Naseem,* ***"Energy Laws in India"****, Kluwer Law International, 3rd Edn, The Netherlands, 2017.*
5	*Alok Kumar & Sushanta K Chaterjee,* ***"Electricity Sector in India: Policy and Regulation"****, OUP, 2012.*
6	*Benjamin K Sovacool & Michael H Dowrkin,* ***"Global Energy Justice: Problems, Principles and Practices"****, Cambridge Univesity Press, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe electric supply and demand of power grid	K1
CO2	Summarize various energy trading strategies	K2
CO3	Relate the electricity acts practically	K3
CO4	Cite the electricity regulatory authorities	K2
CO5	Analyze/check the existing power grid for its technical and economical sustainability	K4

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	1	1
CO3	3	-	2	2
CO4	3	-	1	2
CO5	3	-	3	3
23PSOE20	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	30%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	20%	30%	30%	20%	-	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	30%	-	20%	-	40%	100%
ESE	30%	30%	-	20%	20%	-	100%

23PSOE21	**MODERN AUTOMOTIVE SYSTEMS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To expose the students with theory and applications of Automotive Electrical and Electronic Systems.	
UNIT – I	**INTRODUCTION TO MODERN AUTOMOTIVE ELECTRONICS**	**9 Periods**
Introduction to modern automotive systems and need for electronics in automobiles- Role of electronics and microcontrollers- Sensors and actuators- Possibilities and challenges in automotive industry- Enabling technologies and industry trends.		
UNIT – II	**SENSORS AND ACTUATORS**	**9 Periods**
Introduction- basic sensor arrangement- Types of sensors- Oxygen sensor, engine crankshaft angular position sensor – Engine cooling water temperature sensor- Engine oil pressure sensor- Fuel metering- vehicle speed sensor and detonation sensor- Pressure Sensor- Linear and angle sensors- Flow sensor- Temperature and humidity sensors- Gas sensor- Speed and Acceleration sensors- Knock sensor- Torque sensor- Yaw rate sensor- Tyre Pressure sensor- Actuators - Stepper motors – Relays.		
UNIT – III	**POWERTRAIN CONTROL SYSTEMS IN AUTOMOBILE**	**9 Periods**
Electronic Transmission Control - Digital engine control system: Open loop and close loop control systems- Engine cooling and warm up control- Acceleration- Detonation and idle speed control - Exhaust emission control engineering- Onboard diagnostics- Future automotive powertrain systems.		
UNIT – IV	**SAFETY, COMFORT AND CONVENIENCE SYSTEMS**	**9 Periods**
Cruise Control- Anti-lock Braking Control- Traction and Stability control- Airbag control system- Suspension control- Steering control- HVAC Control.		
UNIT – V	**ELECTRONIC CONTROL UNITS (ECU)**	**9 Periods**
Introduction to Energy Sources for ECU, Need for ECUs- Advances in ECUs for automotives - Design complexities of ECUs- V-Model for Automotive ECU's- Architecture of an advanced microcontroller (XC166 Family, 32-bit Tricore) used in the design of automobile ECUs- On chip peripherals, protocol interfaces, analog and digital interfaces.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Enrique Acha, Manuel Madrigal**, "Power System Harmonics: Computer Modeling and Analysis**", John Wiley and Sons, 2001.*
2	*M. H. J. Bollen, **"Understanding Power Quality Problems, Voltage Sag and Interruptions",** IEEE Press, series on Power Engineering, 2000.*
3	*Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and Wayne Beaty H., **"Electrical Power SystemQuality"**, Second Edition, McGraw Hill Publication Co., 2008.*
4	*G.T.Heydt, **"Electric Power Quality",** Stars in a Circle Publications, 1994(2nd edition).*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about conventional automotive control units and devices.	K1
CO2	Recognize the practical issues in the automotive control systems	K2
CO3	Analyze the impact of modern automotive techniques in various Engineering applications	K4
CO4	Develop modern automotive control system for electrical and electronics systems	K6
CO5	Understand the function of sensors and actuators	K2

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	2	-	3	1
CO5	2	-	1	2
23PS0E21	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	30%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	20%	30%	-	20%	-	30%	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	30%	-	20%	-	40%	100%
ESE	30%	30%	20%	20%	-	-	100%

23PEOE22	**VIRTUAL INSTRUMENTATION** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To comprehend the Virtual instrumentation programming concepts towards measurements and control and to instill knowledge on DAQ, signal conditioning and its associated software tools	
UNIT – I	**INTRODUCTION**	**7 Periods**
Introduction - advantages - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - Data-flow techniques, graphical programming in data flow, comparison with conventional programming.		
UNIT – II	**GRAPHICAL PROGRAMMING AND LabVIEW**	**9 Periods**
Concepts of graphical programming - LabVIEW software - Concept of VIs and sub VI - Display types - Digital - Analog - Chart and Graphs. Loops - structures - Arrays – Clusters- Local and global variables – String - Timers and dialog controls.		
UNIT – III	**MANAGING FILES & DESIGN PATTERNS**	**11 Periods**
High-level and low-level file I/O functions available in LabVIEW – Implementing File I/O functions to read and write data to files – Binary Files – TDMS – sequential programming – State machine programming – Communication between parallel loops –Race conditions – Notifiers & Queues – Producer Consumer design patterns		
UNIT – IV	**PC BASED DATA ACQUISITION**	**9 Periods**
Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Use of timer-counter and analog outputs on the universal DAQ card.		
UNIT – V	**DATA ACQUISITION AND SIGNAL CONDITIONING**	**9 Periods**
Components of a DAQ system, Bus, Signal and accuracy consideration when choosing DAQ hardware – Measurement of analog signal with Finite and continuous buffered acquisition- analog output generation – Signal conditioning systems – Synchronizing measurements in single & multiple devices – Power quality analysis using Electrical Power Measurement tool kit.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Jeffrey Travis, Jim Kring, **"LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (3rd Edition),** Prentice Hall, 2006***.**
2	*Jovitha Jerome, **"Virtual Instrumentation using LabVIEW",** PHI, 2010*
3	*Gary W. Johnson, Richard Jennings, **"LabVIEW Graphical Programming"**, McGraw Hill Professional Publishing, 2019*
4	*Robert H. Bishop, **"Learning with LabVIEW"**, Prentice Hall, 2013.*
5	*Kevin James, "**PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control"**, Newness, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the graphical programming techniques using LabVIEW software.	K2
CO2	Explore the basics of programming and interfacing using related hardware.	K4
CO3	Analyse the aspects and utilization of PC based data acquisition and Instrument interfaces.	K4
CO4	Create programs and Select proper instrument interface for a specific application.	K6
CO5	Familiarize and experiment with DAQ and Signal Conditioning	K3

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	2	1
CO3	3	-	2	2	2
CO4	3	1	3	3	1
CO5	3	1	3	3	2
23PEOE22	3	1	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEOE23	**ENERGY MANAGEMENT SYSTEMS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To Comprehend energy management schemes, perform energy audit and execute economic analysis and load management in electrical systems.	
UNIT – I	**GENERAL ASPECTS OF ENERGY AUDIT AND MANAGEMENT**	**9 Periods**
Energy Conservation Act 2001 and policies – Eight National Missions - Basics of Energy and its forms (Thermal and Electrical) - Energy Management and Audit - Energy Managers and Auditors - Types and Methodology Audit Report - Material and energy balance diagrams - .Energy Monitoring and Targeting.		
UNIT – II	**STUDY OF BOILERS, FURNACES AND COGENERATION**	**9 Periods**
Boiler Systems - Types - Performance Evaluation of boilers - Energy Conservation Opportunity - Steam Distribution - Efficient Steam Utilisation - Furnaces:types and classification - Performance evaluation of a typical fuel fired furnace. Cogeneration: Need - Principle - Technical options - classification - Technical parameters and factors influencing cogeneration choice - Prime Movers - Trigeneration.		
UNIT – III	**ENERGY STUDY OF ELECTRICAL SYSTEMS**	**9 Periods**
Electricity Billing – Electricity load management - Maximum Demand Control - Power Factor improvement and its benefits - pf controllers - capacitors - Energy efficient transformers and Induction motors - rewinding and other factors influencing energy efficiency - Standards and labeling programme of distribution transformers and IM - Analysis of distribution losses - demand side management - harmonics - filters - VFD and its selection.		
UNIT – IV	**STUDY OF ELECTRICAL UTILITIES**	**9 Periods**
Compressor types - Performance - Air system components - Efficient operation of compressed air systems- Compressor capacity assessment - HVAC: psychrometrics and air-conditioning processes - Types of refrigeration system - Compressor types and applications - Performance assessment of refrigeration plants - Lighting Systems: Energy efficient lighting controls - design of interior lighting - Case study.		
UNIT – V	**PERFORMANCE ASSESSMENT FOR EQUIPMENT**	**9 Periods**
Performing Financial analysis: Fixed and variable costs – Payback period – ROI - methods – factors affecting analysis. Energy Performance Assessment: Heat exchangers - Fans and Blowers - Pumps. Energy Conservation in buildings and ECBC.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Murphy W.R. and G.Mckay Butter worth , "**Energy Management**", Heinemann Publications, 2007*
2	*Albert Thumann, Terry Niehus, William J. Younger, "**Handbook of Energy Audits"**, Ninth Edition, River Publishers, 2012.*
3	*Dr. Subhash Gadhave Anup Goel Siddu S. Laxmikant D. Jathar, **"Energy Audit & Management"**, Second edition, Technical Publications, 2019.*
4	*S. M. Chaudhari, S. A. Asarkar, M. A. Chaudhari, **"Energy Conservation and Audit"**, Second Edition, Nirali Prakashan Publications, 2021.*
5	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the feature of energy audit methodology and documentation of report.	K3
CO2	Perform action plan and financial analysis	K4
CO3	Familiarize with thermal utilities.	K4
CO4	Familiarize with electrical utilities.	K4
CO5	Perform assessment of different systems.	K5

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	1	1
CO2	3	2	2	1	1
CO3	3	2	2	1	1
CO4	3	2	2	1	1
CO5	3	2	2	1	1
23PEOE23	3	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30	30	20	20	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEOE24	ADVANCED ENERGY STORAGE TECHNOLOGY *(Common to all Branches)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To explore the fundamentals, technologies and applications of energy storage	
UNIT – I	**ENERGY STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES**	**9 Periods**
Storage Needs- Variations in Energy Demand- Variations in Energy Supply- Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues-conventional energy storage methods: battery-types.		
UNIT – II	**TECHNICAL METHODS OF STORAGE**	**9 Periods**
Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.		
UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**	**9 Periods**
Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage.		
UNIT – IV	**APPLICATION CONSIDERATION**	**9 Periods**
Comparing Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery - Battery Storage System: Introduction with focus on Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management systems, System Performance, Areas of Application of Energy Storage: Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.		
UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**	**9 Periods**
Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, options - Level 1: (Hybrid Power generation) Bacitor "Battery + Capacitor" Combinations: need, operation and Merits; Level 2: (Hybrid Power Generation) Bacitor + Fuel Cell or Flow Battery operation-Applications: Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*DetlefStolten, "**Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications**", Wiley, 2010.*
2	*Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "**Electrochemical Technologies for Energy Storage and Conversion**", John Wiley and Sons, 2012.*
3	*Francois Beguin and ElzbietaFrackowiak, "**Super capacitors**", Wiley, 2013.*
4	*Doughty Liaw, Narayan and Srinivasan, "**Batteries for Renewable Energy Storage**", The Electrochemical Society, New Jersy, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recollect the historical perspective and technical methods of energy storage.	K1
CO2	Explain the basics of different storage methods.	K2
CO3	Determine the performance factors of energy storage systems.	K2
CO4	Identify applications for renewable energy systems.	K4
CO5	Outline the basics of Hydrogen cell and flow batteries.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3
23PEOE24	3	1	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	10	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23AEOE25	**DESIGN OF DIGITAL SYSTEMS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives

- To gain knowledge in the design and VHDL programming of synchronous and asynchronous sequential circuits, PLD's and the basic concepts of testing in VLSI circuits

UNIT–I SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN	**9 Periods**

Analysis of Clocked Synchronous Sequential Circuits - Modeling, state table reduction, state assignment, Design of Synchronous Sequential circuits, Design of iterative circuits- ASM chart –ASM realization.

UNIT–II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN	**9 Periods**

Analysis of Asynchronous Sequential Circuits - Races in ASC – Primitive Flow Table - Flow Table Reduction Techniques, State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards– Data Synchronizers.

UNIT–III SYSTEM DESIGN USING PLDS	**9 Periods**

Basic concepts – Programming Technologies - Programmable Logic Element (PLE) – Programmable Array Logic (PLA)-Programmable Array Logic (PAL) –Design of combinational and sequential circuits using PLDs– Complex PLDs (CPLDs).

UNIT– IV INTRODUCTION TO VHDL	**9 Periods**

Design flow -Software tools – VHDL: Data Objects-Data types – Operators –Entities and Architectures – Components and Configurations – Signal Assignment – Concurrent and Sequential statements ––Behavioral, Dataflow and Structural modeling– Transport and Inertial delays –Delta delays-Attributes - Generics– Packages and Libraries.

UNIT–V LOGIC CIRCUIT TESTING AND TESTABLE DESIGN	**9 Periods**

Digital logic circuit testing - Fault models - Combinational logic circuit testing - Sequential logic circuit testing-Design for Testability - Built-in Self-test, Board and System Level Boundary Scan - Case Study: Traffic Light Controller.

Contact Periods:

Lecture:45Periods Tutorial:0Periods Practical: 0Periods Total: 45Periods

REFERENCES:

1	*Donald G.Givone, "**Digital principles and Design**", TataMcGrawHill, 2002.*
2	*Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D., "**Digital Logic Circuit Analysis and Design**", Prentice Hall International, Inc., NewJersey, 1995.*
3	*VolneiA.Pedroni,"**Circuit Design withVHDL**",PHILearning,2011.*
4	*ParagK Lala,"**Digital Circuit Testing and Testability**",AcademicPress,1997.*
5	*CharlesHRoth,"**Digital Systems Design Using VHDL",**Cencage2ndEdition2012.*
6	*NripendraN.Biswas,"**Logic Design Theory**"PrenticeHallofIndia,2001.*

COURSEOUTCOMES: Upon completion of the course ,students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	To design synchronous sequential circuits based on specifications.	K3
CO2	To design asynchronous sequential circuits based on specifications	K3
CO3	Ability to illustrate digital design implementation using PLDs.	K2
CO4	To develop algorithm and VHDL code for design of digital circuits.	K3
CO5	Understand the different testing methods for combinational and sequential circuits.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE25	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	20%	45%	35%				100%

23AEOE26	**BASICS OF NANO ELECTRONICS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective

- The students will be able to acquire knowledge about nano device fabrication technology, nano structures, nano technology for memory devices and applications of nano electronics in data transmission.

UNIT – I TECHNOLOGY AND ANALYSIS	**9 Periods**
Fundamentals : Dielectric, Ferroelectric and Optical properties - Film Deposition Methods – Lithography Material removing techniques - Etching and Chemical Mechanical Polishing - Scanning Probe Techniques.	
UNIT – II CARBON NANO STRUCTURES	**9 Periods**
Principles and concepts of Carbon Nano tubes - Fabrication - Electrical, Mechanical and Vibration Properties - Applications of Carbon Nano tubes.	
UNIT – III LOGIC DEVICES	**9 Periods**
Silicon MOSFET's: Novel materials and alternative concepts - Single electron devices for logic applications - Super conductor digital electronics - Carbon Nano tubes for data processing.	
UNIT – IV MEMORY DEVICES AND MASS STORAGE DEVICES	**9 Periods**
Flash memories - Capacitor based Random Access Memories - Magnetic Random Access Memories - Information storage based on phase change materials - Resistive Random Access Memories - Holographic Data storage.	
UNIT – V DATA TRANSMISSION AND INTERFACING DISPLAYS	**9 Periods**
Photonic Networks - RF and Microwave Communication System - Liquid Crystal Displays - Organic Light emitting diodes.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

REFERENCES:

1	*Rainer Waser, **"Nano Electronics and Information Technology, Advanced Electronicmaterials and novel devices**", 3rd Edition, Wiley VCH, 2012.*
2	*T. Pradeep, "**Nano: The essentials**", Tata McGraw Hill, 2007.*
3	*Charles Poole, "**Introduction to Nano Technology**", Wiley Interscience, 2003*
4	*Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "**Introduction to Nano Electronics Science, Nanotechnology, Engineering and Applications**", Cambridge University Press, 2011.*
5	*C.Wasshuber Simon, "**Simulation of Nano Structures Computational Single-Electronics**",Springer, 2001.*
6	*Mark Reed and Takhee Lee, "**Molecular Nano Electronics, American Scientific Publisher, California**", 2003.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Explain principles of nano device fabrication technology.	K2
CO2	Describe the concept of Nano tube and Nano structure.	K2
CO3	Explain the function and application of various nano devices	K3
CO4	Reproduce the concepts of advanced memory technologies.	K2
CO5	Emphasize the need for data transmission and display systems.	K2

COURSE ARTICULATION MATRIX									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	2	-	-	1	3	-	1
CO2	3	-	2	-	-	1	3	-	1
CO3	3	-	2	-	-	1	3	-	1
CO4	3	-	2	-	-	1	3	-	1
CO5	3	-	2	-	-	1	3	-	1
23AEOE26	3	-	2	-	-	1	3	-	1
1 – Slight, 2 – Moderate, 3 – Substantial									

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50%	25%	25%				100%
CAT2	50%	25%	25%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50%	25%	25%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50%	25%	25%				100%
ESE	50%	25%	25%				100%

23AEOE27	**ADVANCED PROCESSOR** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective

- The students will be able to acquire knowledge about the high performance RISC, CISC and special purpose processors.

UNIT – I MICROPROCESSOR ARCHITECTURE	**9 Periods**

Instruction set – Data formats – Instruction formats – Addressing modes – Memory hierarchy – registerfile – Cache – Virtual memory and paging – Segmentation – Pipelining – The instruction pipeline – pipeline hazards – Instruction level parallelism – reduced instruction set – Computer principles – RISCversus CISC – RISC properties – RISC evaluation.

UNIT – II HIGH PERFORMANCE CISC ARCHITECTURE –PENTIUM	**9 Periods**

The software model – functional description – CPU pin descriptions – Addressing modes – Processor flags – Instruction set – Bus operations – Super scalar architecture – Pipe lining – Branch prediction – Theinstruction and caches – Floating point unit– Programming the Pentium processor.

UNIT – III HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM INTERFACE	**9 Periods**

Protected mode operation – Segmentation – paging – Protection – multitasking – Exception and interrupts - Input /Output – Virtual 8086 model – Interrupt processing.

UNIT – IV HIGH PERFORMANCE RISC ARCHITECTURE: ARM	**9 Periods**

ARM architecture – ARM assembly language program – ARM organization and implementation – ARM instruction set - Thumb instruction set.

UNIT – V SPECIAL PURPOSE PROCESSORS	**9 Periods**

Altera Cyclone Processor – Audio codec – Video codec design – Platforms – General purpose processor –Digital signal processor – Embedded processor – Media Processor – Video signal Processor – Custom Hardware – Co-Processor.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Daniel Tabak, "**Advanced Microprocessors**", McGraw Hill Inc., 2011.*
2	*James L. Antonakos, "**The Pentium Microprocessor**", Pearson Education, 1997.*
3	*Steve Furber, "**ARM System –On –Chip architecture**", Addison Wesley, 2009.*
4	*Gene. H. Miller, "**Micro Computer Engineering**", Pearson Education, 2003.*
5	*Barry. B. Brey, "**The Intel Microprocessors Architecture, Programming and Interfacing**", PHI, 2008.*
6	*Valvano, "**Embedded Microcomputer Systems**" Cencage Learing India Pvt Ltd, 2011.*
7	*Iain E.G. Richardson, "**Video codec design**", John Wiley & sons Ltd, U.K, 2002.*

COURSE OUTCOMES: Upon completion of the course, students will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the fundamentals of various processor architecture.	K2
CO2	Interpret and understand the high performance features in CISC architecture.	K2
CO3	Describe the concepts of Exception and interrupt processing.	K2
CO4	Develop programming skill for ARM processor.	K3
CO5	Explain various special purpose processor	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE27	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	30%	40%	30%				100%

23VLOE28	**HDLPROGRAMMINGLANGUAGES** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• To code and simulate any digital function in Verilog HDL and understand the difference between synthesizable and non-synthesizable codes.	
UNIT – I	**VERILOG INTRODUCTION AND MODELING**	**9 Periods**
Introduction to Verilog HDL, Language Constructs and Conventions, Gate Level Modeling, Modeling at Dataflow Level, Behavioral Modeling, Switch Level Modeling, System Tasks, Functions and Compiler Directives.		
UNIT – II	**SEQUENTIAL MODELING AND TESTING**	**9 Periods**
Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis. Test Bench - Combinational Circuits Testing, Sequential Circuit Testing, Test Bench Techniques, Design Verification, Assertion Verification.		
UNIT – III	**SYSTEM VERILOG**	**9 Periods**
Introduction, System Verilog declaration spaces, System Verilog Literal Values and Built-in Data Types, System Verilog User-Defined and Enumerated Types, system Verilog Arrays, Structures and Unions, system verilog Procedural Blocks, Tasks and Functions.		
UNIT – IV	**SYSTEMVERILOGMODELING**	**9 Periods**
System Verilog Procedural Statements, Modeling Finite State Machines with System Verilog, System Verilog Design Hierarchy.		
UNIT – V	**INTERFACES AND DESIGN MODEL**	**9 Periods**
System Verilog Interfaces, A Complete Design Modeled with System Verilog, Behavioral and Transaction Level Modeling.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods**		

REFERENCES:

1	*T.R.Padmanabhan, B Bala Tripura Sundari, "**Design through Verilog HDL**",Wiley 2009.*
2	*Stuart Sutherland, Simon Davidmann ,Peter Flake , Foreword by Phil Moorby, "**System Verilog For Design Second Edition A Guide to Using System Verilog for Hardware Design and Modelling**", Springer 2006.*
3	*Samir Palnitkar, "**Verilog HDL**", 2nd Edition, Pearson Education, 2009.*
4	*ZainalabdienNavabi,"**Verilog Digital System Design**",TMH,2ndEdition,2005.*
5	*System Verilog 3.1a, Language Reference Manual, Accellera, 2004*
6	*Dr.SRamachandran, "**Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog**", Springer, 2007.*
7	*Chris Spear, "**System verilog for verification a guide to learning the test bench Language Features**", Springer 2006.*
6	*Stuart Sutherland, Simon Davidmann, Peter Flake, "**System Verilog For Design: A Guide to Using System Verilog for Hardware Design and Modeling**" 1st Edition, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the verilog coding and simulate any digital function using Verilog HDL	K2
CO2	Develop sequential modeling based Verilog HDL code and develop the test bench for the modeling	K3
CO3	Explain the system verilog modeling	K2
CO4	Differentiate the synthesizable and non-synthesizable code	K3
CO5	Apply good coding techniques on system verilog interfaces and complete design model	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		2		2
CO2	3	3		2		2
CO3	3	3		2		2
CO4	3	3		2		2
CO5	3	3		2		2
23VLOE28	3	3		2		2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50%	50%	-	-	-	100%
ESE	40%	40%	20%	-	-	-	100%

23VLOE29	**CMOS VLSI DESIGN** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• To gain knowledge on CMOS Circuits with its characterization and to design CMOS logic and sub-system with low power	
UNIT – I	**INTRODUCTION TO MOS CIRCUITS**	**9 Periods**
MOS Transistor Theory -Introduction MOS Device Design Equations -MOS Transistor as a Switches - Pass Transistor - CMOS Transmission Gate -Complementary CMOS Inverter - Static Load MOS Inverters - Inverters with NMOS loads - Differential Inverter - Tri State Inverter - BiCMOS Inverter.		
UNIT – II	**CIRCUIT CHARACTERIZATION AND PERFORMANCE ESTIMATION**	**9 Periods**
Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Sizing Routing Conductors, Charge Sharing, Design Margin and Reliability.		
UNIT – III	**CMOS CIRCUIT AND LOGIC DESIGN**	**9 Periods**
CMOS Logic Gate Design, Physical Design of CMOS Gate, Designing with Transmission Gates, CMOS Logic Structures, Clocking Strategies, I/O Structures.		
UNIT – IV	**CMOS SUBSYSTEM DESIGN**	**9 Periods**
DataPath Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multipliers, Shifters, Memory Elements, Control-FSM, Control Logic Implementation.		
UNIT – V	**LOW POWER CMOS VLSI DESIGN**	**9 Periods**
Introduction to Low Power Design, Power Dissipation in FET Devices, Power Dissipation in CMOS, Low-Power Design through Voltage Scaling – VTCMOS Circuits, MTCMOS Circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches, Low Power Basics CMOS Gate and Adder Design.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods**		

REFERENCES:

1	*Sung Mo Kang,Yusuf Lablebici,**"CMOS Digital Integrated Circuits:Analysis & Design"**, Tata Mc-Graw Hill, 2011.*
2	*N.Weste and K.Eshranghian, **"Principles of CMOS VLSI Design"**, AddisonWesley,1998.*
3	*Neil H. E. Weste, David Harris, Ayan Banerjee, **"CMOS VLSI Design: A Circuits and Systems Perspective"**, Pearson Education 2013.*
4	*Kiat-Seng Yeo,Kaushik Roy,**"Low-Voltage, Low-Power VLSI Subsystems",** McGraw-Hill Professional, 2004.*
5	*Gary K.Yeap, **"Practical Low Power Digital VLSI Design"**, Kluwer Academic Press, 2002.*
6	*Jan M .Rabaey,**"Digital Integrated Circuits: A Design Perspective"**, Pearson Education, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the MOS circuits and Transmission gates	K2
CO2	Illustrate the CMOS Circuits with its characterization	K2
CO3	Design CMOS logic circuits	K3
CO4	Design CMOS sub-system	K3
CO5	Discuss low power CMOS VLSI Design	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	2	-	3
CO2	2	1	-	2	-	3
CO3	2	1	-	2	-	3
CO4	3	1	-	2	-	3
CO5	3	1	-	2	-	3
23VLOE29	**3**	**1**	**-**	**2**	**-**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50%	50%	-	-	-	100%
ESE	40%	40%	20%	-	-	-	100%

23VLOE30	**HIGH LEVEL SYNTHESIS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• To provide students with foundations in High level synthesis, verification and CAD Tools	
UNIT – I	**HIGH-LEVEL SYNTHESIS (HLS) FUNDAMENTALS**	**9 Periods**
Overview HLS flow, Scheduling Techniques, Resource sharing and Binding Techniques, Data-path and Controller Generation Techniques.		
UNIT – II	**HIGH LEVEL SYNTHESIS**	**9 Periods**
Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed Scheduling, operator binding, Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological mvs. Logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks.		
UNIT – III	**HIGH-LEVEL SYNTHESIS VERIFICATION**	**9 Periods**
Simulation based verification - Formal Verification of digital systems- BDD based approaches, functional equivalence, finite state automata, ω-automata, FSM verification.		
UNIT – IV	**CAD TOOLS FOR SYNTHESIS**	**9 Periods**
CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.		
UNIT – V	**ADVANCED TOPICS**	**9 Periods**
Relative Scheduling, IO scheduling modes - cycle fixed scheduling modes, super-fixed scheduling modes, free-floating scheduling mode, Pipelining, Handshaking, System Design, High-Level Synthesis for FPGA.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Philippe Coussy and Adam Morawiec, "**High-level Synthesis from Algorithm to Digital Circuit**", Springer, 2008.*
2	*Sherwani, N., "**Algorithms for VLSI Physicsl Design Automation**", Springer, 3rd ed., 2005.*
3	*D. Micheli,"**Synthesis and optimization of digital systems**", Mc Graw Hill, 2005.*
4	*Dutt, N. D. and Gajski, D. D., "**High level synthesis**", Kluwer, 2000.*
5	*Gerez S.H., "**Algorithms for VLSI Design Automation**", John Wiley (1998)*
6	*David. C. Ku and G. De Micheli, "**High-level Syntehsis of ASICs Under Timing and Synchronization Constraints**", Kluwer Academic Publishers, 1992.*
7	*K. Parhi, "**VLSI Digital Signal Processing Systems: Design and Implementation**", Jan 1999, Wiley.*
8	*Egon Boerger and Robert Staerk "**Abstract State Machines: A Method for High-Level System Design and Analysis**", Springer,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the fundamentals of High level synthesis	K2
CO2	Synthesis the HDL for operation scheduling	K2
CO3	Simulate and verify any digital systems	K2
CO4	Apply CAD tools for synthesis	K2
CO5	Have knowledge on various scheduling modes	K2

COURSE ARTICULATION MATRIX :

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	2	2	-
CO2	2	2	-	2	2	-
CO3	2	2	-	2	2	-
CO4	2	2	-	2	2	-
CO5	2	2	-	2	2	-
23VL0E30	**2**	**2**	**-**	**2**	**2**	**-**

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50%	50%		-	-	-	100%
CAT2	50%	50%		-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50%	50%	-	-	-	100%
ESE	50%	50%		-	-	-	100%

23CSOE31	**ARTIFICIAL INTELLIGENCE** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	Identify and apply AI techniques in the design of systems that act intelligently, making automatic decisions and learn from experience.	
UNIT – I	**SEARCH STRATEGIES**	**9 Periods**
Uninformed Strategies – BFS, DFS, Djisktra, Informed Strategies – A* search, Heuristic functions, Hill Climbing, Adversarial Search – Min-max algorithm, Alpha-beta Pruning		
UNIT – II	**PLANNING AND REASONING**	**9 Periods**
State Space search, Planning Graphs, Partial order planning, Uncertain Reasoning – Probabilistic Reasoning, Bayesian Networks, Dempster Shafer Theory, Fuzzy logic		
UNIT – III	**PROBABILISTIC REASONING**	**9 Periods**
Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks. Knowledge Representations – Ontological Engineering, Semantic Networks and description logics.		
UNIT – IV	**DECISION MAKING**	**9 Periods**
Utility Theory, Utility Functions, Decision Networks – Sequential Decision Problems – Partially Observable MDPs – Game Theory.		
UNIT – V	**REINFORCEMENT LEARNING**	**9 Periods**
Reinforcement Learning - Passive and active reinforcement learning - Generations in Reinforcement Learning - Policy Search – Deep Reinforcement Learning.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Deepak Khemani, **"A First Course in Artificial Intelligence",** Tata Mc Graw Hill Education 2013*
2	*Yang Q, **" Intelligent Planning: A decomposition and Abstraction based Approach",** Springer, 2006*
3	*Russell and Norvig, **"Artificial Intelligence, A Modern Approach**", 3rd edition, Pearson Prentice Hall,2010.*
4	*Elaine Rich,Kevin Knight,Shivashankar B. Nair, **"Artificial Intelligence",** 3rd edition, TataMcGraw Hill, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use search techniques to solve AI problems	K2
CO2	Reason facts by constructing plans and understand uncertainty efficiently.	K3
CO3	Examine data using statistical codes and solve complex AI problems	K6
CO4	Apply techniques to make apt decisions.	K4
CO5	Use deep reinforcement learning to solve complex AI problems	K6

COURSE ARTICULATION MATRIX						
COs/ POs	**PO 1**	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO6**
CO1	3		2		3	3
CO2	3		2		3	3
CO3	3		3		3	3
CO4	3		3		3	3
CO5	3		3		3	3
23CSOE31	3		3		3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		20	40	20	20		100
CAT2		10	20	40	10	20	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1					50	50	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2					50	50	100
ESE	30	30	40				100

23CSOE32	COMPUTER NETWORK MANAGEMENT *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand the concept of layering in networks, functions of protocols of each layer of TCP/IP protocol suite, concepts related to network addressing and routing and build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes using Cisco Packet Tracer.	
UNIT – I	**INTRODUCTION AND APPLICATION LAYER**	**9 Periods**
Building network – Network Edge and Core – Layered Architecture – OSI Model – Internet Architecture (TCP/IP) Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Performance Metrics - Ethernet Networking – Introduction to Sockets – Application Layer protocols – HTTP – FTP Email Protocols – DNS.		
UNIT – II	**TRANSPORT LAYER AND ROUTING**	**9 Periods**
Transport Layer functions –User Datagram Protocol – Transmission Control Protocol – Flow Control – Retransmission Strategies – Congestion Control - Routing Principles – Distance Vector Routing – Link State Routing – RIP – OSPF – BGP – Introduction to Quality of Service (QoS).Case Study: Configuring RIP, OSPF BGP using Packet tracer		
UNIT – III	**NETWORK LAYER**	**9 Periods**
Network Layer: Switching concepts – Internet Protocol – IPV4 Packet Format – IP Addressing – Subnetting – Classless Inter Domain Routing (CIDR) – Variable Length Subnet Mask (VLSM) – DHCP – ARP – Network Address Translation (NAT) – ICMP – Concept of SDN.Case Study: Configuring VLAN, DHCP, NAT using Packet tracer		
UNIT – IV	**INTERNETWORK MANAGEMENT**	**9 Periods**
Introduction to the Cisco IOS - Router User Interface – CLI - Router and Switch Administrative Functions - Router Interfaces - Viewing, Saving, and Erasing Configurations - Switching Services - Configuring Switches - Managing Configuration Registers - Backing Up and Restoring IOS - Backing Up and Restoring the Configuration - Using Discovery Protocol (CDP) - Checking Network Connectivity		
UNIT – V	**TRAFFIC MANAGEMENT AND WAN PROTOCOLS**	**9 Periods**
Managing Traffic with Access Lists: Introduction to Access Lists - Standard Access Lists - Extended Access Lists - Named Access Lists - Monitoring Access Lists - Wide Area Networking Protocols: Introduction to Wide Area Networks - Cabling the Wide Area Network - High-Level Data-Link Control (HDLC) Protocol - Point-to-Point Protocol (PPP) - Frame Relay: Frame Relay Implementation and Monitoring - Integrated Services Digital Network (ISDN) - Dial-on-Demand Routing (DDR): Configuring DDR		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*James F. Kurose, Keith W. Ross,* ***"Computer Networking: A Top-Down Approach",*** *Seventh Edition, Pearson Education, 2017.*
2	*William Stallings,* ***"Data and Computer Communications",*** *Tenth Edition, Pearson Education, 2014*
3	*Larry L. Peterson, Bruce S. Davie,* ***"Computer Networks: A Systems Approach",*** *Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
4	*Todd Lammle,* ***"CCNA™: Cisco® Certified Network Associate Study Guide",*** *5th Edition, Sybex, 2003*
5	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker,* ***"Computer Networks: An Open Source Approach",*** *McGraw Hill, 2012.*
6	*Ron Gilster, Jeff Bienvenu, and Kevin Ulstad,* ***"CCNA for Dummies",*** *IDG Books Worldwide, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Highlight the significance of the functions of each layer in the network.	K1
CO2	Identify the devices and protocols to design a network and implement it.	K4
CO3	Apply addressing principles such as subnetting and VLSM for efficient routing.	K3
CO4	Build simple LANs, perform basic configurations for routers and switches	K6
CO5	Illustrate various WAN protocols	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3		3		2	1
CO2	3		3		2	2
CO3	3		3		3	2
CO4	3		3		3	3
CO5	3		3		3	3
23CSOE32	3		3		3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20			100
CAT2		30	20	30	10	10	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	10	30	20	20	20		100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2		20	20	20	20	20	100
ESE	20	40	40				100

23CSOE33	**BLOCKCHAIN TECHNOLOGIES** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	The objective of the course is to explore basics of block chain technology and its application in various domain	
UNIT – I	**INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**	**9 Periods**
History of Blockchain - Types of blockchain- CAP theorem and blockchain – benefits and Limitations of Blockchain – Decentalization using blockchain – Blockchain implementations- Block chain in practical use - Legal and Governance Use Cases		
UNIT – II	**BITCOIN AND CRYPTOCURRENCY**	**9 Periods**
Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency		
UNIT – III	**ETHEREUM**	**9 Periods**
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts		
UNIT – IV	**HYPERLEDGER AND SOLIDITY PROGRAMMING**	**9 Periods**
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity – Programming with solidity		
UNIT – V	**BLOCKCHAIN APPLICATIONS**	**9 Periods**
Ten Steps to build your Blockchain application – Application: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Imran Bashir,* ***"Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained"****, Second Edition, Packt Publishing, 2018.*
2	*Joseph J. Bambara Paul R. Allen,* ***"Blockchain A Practical Guide to Developing Business, Law, and Technology Solutions"****,McGraw Hill Education ,2018.*
3	*Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder,* ***"Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"*** *Princeton University Press, 2016.*
4	*Manav Gupta* ***"Blockchain for Dummies",*** *IBM Limited Edition 2017.*
5	*Antonopoulos and G. Wood,* ***"Mastering Ethereum: Building Smart Contracts and Dapps",*** *O'Reilly Publishing, 2018*
6	***NPTEL Course : Blockchain and its applications*** *https://archive.nptel.ac.in/courses/106/105/106105235/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the working of Blockchain technology	K2
CO2	Narrate working principle of smart contracts and create them using solidity for given scenario.	K3
CO3	Comprehend the working of Hyperledger in an real time application	K2
CO4	Apply the learning of solidity to build de-centralized apps on Ethereum	K3
CO5	Develop applications on Blockchain	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		3	2		3
CO2	2	3	3	3	2	3
CO3	3		3	2		3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3
23CSOE33	3	3	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	70				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		40	60				100
ESE	10	60	30				100

23EDACZ1	**ENGLISH FOR RESEARCH PAPER WRITING** *(Common to All Branches)*

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	The objective of the course is to make the learners understand the format and intricacies involved in writing a research paper.	
UNIT – I	**PLANNING AND PREPARATION**	**6 Periods**
Need for publishing articles, Choosing the journal, Identifying a model journal paper, Creation of files for each section, Expectations of Referees, Online Resources.		
UNIT – II	**SENTENCES AND PARAGRAPHS**	**6 Periods**
Basic word in English, Word order in English and Vernacular, placing nouns, Verbs, Adjectives, and Adverb suitably in a sentence, Using Short Sentences, Discourse Markers and Punctuations- Structure of a Paragraph, Breaking up lengthy Paragraphs.		
UNIT – III	**ACCURACY, BREVITY AND CLARITY (ABC) OF WRITING**	**6 Periods**
Accuracy, Brevity and Clarity in Writing, Reducing the linking words, Avoiding redundancy, Appropriate use of Relative and Reflexive Pronouns, Monologophobia, verifying the journal style, Logical Connections between others author's findings and yours.		
UNIT – IV	**HIGHLIGHTING FINDINGS, HEDGING AND PARAPHRASING**	**6 Periods**
Making your findings stand out, Using bullet points headings, Tables and Graphs- Availing non-experts opinions, Hedging, Toning Down Verbs, Adjectives, Not over hedging, Limitations of your research.		
UNIT – V	**SECTIONS OF A PAPER**	**6 Periods**
Titles, Abstracts, Introduction, Review of Literature, Methods, Results, Discussion, Conclusions, References.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

1	*Goldbort R , **"Writing for Science", Yale University Press** (available on GoogleBooks),2006*
2	*Day R , **How to Write and Publish a Scientific Paper**, Cambridge University Press, 2006.*
3	*Highman N, **"Handbook of Writing for the Mathematical Sciences"**, SIAM. Highman's book, 1998.*
4	*Adrian Wallwork," **English for Writing Research Papers"**, Springer New York Dordrecht Heidelberg London, 2011.*

COURSE OUTCOMES : Upon completion of this course the learners will be able to		**Bloom's Taxonomy Mapped**
CO1	**U**nderstand the need for writing good research paper.	K2
CO2	Practice the appropriate word order, sentence structure and paragraph writing.	K4
CO3	Practice unambiguous writing.	K3
CO4	Avoid wordiness in writing.	K2
CO5	Exercise the elements involved in writing journal paper.	K3

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
23EDACZ1	3	3	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	-	50	50	-	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	50	50	-	-	-	100
ESE	30	30	40	-	-	-	100

23EDACZ2	**DISASTER MANAGEMENT** *(Common to all branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. To become familiar in key concepts and consequences about hazards, disaster and area of occurrence. 2. To know the various steps in disaster planning. 3. To create awareness on disaster preparedness and management.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Areas proneto ,EarthquakesFloods , Droughts, Landslides ,Avalanches ,Cyclone and Coastal Hazards with Special Reference to Tsunami.		
UNIT – II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6 Periods**
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.		
UNIT – III	**DISASTER PLANNING**	**6 Periods**
Disaster Planning-Disaster Response Personnel roles and duties, Community MitigationGoals, Pre-Disaster Mitigation Plan, Personnel Training, Comprehensive Emergency Management, Early Warning Systems.		
UNIT – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6 Periods**
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.		
UNIT – V	**RISK ASSESSMENT**	**6 Periods**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies for Survival.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*R. Nishith, Singh AK, **"Disaster Management In India: Perspectives, Issues And Strategies"**, New Royal book Company, 2007.*
2	*Sahni, PardeepEt.Al. (Eds.), **"Disaster Mitigation Experiences And Reflections"**, Prentice Hall Of India, New Delhi, 2010*
3	*Goel S. L, **"Disaster Administration And Management Text And Case Studies"**, Deep &Deep Publication Pvt. Ltd., New Delhi, 2008.*
4	*Jagbir Singh, **"Disaster Management: Future Challenges And Opportunities"**, I.K. International Publishing House Pvt. Ltd., New Delhi, 2007.*
5	*Damon Coppola **"Introduction To International Disaster Management"**, Butterworth-Heinemann, 2015*
6	*Ryan Lanclos **"Dealing With Disasters: Gis For Emergency Management"**,ESRI Press 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate hazard and disaster with their significance.	K4
CO2	Analyse the causes and impact of natural and manmade disaster.	K4
CO3	Execute the steps involved in disaster planning.	K4
CO4	Predict vulnerability of disaster and to prevent, mitigate their impact.	K4
CO5	Prepare risk assessment strategy for national and global disaster.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23EDACZ2	1	1	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50					100
CAT2			100				100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	50	50					100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2			100				100
ESE	25	25	50				100

23EDACZ3	**VALUE EDUCATION** *(Common to all branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. Value of education and self- development 2. Requirements of good values in students 3. Importance of character	
UNIT – I	**ETHICS AND SELF-DEVELOPMENT**	**6 Periods**
Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements.		
UNIT – II	**PERSONALITY AND BEHAVIOR DEVELOPMENT**	**6 Periods**
Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.		
UNIT – III	**VALUES IN HUMAN LIFE**	**6 Periods**
Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature,Discipline.		
UNIT – IV	**VALUES IN SOCIETY**	**6 Periods**
True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association andCooperation. Doing best for saving nature.		
UNIT – V	**POSITIVE VALUES**	**6 Periods**
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

1	*Chakroborty, S.K.* ***"Values and Ethics for organizations Theory and practice"****, Oxford University Press, New Delhi,1998*
2	*Dr. Yogesh Kumar Singh,* ***"Value Education"****, A.P.H Publishing Corporation,New Delhi,2010*
3	*R.P Shukla,* ***"Value Education and Human Rights"****, Sarup and Sons, NewDelhi,2004*
4	*https://nptel.ac.in/courses/109104068/36*

COURSE OUTCOMES : Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the values and work ethics.	K3
CO2	Enhance personality and 149ehavior development.	K3
CO3	Apply the values in human life.	K3
CO4	Gain Knowledge of values in society.	K3
CO5	Learn the importance of positive values in human life.	K3

COURSE ARTICULATION MATRIX						
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	-	-	1
CO2	-	-	3	-	-	1
CO3	-	-	3	-	-	1
CO4	-	-	3	-	-	1
CO5	-	-	3	-	-	1
23EDACZ3	-	-	3	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EDACZ4	**CONSTITUTION OF INDIA** *(Common to all branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	**2**	**0**	**0**	**0**

Course Objectives	• To address the importance of constitutional rights and duties • To familiarize about Indian governance and local administration. • To know about the functions of election commission.	
UNIT – I	**INDIAN CONSTITUTION**	**6 Periods**
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) - Philosophy of the Indian Constitution: Preamble Salient Features.		
UNIT – II	**CONSTITUTIONAL RIGHTS & DUTIES**	**6 Periods**
Contours of Constitutional Rights & Duties: Fundamental Rights , Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
UNIT – III	**ORGANS OF GOVERNANCE**	**6 Periods**
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.		
UNIT – IV	**LOCAL ADMINISTRATION**	**6 Periods**
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.		
UNIT – V	**ELECTION COMMISSION**	**6 Periods**
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	***"The Constitution of India"****, 1950 (Bare Act), Government Publication.*
2	*Dr. S. N. Busi, Dr. B. R. Ambedkar* ***"Framing of Indian Constitution"****, 1st Edition, 2015.*
3	*M. P. Jain,"****Indian Constitution Law"****, 7th Edn., Lexis Nexis, 2014.*
4	*D.D. Basu,"****Introduction to the Constitution of India"****, Lexis Nexis, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the growth of the demand for civil rights in India.	K2
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	K2
CO3	Understand the various organs of Indian governance.	K2
CO4	Familiarize with the various levels of local administration.	K2
CO5	Gain knowledge on election commission of india.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	1	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	1	1
CO5	-	-	1	1	1	1
23EDACZ4	**-**	**-**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EDACZ5	**PEDAGOGY STUDIES** *(Common to all branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. To Understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. 2. Application of knowledge in modification of curriculum, its assessment and introduction of innovation in teaching methodology.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.		
UNIT – II	**PEDAGOGICAL PRACTICES**	**6 Periods**
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies		
UNIT – III	**PEDAGOGICAL APPROACHES**	**6 Periods**
How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teacher's attitudes and beliefs and Pedagogic strategies.		
UNIT – IV	**PROFESSIONAL DEVELOPMENT**	**6 Periods**
Professional development: alignment with classroom practices and follow-up support. Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.		
UNIT – V	**CURRICULUM AND ASSESSMENT**	**6 Periods**
Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.		
Contact Periods: **Lecture: 30 Periods Tutorial: Nil Practical: Nil Total: 30 Periods**		

REFERENCES:

1	*Ackers J, Hardman F ,**Classroom interaction in Kenyan primary schools,Compare**, 31 (2): 245-261, 2001.*
2	*Alexander RJ ,**Culture and pedagogy: International comparisons in primary education**. Oxford and Boston: Blackwell, 2001*
3	*Akyeampong K, Lussier K, Pryor J, Westbrook J, **Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?** International Journal Educational Development, 33 (3): 272–282, 2013.*
4	*Agrawal M ,**Curricular reform in schools: The importance of evaluation**, Journal of Curriculum Studies, 36 (3): 361-379, 2004*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of curriculum, formal and informal education systems and teacher education.	K3
CO2	Explain the present pedagogical practices and the changes occurring in pedagogical approaches	K3
CO3	Understand the relation between teacher and community, support from various levels of teachers to students and limitation in resources and size of the class.	K3
CO4	Perform research in design a problem in pedagogy and curriculum development.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	2	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	2	1
23EDACZ5	**-**	**-**	**1**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EDACZ6	**STRESS MANAGEMENT BY YOGA** *(Common to all branches)*

PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		AC	2	0	0	0
Course Objectives	1. To create awareness on the benefits of yoga and meditation. 2. To understand the significance of Asana and Pranayama.					
UNIT – I	**PHYSICAL STRUCTURE AND ITS FUNCTIONS**					**6 Periods**
Yoga - Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation.						
UNIT – II	**YOGA TERMINOLOGIES**					**6 Periods**
Yamas - Ahimsa, satya, astheya, bramhacharya, aparigraha Niyamas- Saucha, santosha, tapas, svadhyaya, Ishvara pranidhana.						
UNIT – III	**ASANA**					**6 Periods**
Asana - Rules & Regulations – Types & Benefits						
UNIT – IV	**PRANAYAMA**					**6 Periods**
Regularization of breathing techniques and its effects-Types of pranayama						
UNIT – V	**MIND**					**6 Periods**
Bio magnetism& mind - imprinting & magnifying – eight essential factors of living beings, Mental frequency and ten stages of mind, benefits of meditation, such as perspicacity, magnanimity, receptivity, adaptability, creativity.						
Contact Periods: **Lecture: 30 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**						

REFERENCES :

1	*Janardan Swami Yogabhyasi Mandal , **"Yogic Asanas for Group Training-Part-I"**, Nagpur.*
2	*Swami Vivekananda, **"Rajayoga or conquering the Internal Nature"**, Advaita Ashrama (Publication Department), Kolkata.*
3	*Pandit Shambu Nath, **"Speaking of Stress Management Through Yoga and Meditation"**, New Dawn Press, New Delhi, 2016.*
4	*K. N. Udupa, **"Stress and its management by Yoga",** Motilal Banarsidass Publishers, New Delhi, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Practice physical exercises and maintain good health.	K3
CO2	Attain knowledge on the various concepts of Yoga.	K2
CO3	Perform various asanas with an understanding on their benefits.	K3
CO4	Practice breathing techniques in a precise manner.	K3
CO5	Attain emotional stability and higher level of consciousness.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	-	-	-	2
CO2	-	-	-	-	3
CO3	-	-	-	-	2
CO4	-	-	-	-	1
CO5	-	-	-	-	1
23EDACZ6	-	-	-	-	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	30%	30%	-	-	-	100%
CAT2	30%	40%	30%	-	-	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	40%	40%	20%	-	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	30%	30%	40%	-	-	-	100%
ESE	30%	30%	40%	-	-	-	100%

23EDACZ7	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** *(Common to all branches)*

PREREQUISITES :	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	AC	**2**	**0**	**0**	**0**

Course Objectives	1. To familiar with Techniques to achieve the highest goal in life. 2. To become a person with stable mind, pleasing personality and determination.	
UNIT – I		**6 Periods**
Neetisatakam-Holistic development of personality-Verses- 19,20,21,22 (wisdom)-Verses29,31,32 (pride & heroism)-Verses- 26,28,6.		
UNIT – II		**6 Periods**
Verses- 52,53,59 (dont's)-Verses- 71,73,75,78 (do's). - Approach to day to day work and duties.- Shrimad BhagwadGeeta - Chapter 2-Verses 41, 47,48,		
UNIT – III		**6 Periods**
Shrimad BhagwadGeeta -Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,- Chapter 18-Verses 45, 46, 48.		
UNIT – IV		**6 Periods**
Statements of basic knowledge.-Shrimad BhagwadGeeta: -Chapter2-Verses 56, 62, 68 -Chapter 12 -Verses 13, 14, 15, 16,17, 18-Personality of Role model.		
UNIT – V		**6 Periods**
Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39-Chapter18 – Verses 37,38,63.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

1	*Swami SwarupanandaAdvaita Ashram "**Srimad Bhagavad Gita**",AdvaitaAshrama, Kolkata,2016*
2	*P.Gopinath, Rashtriya Sanskrit Sansthanam "**Bhartrihari's Three Satakam**" (Niti-sringar-vairagya), New Delhi, 1986.*
3	*Swami Mukundananda, JagadguruKripalujiYog "**Bhagavad Gita: The Song Of God**", USA,2019*
4	*A.C. Bhaktivedanta Swami Prabhupada "**Bhagavad-Gita As It Is**",Bhaktivedanta Book Trust Publications,2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Holistic development in life	K4
CO2	Effective Planning of day to day work and duties	K4
CO3	Identify mankind to peace and prosperity	K4
CO4	Develop versatile personality.	K4
CO5	Awakening wisdom in life	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	-	-	-
CO2	-	-	1	-	-	-
CO3	-	-	1	-	-	-
CO4	-	-	1	-	-	-
CO5	-	-	1	-	-	-
23EDACZ7	**-**	**-**	**1**	**-**	**-**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EDACZ8	**SANSKRIT FOR TECHNICAL KNOWLEDGE** *(Common to all Branches)*

PREREQUISITES:	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world. 2. Learning of Sanskrit to improve brain functioning. 3. Enhancing the memory power. 4. Learning of Sanskrit to develop the logic in mathematics, science & other subjects.	
UNIT – I	**BASICS OF SANSKRIT**	**6 Periods**
Alphabets in Sanskrit, Past/Present/Future Tense.		
UNIT – II	**SENTENCES AND ROOTS**	**6 Periods**
Simple Sentences - Order, Introduction of roots		
UNIT – III	**SANSKRIT LITERATURE**	**6 Periods**
Technical information about Sanskrit Literature		
UNIT – IV	**TECHNICAL CONCEPTS -1**	**6 Periods**
Technical concepts of Engineering-Electrical, Mechanical		
UNIT – V	**TECHNICAL CONCEPTS -2**	**6 Periods**
Technical concepts of Engineering-Architecture, Mathematics		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*Dr.Vishwas, "**Abhyaspustakam",** Samskrita -Bharti Publication, New Delhi, 2020.*
2	*Prathama Deeksha Vempati Kutumbshastri, "**Teach Yourself Sanskrit**", Rashtriya Sanskrit Sansthanam, New Delhi, Publication, 2009.*
3	*Suresh Soni, **"India's Glorious Scientific Tradition**" , Ocean books (P) Ltd., New Delhi,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize ancient literature and their basics	K3
CO2	Formulate the sentences with order and understand the roots of Sanskrit	K2
CO3	Acquire familiarity of the major traditions of literatures written in Sanskrit	K3
CO4	Distinguish the Technical concepts of Electrical & Mechanical Engineering	K2
CO5	Categorize the Technical concepts of Architecture & Mathematics	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	1	2	1
CO2	-	-	-	1	2	-
CO3	-	-	-	1	1	1
CO4	-	-	-	2	1	1
CO5	-	-	-	1	2	1
23EDACZ8	**-**	**-**	**-**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%