GOVERNMENT COLLEGE OF TECHNOLOGY

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

Curriculum For

M. E. MANUFACTURING ENGINEERING

2023

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
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GOVERNMENT COLLEGE OF TECHNOLOGY

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VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind**.**

MISSION

- To achieve academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship.
- To improve the research competence to address societal needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society.

GOVERNMENT COLLEGE OF TECHNOLOGY
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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.

GOVERNMENT COLLEGE OF TECHNOLOGY
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M.E. MANUFACTURING ENGINEERING

PROGRAMME EDUCATIONAL OUTCOMES (PEOs)

The PEO's are to facilitate graduating students to

PEO1 : Develop the skills for examining the real life problems and to identify the mechanism for finding the feasible solution.

PEO2 : Prepare a technical report to imply the Manufacturing Engineering principles and concepts on Local and Global societial needs.

PEO3 : Become effective and excellent need based engineer, to provide solutions for social and technical Challenges through innovative technologies and modern machineries.

GOVERNMENT COLLEGE OF TECHNOLOGY
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M.E. MANUFACTURING ENGINEERING

PROGRAMME OUTCOMES (POs)

On successful completion of the programme the graduates will be able,

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 of Expertise in Manufacturing Engineering.

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 Geometry / Environment/ Recyclable / Disposal through inter disciplinary activities.

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.	23MFFCZ1	RESEARCH METHODOLOGY AND IPR (Common to all branches)	FC	40	60	100	3	0	0	3
2.	23MFFC02	APPLIED MATHEMATICS FOR MANUFACTURING ENGINEERING	FC	40	60	100	3	1	0	4
3.	23MFPC01	THEORY OF METAL CUTTING AND PRACTICES	PC	40	60	100	3	1	0	4
4.	23MFPC02	ADVANCES IN CASTING AND WELDING TECHNOLOGIES	PC	40	60	100	3	0	0	3
5.	23MFPC03	CORROSION AND SURFACE ENGINEERING	PC	40	60	100	3	1	0	4
6.	23MFPEXX	PROFESSIONAL ELECTIVE - I	PE	40	60	100	3	0	0	3
7.	23MFACXX	AUDIT COURSE - I	AC	40	60	100	2*	0	0	0
PRACTICAL COURSES										
8.	23MFPC04	PROCESS MODELING AND SIMULATION LABORATORY	PC	60	40	100	0	0	4	2
TOTAL				**340**	**440**	**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.	23MFPC05	OPTIMIZATION TECHNIQUES IN MANUFACTURING	PC	40	60	100	3	1	0	4
2	23MFPC06	MATERIAL TESTING AND CHARACTERIZATION	PC	40	60	100	3	1	0	4
3.	23MFPC07	INDUSTRIAL AUTOMATION	PC	40	60	100	3	0	0	3
4.	23MFPEXX	PROFESSIONAL ELECTIVE - II	PE	40	60	100	3	0	0	3
5.	23MFPEXX	PROFESSIONAL ELECTIVE - III	PE	40	60	100	3	0	0	3
6.	23MFACXX	AUDIT COURSE - II	AC	40	60	100	2*	0	0	0
PRACTICAL COURSES										
7.	23MFPC08	MODERN MANUFACTURING ENGINEERING LABORATORY	PC	60	40	100	0	0	4	2
8.	23MFEE01	MINI PROJECT	EEC	60	40	100	0	0	4	2
TOTAL				**360**	**440**	**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	23MFPEXX	PROFESSIONAL ELECTIVE IV	PE	40	60	100	3	0	0	3
2	23MFOEXX	OPEN ELECTIVE	OE	40	60	100	3	0	0	3
PRACTICAL COURSES										
3	23MFEE02	INTERNSHIP / INDUSTRIAL TRAINING	EEC	100	-	100	-	-	*	2
4	23MFEE03	PROJECT - I	EEC	60	40	100	0	0	24	12
TOTAL				**240**	**160**	**400**	**6**	**0**	**24**	**20**

* - 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	23MFEE04	PROJECT - II	EEC	60	40	100	0	0	48	24
TOTAL				**60**	**40**	**100**	**0**	**0**	**48**	**24**

Note:* No Credit Courses **TOTAL CREDITS : 88**

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	23MFPE01	DIGITAL MANUFACTURING	PE	40	60	100	3	0	0	3
2	23MFPE02	ADVANCES IN METROLOGY AND MEASUREMENTS	PE	40	60	100	3	0	0	3
3	23MFPE03	INDUSTRY 4.0 AND IoT	PE	40	60	100	3	0	0	3
4	23MFPE04	ADVANCED ENGINEERING MATERIALS AND METALLURGY	PE	40	60	100	3	0	0	3
5	23MFPE05	ADVANCED FINITE ELEMENT METHODS	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE II										
6	23MFPE06	WEAR ANALYSIS AND CONTROL	PE	40	60	100	3	0	0	3
7	23MFPE07	MACHINE TOOL DRIVES AND CONTROL	PE	40	60	100	3	0	0	3
8	23MFPE08	SENSORS FOR INTELLIGENT MANUFACTURING	PE	40	60	100	3	0	0	3
9	23MFPE09	MEMS AND NEMS	PE	40	60	100	3	0	0	3
10	23MFPE10	LEAN MANUFACTURING SYSTEMS AND IMPLEMENTATION	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE III										
11	23MFPE11	HIGH SPEED MACHINING	PE	40	60	100	3	0	0	3
12	23MFPE12	SUPPLY CHAIN MANAGEMENT	PE	40	60	100	3	0	0	3
13	23MFPE13	DESIGN FOR MANUFACTURE, ASSEMBLY AND MANUFACTURING ENVIRONMENT	PE	40	60	100	3	0	0	3
14	23MFPE14	THEORY OF METAL FORMING	PE	40	60	100	3	0	0	3
15	23MFPE15	NON-DESTRUCTIVE EVALUATION	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE IV										
S. No	**Course Code**	**Course Title**	**Category**	**CA Marks**	**End Sem Marks**	**Total Marks**	**L**	**T**	**P**	**C**
16	23MFPE16	GREEN MANUFACTURING	PE	40	60	100	3	0	0	3
17	23MFPE17	VIBRATION CONTROL AND CONDITION MONITORING	PE	40	60	100	3	0	0	3
18	23MFPE18	PRODUCT DESIGN AND DEVELOPMENT	PE	40	60	100	3	0	0	3
19	23MFPE19	RELIABILITY AND QUALITY ENGINEERING	PE	40	60	100	3	0	0	3
20	23MFPE20	ADVANCES IN MANUFACTURING PROCESSES	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

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
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
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	23MFACZ1	ENGLISH FOR RESEARCH PAPER WRITING	AC	40	60	100	2	0	0	0
2	23MFACZ2	DISASTER MANAGEMENT	AC	40	60	100	2	0	0	0
3	23MFACZ3	VALUE EDUCATION	AC	40	60	100	2	0	0	0
4	23MFACZ4	CONSTITUTION OF INDIA	AC	40	60	100	2	0	0	0
5	23MFACZ5	PEDAGOGY STUDIES	AC	40	60	100	2	0	0	0
6	23MFACZ6	STRESS MANAGEMENT BY YOGA	AC	40	60	100	2	0	0	0
7	23MFACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT	AC	40	60	100	2	0	0	0
8	23MFACZ8	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	IISEM	IIISEM	IVSEM	Total	
1.	FC	7	-	-	-	07	**7.95 %**
2.	PC	13	13	-	-	26	**29.54%**
3.	PE	3	6	3	-	12	**13.63%**
4.	OE	-	-	3	-	03	**3.40%**
5.	AC	0	0	-	-	(Non Credit)	**0%**
6.	EEC	-	2	14	24	40	**45.45 %**
Total Credits		**23**	**21**	**20**	**12**	**88**	**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.	23MFFCZ1	RESEARCH METHODOLOGY AND IPR	FC	40	60	100	3	0	0	3
2.	23MFFC02	APPLIED MATHEMATICS FOR MANUFACTURING	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.	23MFPC01	THEORY OF METAL CUTTING AND PRACTICES	PC	40	60	100	3	1	0	4
2.	23MFPC02	ADVANCES IN CASTING AND WELDING TECHNOLOGIES	PC	40	60	100	3	0	0	3
3.	23MFPC03	CORROSION AND SURFACE ENGINEERING	PC	40	60	100	3	1	0	4
4.	23MFPC04	PROCESS MODELING AND SIMULATION LABORATORY	PC	60	40	100	0	0	4	2
5.	23MFPC05	OPTIMIZATION TECHNIQUES IN MANUFACTURING	PC	40	60	100	3	1	0	4
6.	23MFPC06	MATERIAL TESTING AND CHARACTERIZATION	PC	40	60	100	3	1	0	4
7.	23MFPC07	INDUSTRIAL AUTOMATION	PC	40	60	100	3	0	0	3
8.	23MFPC08	MODERN MANUFACTURING ENGINEERING LABORATORY	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.	23MFPEXX	PROFESSIONAL ELECTIVE I	PE	40	60	100	3	0	0	3
2.	23MFPEXX	PROFESSIONAL ELECTIVE II	PE	40	60	100	3	0	0	3
3.	23MFPEXX	PROFESSIONAL ELECTIVE III	PE	40	60	100	3	0	0	3
4.	23MFPEXX	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.	23MFOEXX	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.	23MFACXX	AUDIT COURSE - I	AC	40	60	100	2	0	0	0
2.	23MFACXX	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	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23MFEE01	MINI PROJECT	EEC	60	40	100	0	0	4	2
2	23MFEE02	INTERNSHIP / INDUSTRIAL TRAINING	EEC	100	0	100	0	0	**	2
3	23MFEE03	PROJECT - I	EEC	60	40	100	0	0	24	12
4	23MFEE04	PROJECT - II	EEC	60	40	100	0	0	48	24
				280	**120**	**400**	**0**	**0**	**76**	**40**

**4 WEEKS OF INTERNSHIP / INDUSTRIAL TRAINING

23MFFCZ1	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
23MFFCZ1	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

23MFFC02	APPLIED MATHEMATICS FOR MANUFACTURING ENGINEERING	I

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

Course Objectives	To gain the concepts of probability, random variables, test of hypothesis, numerical interpolation, numerical differentiation, numerical integration, numerical solution of ordinary differential equations and partial differential equations.	
UNIT – I	**PROBABILITY AND RANDOM VARIABLES**	**9+3 Periods**
Sample Spaces, Events, Probability Axioms, Conditional Probability, Independent Events, Bayes' Theorem. Random Variables**:** Distribution Functions, Expectation, Moments, Moment Generating Functions.		
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	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9+3 Periods**
Interpolation with equal interval: Newton's forward and backward difference methods -Interpolation with unequal intervals: Newton's divided difference and Lagrange's method-Numerical Differentiation: Newton's methods-Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.		
UNIT – IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Ordinary differential equations: Taylor's series method-Euler and modified Euler's methods – Runge-Kutta method of fourth order for solving first and second order equations-Milne's and Adam's predicator-corrector methods		
UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Partial differential equations: Finite difference solution two dimensional Laplace equation and Poisson equation- Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods)-Finite difference explicit method for wave equation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES:

1	*B.S. Grewal, "**Higher Engineering Mathematics"**, Khanna Publishers, New Delhi, 44thEdition, 2018.*
2	*Veerarajan T, "**Probability and Random Processes:,** (with Queuing Theory and Queuing Networks), McGraw Hill Education(India) Pvt Ltd., New Delhi, 4th Edition,2016.*
3	*Gupta S.C and Kapoor V.K., **"Fundamentals of Mathematical Statistics"**, Sultan Chand & Sons, New Delhi, 2015.*
4	*S.S. Sastry, "**Introductory Methods of Numerical Analysis"**, PHI, New Delhi, 5th Edition, 2015.*
5	*Ward Cheney, David Kincaid, "**Numerical Methods and Computin",** Cengage Learning**,** Delhi, 7th Edition 2013.*
6	*P. Kandasamy, K. Thilagavathy, K. Gunavathi, "**Numerical Methods"**, S. Chand & Company, 3rd Edition, Reprint 2013.*
7	*S. Larsson, V. Thomee, "**Partial Differential Equations with Numerical Methods"**, Springer, 2003.*
8	*Trivedi K.S, "**Probability and Statistics with Reliability, Queuing and Computer Science Applications"**, Prentice Hall of India, New Delhi.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire fluency in solving probability oriented problems	K4
CO2	Test for significance of hypothesis connected to small and large samples using different parameters.	K4
CO3	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to polynomial and transcendental equations, derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations.	K4
CO4	Construct one-step and linear multistep methods for the numerical solution of initial-value problems for ordinary differential equations and systems of such equations.	K4
CO5	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.	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1	2	1
CO2	1	1	2	1	3
CO3	3	3	1	1	1
CO4	1	2	3	1	2
CO5	3	1	1	2	1
23MFFC02	3	2	1	1	1

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

23MFPC01	THEORY OF METAL CUTTING AND PRACTICES	I

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

Course Objectives	To acquire knowledge in orthogonal cutting, oblique cutting, thermal aspects, cutting fluids, cutting tool materials, tool life, tool wear and design of cutting tools.	
UNIT – I	**ORTHOGONAL CUTTING**	**9+3 Periods**
Introduction - Machining fundamentals – Metal Cutting - Chip formation - types of chips – Chip breakers - Expression for Shear plane angle - Cutting force and velocity relationship - Ernst and Merchant Upper bound solution - Lee and Shaffer Lower bound solution - Oxley's thin shear zone model - Stress and Strain in the chip - Energy consideration in machining.		
UNIT– II	**OBLIQUE CUTTING**	**9+3 Periods**
Direction of Chip flow - Normal, Velocity and Effective Rake angles - Relationship between rake angles - Cutting ratio in oblique cutting - Shear angle and Velocity relationship - Stabler's rule.		
UNIT – III	**THERMAL ASPECTS AND CUTTING FLUIDS**	**9+3 Periods**
Heat distributions in machining - Experimental determination and Analytical calculation of Cutting tool temperature -Methods of Controlling Cutting Temperature - Cutting fluids - Effects of cutting fluid - Functions - Requirements -Types and Selection of Cutting Fluids.		
UNIT – IV	**CUTTING TOOL MATERIALS, TOOL LIFE AND TOOL WEAR**	**9+3 Periods**
Essential requirements of tool materials – Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, Indexable inserts Coated tools - Tool wear and Tool life - Machinability - Economics of metal machining - Theory of Chatter – ISO specifications for inserts and tool holders.		
UNIT – V	**DESIGN OF CUTTING TOOLS**	**9+3 Periods**
Geometry of single-point cutting tool: Tool-in hand system, ASA system, Significance of various angles of single point cutting tools, Orthogonal Rake System (ORS), Conversions between ASA and ORS systems – Graphical and Analytical Methods, Normal Rake System (NRS) & relation with ORS. Drill Geometry and Mechanics of Drilling Process, Geometry of Milling Cutters and Mechanics of Milling process, Mechanics of Grinding (plunge grinding and surface grinding), Grinding wheel wear.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES:

1	*A. Bhattacharyya, "**Metal Cutting Theory and Practice**", Central Book Publishers, Calcutta, 2012.*
2	*Geoffrey Boothroyd and W.A. Knight, **"Fundamentals of Machining and Machine Tools",** Marcel Dekkor, New York, 2006.*
3	*M C Shaw, "**Metal Cutting Principles**", Oxford Press, 2005.*
4	*B.LJuneja and G.S. Sekhon, **"Fundamentals of Metal Cutting and Machine Tools",** New Age International Publishers Limited, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the metal cutting theory in engineering materials and employ the various aspects in orthogonal cutting activities.	K3
CO2	Evaluate the oblique cutting principle in machinability and practice its various aspects.	K4
CO3	Select cutting fluids for different machining conditions	K3
CO4	Choose appropriate cutting tools and machining conditions for different materials.	K3
CO5	Design the cutting tools for metal removal process.	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	3
CO2	1	1	3	2	1
CO3	3	2	2	1	1
CO4	1	3	1	1	2
CO5	3	1	2	3	1
23MFPC01	3	1	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			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

23MFPC02	ADVANCES IN CASTING AND WELDING TECHNOLOGIES	I

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

Course Objectives	To acquire the metallurgical concepts during solidification of metals & alloys, special casting processes, metallurgical concepts during welding metallurgy, special welding processes, recent advances in casting and welding.	
UNIT – I	**CASTING METALLURGY AND DESIGN**	**9 Periods**
Heat Transfer Between Metal and Mould – Solidification of Pure Metal and Alloys – Shrinkage in Cast Metals – Progressive and Directional Solidification – Principles of Gating and Rising – Degasification of the Melt – Design Considerations in Casting – Designing for Directional Solidification and Minimum Stress – Casting Defects.		
UNIT – II	**SPECIAL CASTING PROCESSES**	**9 Periods**
Shell Molding – Precision Investment Casting – CO_2Molding – Centrifugal Casting – Die Casting – Continuous Casting.		
UNIT – III	**WELDING METALLURGY AND DESIGN**	**9 Periods**
Heat Affected Zone and its characteristics – Weldability of Steels, Cast Iron, Stainless Steel, Aluminium and Titanium Alloys – Hydrogen Embrittlement – Lamellar Tearing – Residual Stress – Heat transfer and Solidification – Analysis of Stress in Welded Structures – Pre and Post Welding Heat Treatments – Weld Joint Design – Welding Defects – Testing of Weldment.		
UNIT – IV	**UNCONVENTIONAL AND SPECIAL WELDING PROCESSES**	**9 Periods**
Friction Welding –Friction Stir Welding-Friction Stir Processing-Explosive Welding – Diffusion Bonding – High Frequency Induction Welding – Ultrasonic Welding – Electron Beam Welding – Laser Beam Welding.		
UNIT – V	**RECENT ADVANCES IN CASTING AND WELDING**	**9 Periods**
Layout of Mechanized Foundry – Sand Reclamation – Material Handling in Foundry – Pollution Control in Foundry – Recent Trends in Casting – Computer Aided Design of Castings, Low Pressure Die Casting, Squeeze Casting and Full Mould Casting Process – Automation in Welding – Welding Robots – Overview of Automation of Welding in Aerospace, Nuclear, Surface Transport Vehicles and Under Water Welding.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, "**Principles of Metal Casting**", McGraw Hill Education, 2014.*
2	*Ghosh, Ghosh Amitabha, Mallik AsokKumar, "**Manufacturing Science**", EAST WEST, 2010.*
3	*Chakrabarti A K, "**Casting technology and casting alloys**", PHI Publishing Co, New Delhi, 2015.*
4	*P.N.Rao, "**Manufacturing Technology (Foundry, Forming and Welding)**", 2nd Edition, Tata McGraw Hill Pub.Co. Ltd, 2004.*
5	*R S Parmar, "**Welding Processes and Technology**", Khanna Publications, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply the Thermal, Metallurgical aspects during solidification in Casting.	K2
CO2	Apply on special casting process for specific applications.	K3
CO3	Analyze the metallurgical aspects during solidification in welding.	K3
CO4	Relate the Unconventional and Special Welding processes for Industrial production of components.	K3
CO5	Evaluate the recent advances in Casting and Welding in Industrial applications.	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	1	3
CO2	3	2	3	2	1
CO3	2	1	2	2	3
CO4	3	2	1	2	1
CO5	1	3	1	2	2
23MFPC02	2	2	2	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 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			100				100
ESE		50	50				100

23MFPC03	CORROSION AND SURFACE ENGINEERING	I

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

Course Objectives	To understand the different types of corrosion on engineering structures and testing and prevention of corrosion.	
UNIT – I	**MECHANISMS AND TYPES OF CORROSION**	**(9+3 Periods)**
Principles of direct and Electro Chemical Corrosion, Hydrogen evolution and Oxygen absorption mechanisms – Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitation's, Crevice Fretting, Erosion and Stress Corrosion – Factors influencing corrosion		
UNIT – II	**TESTING AND PREVENTION OF CORROSION**	**(9+3 Periods)**
Corrosion testing techniques and procedures – Prevention of Corrosion – Design against corrosion –Modifications of corrosive environment – Inhibitors – Catholic Protection – Protective surface coatings.		
UNIT – III	**CORROSION BEHAVIOR OF MATERIALS**	**(9+3 Periods)**
Corrosion of steels, stainless steel, Aluminum alloys, copper alloys, Nickel and Titanium alloys corrosion of Polymers, Ceramics and Composite materials.		
UNIT – IV	**SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE**	**(9+3 Periods)**
Diffusion coatings – Electro and Electro less Plating – Hot dip coating – Hard facing, Metal spraying, Flame and Arc processes – Conversion coating – Selection of coating for wear and Corrosion resistance.		
UNIT – V	**THIN LAYER ENGINEERING PROCESSES**	**(9+3 Periods)**
Laser and Electron Beam hardening – Effect of process variables such as power and scan speed – Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating – Chemical vapor deposition – Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating – Properties and applications of thin coatings.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES:

1	*Ken N. Strafford,* **"Surface Engineering: Processes and Applications",** *A Technomic Publication, Lanchester, Pennsylvania, 2018.*
2	*P. A. Dearnley,* ***"Surface Engineering Basics",*** *Published online by Cambridge University Press, 2017.*
3	*J. DuttaMajumdar; I. Manna,"****Laser Surface Engineering of Titanium and Its Alloys for Improved Wear, Corrosion and High-Temperature Oxidation Resistance****", Indian Institute of Technology, Kharagpur, India, 2015.*
4	*Andrew W Batchelor, MargamChandrasekaran Material,* ***"Degradation and Its Control by Surface Engineering",*** *Bio-Scaffold International Pvt, Ltd, Singapore, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the mechanisms and types of corrosion	K1
CO2	Analyze the corrosion and know the prevention of corrosion	K1
CO3	Select the type of corrosion in the different materials and its behavior	K3
CO4	Evaluate the surface coating for wear and corrosion resistance	K3
CO5	Apply thin layer engineering processes for engineering materials	K3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	2	2
CO2	1	1	2	2	2
CO3	1	1	2	2	3
CO4	1	1	2	3	3
CO5	1	2	2	3	3
23MFPC03	1	1	2	1	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	100						100
CAT2			100				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	100						100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			100				100
ESE	50		50				100

23MFPC04	PROCESS MODELING AND SIMULATION LABORATORY	I

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

Course Objectives	To give an overview of various methods of process modeling and different computational techniques for simulation.

List of Exercises:

1. Model and simulate the Coupling Joint used in Railway Passenger Coaches
2. Model and simulate the Impeller Assembly
3. Model and simulate the Stapler Assembly
4. Model and simulate the Oldham's Coupling
5. Model and analyse the Crane Hook
6. Model and analyse the 3D Printed Components
7. Conduct stress analysis of Axis Symmetric Components using ANSYS
8. Conduct dynamic analysis of Mechanical Engineering Components
9. Make CNC Turning and Milling simulations

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	Apply the concept of modeling and simulation techniques for different mechanical joints	K3
CO2	Apply the techniques in model and simulation for manufacturing assembly	K3
CO3	Analyze structural problems for mechanical engineering components	K4
CO4	Analyze dynamic problems for mechanical engineering components	K4
CO5	Apply the knowledge in the simulation practices in CNC machining	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	1	1
CO2	2	3	2	1	1
CO3	2	3	3	1	1
CO4	3	3	2	1	1
CO5	2	3	2	1	1
23MFPC04	2	3	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

23MFPC05	OPTIMIZATION TECHNIQUES IN MANUFACTURING	II

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

Course Objectives	1. To impart knowledge on theory of optimization and conditions for optimality for unconstrained and constrained optimization problems. 2. To inculcate modeling skills necessary to describe and formulate optimization problems in design and manufacturing. 3. To familiarize with the working principle of optimization algorithms used to solve linear and non–linear problems. 4. To know the basics of non linear programming and integer programming techniques to solve Engineering problems. 5. To understand and differentiate traditional and non–traditional methods of Optimization.	
UNIT – I	**EVOLUTION OF OPTIMIZATION**	**9+3 Periods**
Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – Classification of optimization problems.		
UNIT – II	**CLASSIC OPTIMIZATION TECHNIQUES**	**9+3 Periods**
Linear programming – Graphical method – Simplex method – Dual simplex method – Revised simplex method – Duality in LP – Parametric Linear programming – Goal Programming.		
UNIT – III	**NON–LINEAR PROGRAMMING**	**9+3 Periods**
Introduction – Lagrangian Method – Kuhn–Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming		
UNIT – IV	**INTEGERPROGRAMMING, AND DYNAMIC PROGRAMMING NETWORK TECHNIQUES**	**9+3 Periods**
Integer programming – Cutting plane algorithm, Branch and bound technique, Zero–one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.		
UNIT – V	**ADVANCES IN SIMULATION**	**9+3 Periods**
Genetic algorithms – Simulated annealing – Neural Network, Fuzzy systems and Particle swam optimization– Data Analytics and optimization using Machine learning approach		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES:

1	*R. Panneerselvam,* ***Operations Research****, Prentice Hall of India Private Limited, New Delhi L, 2019.*
2	*P.K. Guptha and Man–Mohan,* ***Problems in Operations Research****, Sultan Chand & Sons, 2014.*
3	*Ravindran, Philips and Solberg,* ***Operations Research Principles and Practice****, John Wiley & Sons, Singapore, 2017.*
4	*J.K.Sharma,* ***Operations Research – Theory and Applications*** *, Macmillan India Ltd., 2017.*
5	*Hamdy A. Taha* ***Operations Research – An Introduction****, Pearson Education Ltd., 2017.*
6	*https://nptel.ac.in/courses/106106139*
7	*https://nptel.ac.in/courses/111105039*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply basic theoretical principles in optimization and formulate the optimization models.	**K3**
CO2	Implement optimization techniques in engineering problems.	**K4**
CO3	Solve the constraints for optimal solution to interface in industrial scenario.	**K4**
CO4	Interpret and apply modern heuristic algorithms for solving optimization problems.	**K3**
CO5	Understand and apply different evolutionary algorithms for solving engineering problems.	**K2**

COURSE ARTICULATION MATRIX:

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	1	3	1
CO2	3	2	2	3	2
CO3	3	1	1	2	3
CO4	1	1	2	3	1
CO5	1	2	2	2	1
23MFPC05	2	2	2	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			50	50			100
CAT2		30	40	30			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			50	50			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	50	20			100
ESE		20	40	40			100

23MFPC06	MATERIAL TESTING AND CHARACTERIZATION	II

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

Course Objectives	1. To make them acquainted with microscopic techniques to analyse crystal structures. 2. To acquire an understanding on the electron microscopic techniques for characterization. 3. To familiarize with a fundamental knowledge on chemical and thermal analysis. 4. To enable students to widen knowledge on various static methods to characterize materials. 5. To study the failure of materials under dynamic stresses.	
UNIT – I	**MICRO AND CRYSTAL STRUCTURE ANALYSIS**	**9+3 Periods**
Principles of Optical Microscopy –Polishing and Etching – Polarization Techniques – Quantitative Metallography – grain size and ASTM number – Microstructure of Engineering Materials – Crystallography – X– ray Diffraction– Geiger Diffractometer – Analysis of patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction – Estimation of residual stress and grain size.		
UNIT – II	**ELECTRON MICROSCOPY**	**9+3 Periods**
Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF – SAD – Electron Probe Microanalysis – Scanning. Electron Microscopy –Atomic Force Microscopy– Construction &Applications.		
UNIT – III	**CHEMICAL AND THERMAL ANALYSIS**	**9+3 Periods**
X–Ray Spectrometry– Energy dispersive and Wave Dispersive X–Ray Spectrometry– Auger Spectroscopy– Secondary Ion Mass Spectroscopy– Fourier Transform Infra–Red Spectroscopy (FTIR)– Proton Induced X–Ray Emission Spectroscopy– Differential Thermal Analysis– Differential Scanning Calorimetry (DSC)– Thermo Gravity metric Analysis (TGA)– Dynamic Mechanical Analysis (DMA)		
UNIT – IV	**MECHANICAL TESTING – STATIC TESTS**	**9+3 Periods**
Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test, Rebound hardness and Indendation – Tensile Test – Stress-Strain plot, Proof Stress – Torsion Test – Ductility Measurement – Impact Test – Charpy and Izod – DWTT – Fracture Toughness Test–Codes and standards for testing metallic and composite materials.		
UNIT – V	**MECHANICAL TESTING – DYNAMIC TESTS**	**9+3 Periods**
Fatigue – Low and High Cycle Fatigues – Rotating Beam and Plate Bending HCF tests – S–N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests–modal analysis – Applications of Dynamic Tests – Fatigue life estimation.		
Contact Periods: **Lecture: 45 Periods Tutorial : 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES:

1	*Cullity B.D., Stock S.R and Stock S.,* ***Elements of X ray Diffraction,*** *3rdEdition. Prentice Hall, 2018.*
2	*Skoog, Holler and Nieman,* ***Principles of Instrumental Analysis****, 7th edition, Cengage Learning, 2017.*
3	*Angelo P C,* ***Material characterization****, Cengage Learning India, 2016.*

4	*Yang Leng,* ***Materials Characterization: Introduction to Microscopic and Spectroscopic Methods****, Hong Kong University Of Science And Technology, John Wiley and Sons (Asia) Pte Ltd., 2nd Edition, 2013.*
5	*Suryanarayana A. V. K.,* ***Testing of metallic materials*** *, BSP Books Private Limited publications, 2 nd Edition, 2018.*
6	*https://nptel.ac.in/courses/115103030*
7	*https://nptel.ac.in/courses/113105101*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the test and quantify the mechanical properties of Engineering Materials.	**K2**
CO2	Characterize the microstructure of various materials and apply to various applications.	**K3**
CO3	Perform Chemical and Thermal Analysis on Engineering Materials	**K3**
CO4	Analyze the behavior of various materials under static and dynamic condition.	**K4**
CO5	Characterize novel engineering materials using standard tests.	**K3**

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	3	1
CO2	3	3	2	2	2
CO3	3	2	2	2	1
CO4	2	3	3	1	1
CO5	2	1	2	3	1
23MFPC05	2	3	2	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		30	40	30			100
CAT2			50	50			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	40	30			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			50	50			100
ESE		20	40	40			100

23MFPC07	INDUSTRIAL AUTOMATION	II

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

Course Objectives	1. To familiarize with the concepts of robot manipulator and build confidence to choose, evaluate and incorporate robots in engineering systems. 2. To inculcate the significance of simple sensor systems in automation. 3. To understand the basic concept of automation and the Programmable logic controllers. 4. To acquire knowledge on supervisory control and data acquisition system. 5. To gain knowledge about distributed control system.	
UNIT – I	**AUTOMATION COMPONENTS**	**9 Periods**
Sensors for temperature – pressure – force – displacement – speed – flow– level – humidity and pH measurement. Actuators – process control valves – power electronic drives DIAC– TRIAC – power MOSFET – IGBT– Introduction to DC and AC servo drives for motion control		
UNIT – II	**ROBOTS AND CONTROLS**	**9 Periods**
Controlling the robot motion–Position and velocity sensing devices–Design of drive systems–Hydraulic and Pneumatic drives–Linear and rotary actuators and control valves–Electro hydraulic servo valves, electric drives– Motors–designing of end effectors–Vacuum, magnetic and air operated grippers.		
UNIT – III	**PROGRAMMABLE LOGIC CONTROLLERS**	**9 Periods**
PLC Hardware – PLC programming – Ladder diagram – Sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.		
UNIT – IV	**SCADA**	**9 Periods**
Introduction – Supervisory Control and Data Acquisition Systems (SCADA) – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software		
UNIT – V	**DISTRIBUTED CONTROL SYSTEM (DCS)**	**9 Periods**
Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers– Case studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Cameron Hughes, Trarey Hughes,* ***Robot Programming****, Pearson, 5th Edition., 2016.*
2	*Groover, M.P.* ***Industrial Robotics – Technology, Programming and Applications****, McGraw–Hill, 2012.*
3	*Frank D. Petruzella,* ***Programmable Logic Controllers****, 5th Edition, McGraw Hill, 2016.*
4	*M. P. Lukcas, Distributed Control Systems, Van Nostrand Reinhold Co., 1986.*
5	*W. Bolton, Mechatronics, 5th edition, Addison Wesley Longman Ltd, 2010*
6	*https://nptel.ac.in/courses/108105063*
7	*https://archive.nptel.ac.in/courses/108/106/108106022/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain automation components and systems application.	K2
CO2	Appreciate the importance of robot in the emerging trend of manufacturing and to select and design robots for various applications taking kinematic aspects and precision into account	K3
CO3	Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications	K3
CO4	Describe the basics of SCADA technology	K2
CO5	Illustrate the functionary components and supervisory control of DCS with relevant diagrams	K2

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	3	2	3
CO2	3	2	3	2	1
CO3	2	1	2	2	3
CO4	3	2	1	2	1
CO5	1	3	1	3	2
23MFPC07	3	2	2	3	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		60	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		60	40				100
ESE		60	40				100

23MFPC08	MODERN MANUFACTURING ENGINEERING LABORATORY	II

PRE–REQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	1. To familiarize the students with extrusion based additive manufacturing 2. To acquaint the students with nontraditional machining processes. 3. To introduce the application of 3D scanners and 3D printing in reverse engineering. 4. To familiarize with the process capabilities of Friction Stir Welding and Stir Casting.

List of Exercises

1. Study on 3D printing technologies, and its impacts on manufacturing industries.
2. Study on commercially available slicing software and its challenges involved.
3. Make a 3D model using PLA filament and evaluate the printed properties.
4. Make a 3D model using TPU blended with PLA filament and evaluate the printed properties.
5. Make a 3D model using Bio–polymer filaments and evaluate the printed properties.
6. Make a 3D model using SLS and evaluate its properties.
7. Evaluate the performance characteristics of ECDM of Ceramics.
8. Scan any commercially available engineering components using high resolution 3D scanners and make a product using available 3D printing technique.
9. Determine the tribological characteristics of the given 3D Printed specimens.
10. Prepare the composites samples using stir casting/squeeze casting and evaluate their mechanical properties.
11. Develop a water hammer setup and evaluate the product formability.
12. Conduct images analysis of 3D printed products using metallurgical microscope and SEM.
13. Study on joining of dissimilar materials using Friction Stir Welding.

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	Create 3D printed models and evaluate their characteristics	K6
CO2	Analyze the characteristics of ECDM	K4
CO3	Develop and analyze new composite materials for modern engineering applications.	K6
CO4	Evaluate the tribological characteristics of mechanical products	K5
CO5	Understand the dissimilar materials joining using Friction Stir Welding	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	1	1
CO2	3	2	3	1	1
CO3	2	3	3	3	2
CO4	3	2	3	2	2
CO5	2	2	2	1	1
23MFPC08	3	3	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

23MFEE01	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 manufacturing engineering and then apply Engineering knowledge to provide feasible solutions.

SYLLABUS

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

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.	K5
CO2	Solve a live problem using software/analytical/computational tools.	K6
CO3	Learn to write technical reports.	K3
CO4	Develop skills to present and defend their work in front of technically qualified audience.	K4
CO5	Able to do 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
23MFEE01	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

23MFEE02	INDUSTRIAL TRAINING AND PRACTICES	III

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

Course Objectives	1. To make students industry ready to become an entrepreneur or an effective administrator. 2. To acquire the knowledge about industrial scenario.

LIST OF EXPERIMENTS

1. Conduct literature survey on selected technical domain. (Minimum 20 literatures to be reviewed) and prepare a survey report.
2. Visit any two industry and prepare a technical report about the visit
3. Conduct market survey and prepare report on any selected product by meeting the customers / retailers using any methods. (Questionnaire, Audio / Video recording etc.)
4. Assess the risk involved in any industries. (Existing risk or upcoming risk in the market).
5. Perform process planning and estimate the cost of production for a product.
6. Design an alternate mechanism for an existing product to perform the same function or a function in addition to the existing function.
7. Perform tolerance analysis in production and assembly drawings.

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.	K1
CO2	Write technical report about any industrial activity.	K4
CO3	Perform market survey and risk assessment to find an area of scope in the market.	K5
CO4	Innovate new mechanism design and estimate cost for a product or process.	K6
CO5	Read Engineering drawings and analyze tolerances.	K4

COURSE ARTICULATION MATRIX:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	1	1
CO2	1	3	2	1	1
CO3	2	1	1	2	1
CO4	2	1	3	1	2
CO5	1	2	3	1	1
23MFEE02	2	2	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

23MFEE03	PROJECT - I	III

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

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.

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	Identify the project work/research gap scientifically in a systematic way.	K1
CO2	Analyze the problem and data of literatures clearly to explore the ideas and methods.	K4
CO3	Formulate the objectives and methodology to solve the identified problem.	K5

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	2	2	3	2	2
CO3	3	2	3	3	1
23MFEE03	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

23MFEE04	PROJECT - II	IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	48	24

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	
Lecture: 0 Periods Tutorial: 0 Periods Practical: 720 Periods Total:720 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.	K4
CO2	Investigate the findings and infer observations logically.	K5
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	2	2	3
CO3	2	3	3	3	3
23MFEE04	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial					

23MFPE01	DIGITAL MANUFACTURING	SEMESTER

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

Course Objectives	To gain knowledge in concepts of rapid product development, various software tools, processes, techniques of additive manufacturing, industry 4.0, IoT, cloud computing and data analytics.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Rapid Product Development (RPD) – Product Development Cycle – Detail Design– Prototype and Tooling Principle of AM Technologies and Their Classification of AM Systems–Selection of AM Process; Issues in AM – IOT.		
UNIT – II	**ADDITIVE MANUFACTURING (AM)**	**9 Periods**
Stereo Lithography Systems – Fusion Deposition Modeling – Laminated Object Manufacturing – Selective Laser Sintering - Direct Metal Laser Sintering (DMLS) - Three Dimensional Printing - Reverse Engineering - Engineering Applications – 4D Printing – Medical Applications – Principle – Process Parameters – Process Details – Applications – Case Study.		
UNIT – III	**PROCESSING POLYHEDRAL DATA**	**9 Periods**
Polyhedral B-Rep Modeling–STL Format – Defects and Repair of STL Files– Processing STL Files – Overview of the Algorithms Required for RP and RT - Slicing, Support Generation, Feature Recognition.		
UNIT – IV	**ADDITIVE TOOLING (AT)**	**9 Periods**
Introduction to AT –Indirect AT Processes – Silicon Rubber Molding, Epoxy Tooling, Spray Metal Tooling and Investment Casting Direct AT Processes – Laminated Tooling, Powder Metallurgy Based Technologies, Welding Based Technologies, Direct Pattern Making (Quick Cast, Full Mold Casting); Emerging Trends in AT.		
UNIT – V	**INDUSTRY 4.O**	**9 Periods**
Digitalization and the Networked Economy - Introduction to Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Internet of Things (IoT) - Industrial Internet of Things (IoT) - Smart Devices and Products - Smart Logistics - Support System for Industry 4.0 – Cyber- Physical Systems Requirements - Data as a New Resource for Organizations - Cloud Computing - Trends of Industrial Big Data and Predictive Analytics for Smart Business-Architecture of Industry 4.0.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Kaushik Kumar Divya Zindani, J.Paulo Davim., "**Digital Manufacturing and Assembly Systems in Industry 4.0"**, CRC Press, 2022.*
2	*Chee Kai & K F Leong "**3D Printing and Additive Manufacturing - Principles and Applications"**, 5th EditionBSP Publishers, 2019.*
3	*Kaushik Kumar, Divya Zindani, J.Paulo Davim., "**Additive Manufacturing Technologies From an Optimization Perspective**", IGI Global. 2019.*
4	*Alp Ustundag, Emre Cevikcan, **"Industry 4.0: Managing The Digital Transformation"**, Springer, 2018.*

5	*Alasdair Gilchrist, **"Industry 4.0: The Industrial Internet of Things"**, A Press, 2016.*
6	*Gibson, I, Rosen, D.W., Stucker, B., "**Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing"**, 2nd Edition, Springer, 2015.*

COURSE OUTCOMES: Upon Completion of the Course, the Students will be Able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Concept of Liquid, Solid and Powder Based Rapid Prototyping Techniques for Rapid Product Development.	K3
CO2	Apply the Rapid Tooling and Software for Rapid Manufacturing to Meet International Needs.	K3
CO3	Select Appropriate Process for Production of a Part/Component that Meet International Standards of Quality and Time Constraints	K3
CO4	To Demonstrate the Basic Technical Understanding of the Physical Principles, Materials, and Operation of the Types of AM Processes.	K4
CO5	Realize the Need of Industry 4.0 and it's Inter- Connectivity.	K2

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	1	1	2	2	1
CO3	2	2	2	1	1
CO4	2	1	2	2	2
CO5	1	2	1	2	3
23MFPE01	1	2	2	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			100				100
CAT2			50	50			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			100				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			50	50			100
ESE			50	50			100

23MFPE02	ADVANCES IN METROLOGY AND MEASUREMENTS	SEMESTER

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

Course Objectives	To gain knowledge in the methods of measurement, selection of measuring instruments, standards of measurement, various measuring instruments, accurate and precise measurement of a given quantity.	
UNIT – I	**LASER METROLOGY**	**9 Periods**
Introduction – Types of Lasers – Laser in Engineering Metrology – Metrological Laser Methods for Applications in Machine Systems – Interferometer Applications – Speckle Interferometer – Laser Interferometers in Manufacturing and Machine Tool Alignment Testing – Calibration Systems for Industrial Robot's Laser Doppler Technique – Laser Doppler Anemometry.		
UNIT – II	**MEASUREMENT OF SURFACE FINISH AND MEASURING MACHINES**	**9 Periods**
Definitions – Types of Surface Texture: Surface Roughness Measurement Methods– Comparison, Profilometer, 3D Surface Roughness Measurement – Instruments.		
UNIT – III	**CO-ORDINATE MEASURING MACHINE**	**9 Periods**
Co-Ordinate Metrology – CMM Configurations – Hardware Components – Software – Probe Sensors – Displacement Devices – Performance Evaluations – Software – Hardware – Dynamic Errors – Thermal Effects Diagram – Temperature Variations Environment Control – Applications.		
UNIT – IV	**OPTO ELECTRONICS AND VISION SYSTEM**	**9 Periods**
Optoelectronic Devices – CCD – On-Line and In-Process Monitoring in Production –Applications Image Analysis and Computer Vision – Image Analysis Techniques – Spatial Feature – Image Extraction – Segmentation – Digital Image Processing – Vision System for Measurement – Comparison Laser Scanning with Vision System.		
UNIT – V	**QUALITY IN MANUFACTURING ENGINEERING**	**9 Periods**
Importance of Manufacturing Planning for Quality – Concepts of Controllability – Need or Quality Management System and Models – Quality Engineering Tools and Techniques – Statistical Process Control – Six Sigma Concepts – Poka Yoke – Computer Controlled Systems Used in Inspection.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*N.V. Raghavendra, L. Krishnamurthy, "**Engineering Metrology and Measurements**", Oxford University Press, USA, 2013.*
2	*Brian cantor, "**Automotive Engineering: Light Weight, Functional and Novel Materials**", Taylor and Francis, 2010.*
3	*S. K. Singh, "**Industrial Instrumentation and Control**", 3rd Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2009.*
4	*B.C. Nakra and K.K. Choudhary, "**Instrumentation measurement and analysis**", 3rd Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2009.*
5	*A.K. Sawhney and Puneet Sawhney, "**Mechanical Measurement and Instrumentation and Control**", 12th Edition, Dhanpat Rai& Co, 2009.*
6	*Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard V, "**Mechanical Measurements"** 6th Edition, by, Published by Addison Wesley, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply principle of metrology in working of various measuring instruments.	K2
CO2	Select the different measuring in the manufacturing inspection	K3
CO3	Use the different measuring instruments to measure the qualitative and quantitative characteristics of components.	K2
CO4	Analyze the data statistically	K3
CO5	Evaluate the data and decision to be taken for controlling the quality complying with international standards.	K3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	1	2	1
CO2	1	2	2	2	1
CO3	1	2	3	2	1
CO4	2	1	1	2	1
CO5	1	2	3	2	2
23MFPE02	1	2	2	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		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

23MFPE03	INDUSTRY 4.0 AND IoT	SEMESTER

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

Course Objectives	To introduce and familiarize the industry 4.0 physical structure, interconnectivity, architecture, IoT, cloud computing, data analytics, concepts of integrated IoT, cloud computing and data analytics.	
UNIT – I	**INDUSTRY 4.0**	**9 Periods**
Digitalization and the Networked Economy –Introduction to Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory –Internet of Things (IoT) –Industrial Internet of Things (IoT) –Smart Devices and Products –Smart Logistics –Support System for Industry 4.0 –Cloud Computing –Trends of Industrial Big Data and Predictive Analytics for Smart Business – Architecture of Industry 4.0.		
UNIT – II	**IoT AND ITS PROTOCOLS**	**9 Periods**
Definitions and Functional Requirements – Motivation – Architecture - Web 3.0 View of IoT – Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT – Communication Middleware for IoT – IoT Information Security. IoT Reference Architecture - Unified Data Standards – Protocols – IEEE 802.15.4 – BAC Net Protocol – Modbus –KNX – Zigbee Architecture – Network Layer APS Layer – Security.		
UNIT – III	**CLOUD COMPUTING**	**9 Periods**
Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT – Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems – Mobile Cloud Computing – The Cloud of Things Architecture and Data Analytics.		
UNIT – IV	**INTEGRATED IoT**	**9 Periods**
Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things – Network Dynamics: Population Models – Information Cascades – Network Effects - Network Dynamics: Structural Models – Cascading Behavior in Networks – The Small–World Phenomenon.		
UNIT – V	**APPLICATIONS**	**9 Periods**
The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments – Resource Management in the Internet of Things: Clustering, Synchronization and Software Agents–Industry 4.0 in Car Manufacturing – Electronics Manufacturing – IOT Based Building Automation –Agricultural Automation.		
Contact Periods: **Lecture 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Kiran Kumar Pabbathi, **"Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0"**, Create space Independent Publishing Platform, 2018.*
2	*Alasdair Gilchrist, **"Industry 4.0: The Industrial Internet of Things"**, A Press, 2016.*
3	*Natalie Enright Jerger and Li ShiuanPeh, **"On-Chip Networks, Synthesis Lectures on Computer Architecture"**, Morgan and Claypool Publishers, 2009.*
4	*Duato J, Yalamanchili S, and Lionel Ni, **"Interconnection Networks: An Engineering Approach"**, Morgan Kaufmann Publishers, 2004.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Realize the need of industry 4.0 and its inter-connectivity.	K4
CO2	Interpret the architecture of IoT and its protocols	K4
CO3	Recognize the uses of cloud computing and data analytics	K4
CO4	Familiar the concepts of integrated IoT.	K4
CO5	Plan the uses of IoT, cloud computing, data analytics and Industry 4.0 technologies.	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	1
CO2	1	2	2	1	2
CO3	1	2	1	2	3
CO4	1	1	2	1	3
CO5	2	2	3	2	2
23MFPE03	1	2	2	1	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				100			100
CAT2				100			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1				100			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2				100			100
ESE				100			100

23MFPE04	ADVANCED ENGINEERING MATERIALS AND METALLURGY	SEMESTER

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

Course Objectives	To Gain the Concepts, Fracture Behavior, selection of modern metallic materials and non - metallic materials.	
UNIT – I	**ELASTIC AND PLASTIC BEHAVIOR**	**9 Periods**
Elasticity in Metals and Polymers An Elastic and Visco- Elastic Behavior – Mechanism of Plastic Deformation and Non- Metallic Shear Strength of Perfect and Real Crystals – Strengthening Mechanisms, Work Hardening, Solid Solutioning, Grain Boundary Strengthening, Poly Phase Mixture, Precipitation, Particle, Fiber and Dispersion Strengthening. Effect of Temperature, Strain and Strain Rate on Plastic Behavior – Super Plasticity – Deformation of Non – Crystalline Materials.		
UNIT – II	**FRACTURE BEHAVIOUR**	**9 Periods**
Griffith's theory, Stress Intensity Factor and Fracture Toughness – Toughening Mechanisms – Ductile, Brittle Transition in Steel – High Temperature Fracture, Creep –Larson Miller Parameter – Deformation and Fracture Mechanism Maps – Fatigue, Low and High Cycle Fatigue Test, Crack Initiation and Propagation Mechanisms and Paris Law Effect of Surface and Metallurgical Parameters on Fatigue – Fracture of Non - Metallic Materials – Failure Analysis, Sources of Failure, Procedure of Failure Analysis.		
UNIT – III	**SELECTION OF MATERIALS**	**9 Periods**
Motivation for Selection, Cost Basis and Service Requirements – Selection for Mechanical Properties,Strength, Toughness, Fatigue and Creep – Selection for Surface Durability Corrosion and Wear Resistance – Relationship Between Materials Selection and Processing – Case Studies in Materials Selection With Relevance to Aero, Auto, Marine, Machinery and Nuclear Applications – Computer Aided Materials Selection.		
UNIT – IV	**MODERN METALLIC MATERIALS**	**9 Periods**
Dual Phase Steels, High Strength Low Alloy (HSLA) Steel, Transformation Induced Plasticity (TRIP) Steel, Maraging Steel, Nitrogen Steel – Intermetallics, Ni and Ti-Aluminides – Smart Materials, Shape Memory Alloys – Metallic Glass and Nano Crystalline Materials.		
UNIT – V	**NON - METALLIC MATERIALS**	**9 Periods**
Bio Materials – Polymeric Materials – Formation of Polymer Structure – Production Techniques of Fibers, Foams, Adhesives and Coating – Structure, Properties and Applications of Engineering Polymers – Advanced Structural Ceramics, WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and Diamond – Properties, Processing and Applications.		
Contact Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

REFERENCES:

1	*Pravin Kumar,* ***"Basic Mechanical Engineering",*** *Pearson Education; 2nd Edition. 2018.*
2	*Yongchang Liu, Yingquan Peng,* ***"Advanced Material Engineering - Proceedings Of The 2015 International Conference",*** *World Scientific Publishing Co Pt Ltd, 2015.*
3	*R. Balasubramaniam, Callister's,* ***"Materials Science and Engineering",*** *Wiley; 2nd Edition 2014.*
4	*Datta B.K,* ***"Powder Metallurgy: An Advanced Technique of Processing Engineering Materials",*** *Prentice Hall India Learning Private Limited; 2nd edition 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the Concepts of Material Behavior for Specific Applications.	K3
CO2	Identify the Performance Requirements of a Desired Material for a Specific Engineering Application.	K2
CO3	Select Modern Materials for Automotive and Aerospace Applications.	K2
CO4	Identify and Describe Different Types of Material Processing Techniques for Advanced Materials	K3
CO5	Ability to Select Suitable Material for Specific Applications	K2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	1	3
CO2	1	1	2	1	1
CO3	2	1	2	1	2
CO4	2	1	2	1	3
CO5	1	2	2	1	3
23MFPE04	1	2	2	1	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		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

23MFPE05	ADVANCED FINITE ELEMENT METHODS	SEMESTER

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

Course Objectives	To introduce non- linear computational methods to solve problems in solids & structure, basic principles of finite element analysis procedure, solutions to structural, thermal, dynamic and formulation methods in FEM.	
UNIT – I	**MATHEMATICAL MODELS**	**9 Periods**
Modeling and Discretization – Interpolation, Elements, Nodes and degrees-of-freedom. Computational Procedures–Stiffness Matrices – Boundary Conditions–Solution of Equations Ritz Method, Variation Method, Method of Weighted residuals		
UNIT – II	**BASIC ELEMENTS**	**9 Periods**
Interpolation and Shape Functions – Element Matrices – Linear Triangular Elements (CST) – Quadratic Triangular Elements – Bilinear Rectangular Elements – Quadratic Rectangular Elements –Solid Elements – Higher Order Elements – Nodal Loads-Stress Calculations – Example Problems.		
UNIT – III	**ISOPARAMETRIC ELEMENTS**	**9 Periods**
Introduction– Bilinear Quadrilateral Elements – Quadratic Quadrilaterals – Hexahedral Elements – Determination of Shape Functions – Numerical Integration – Quadrature – Static Condensation – Load Considerations – Stress Calculations – Examples Of 2D and 3D Applications.		
UNIT – IV	**FINITE ELEMENT FORMULATION FOR STRUCTURAL APPLICATIONS**	**9 Periods**
Linear Elastic Stress Analysis –2D, 3D and Ax Symmetric Problems – Analysis of Structural Vibration – Mass And Damping Matrices – Damping – Harmonic Response – Direct Integration Techniques – Explicit And Implicit Methods.		
UNIT – V	**HEAT TRANSFER AND FLUID MECHANICS APPLICATIONS**	**9 Periods**
Nonlinear Problems – Element Formulation – Heat Conduction, Fluid flow, etc–Transient Thermal Analysis–Acoustic Frequencies and Modes- Incompressible and Rotational Flows.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Gilbert Strang & George Fix*, ***"An Analysis of the Finite Element Method"****, Wellesley-Cambridge Press,2018.*
2	*W.B. Bickford,* ***"Advanced Mechanics of Materials"****, Pearson; 1st Edition, 2015*
3	*Thomas Apel, "****Advanced Finite Element Methods and Applications****", Springer; 2013th edition 2014.*
4	*R. D. Cook & W. C. Young,* ***"Advanced Mechanics of Materials"****, Pearson; 2nd edition, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply numerical solutions to elasticity and possibly heat transfer problems using the finite element method.	**K2**
CO2	Describe Energy Theorems and their implementation in the finite element setting	**K2**
CO3	Evaluate approximations associated with the finite element method	**K3**
CO4	Apply convergence requirements and associated modeling techniques and methods.	**K4**
CO5	Select appropriate elements and analysis types given a physical system.	**K4**

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	1	3
CO2	1	2	1	3	3
CO3	1	1	3	2	2
CO4	1	2	2	3	1
CO5	1	1	2	2	3
23MFPE05	1	2	2	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		100					100
CAT2			50	50			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		100					100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			50	50			100
ESE		50	25	25			100

23MFPE06	WEAR ANALYSIS AND CONTROL	SEMESTER

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

Course Objectives	Upon completion of this course, the students will be able; 1. To acquire knowledge on wear and its types. 2. To familiar with parameters of surface roughness and wear measurements. 3. To observe and identify wear in lubricated contacts. 4. To formulate the diagnosis and mitigation of wear. 5. To understand the nature of wear in mechanical components.	
UNIT–I	**INTRODUCTION TO WEAR**	**9 Periods**
Types of wear, Adhesive wear, two-body and three-body abrasive wear, erosive wear, cavitations wear, wear due to surface fatigue – Chemical reaction.		
UNIT– II	**SURFACE ROUGHNESS AND WEAR MEASUREMENTS**	**9 Periods**
Tribo systems and tribo-elements, Characteristics of surface layers, Roughness parameters, Multi scale characterization of surface topography, Surface roughness measurement using pin-on-ring (POR) and pin-on-disc (POD) machines, Advanced techniques for surface topography evaluation, Contact of ideally smooth surfaces, contact of rough surfaces.		
UNIT– III	**WEAR IN LUBRICATED CONTACTS**	**9 Periods**
Rheological lubrication regime, Functional lubrication regime, Fractional film defect, Load sharing in lubricated contacts, Adhesive wear equation, Fatigue wear equation, Numerical example		
UNIT– IV	**DIAGNOSIS AND CONTROL OF WEAR**	**9 Periods**
Diagnosis of wear mechanisms using optical microscopy and scanning electron microscopy, Wear resistant materials, wear resistant coatings, eco-friendly coatings designing for wear, systematic wear analysis, wear coefficients, filtration for wear control.		
UNIT– V	**WEAR IN MECHANICAL COMPONENTS**	**9 Periods**
Component wear, bushings, lubricated piston rings and cylinder bore wear, dry piston rings, rolling bearings, seal wear, gear wear, gear couplings, wear of brake materials, wear of cutting tools, chain wear.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*B. Pugh,* ***Friction & Wear****, Wiley India Pvt. Ltd., New Delhi, 2012.*
2	*Harish Hirani,* ***Fundamentals of Engineering Tribology with Applications,*** *Cambridge English, 2017.*
3	*Ludema K C,* ***Friction, Wear, Lubrication:A textbook in Tribology****, CRC Press, 2010.*
4	*Paulo Davim,* ***Tribology for Engineers:A practical guide****, Woodhead publishing, 2011*
5	*Basu, Sen Gupta and Ahuja,* ***Fundamentals of Tribology****, PHI, 2000*
6	*https://nptel.ac.in/courses/113108083*
7	*https://nptel.ac.in/courses/113105086*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate wear behaviour of materials under different environmental conditions.	K3
CO2	Analyze contact behaviour of smooth and rough surfaces and identify the type of wear.	K4
CO3	Analyze the friction phenomena and select a suitable lubricant for a specific application.	K4
CO4	Diagnose and control wear in metallic parts.	K3
CO5	Determine the cause of wear in mechanical components.	K2

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	3	3
CO2	2	1	1	2	3
CO3	1	1	1	2	3
CO4	2	2	1	3	2
CO5	2	2	2	2	2
23MFPE06	2	2	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	60			100
CAT2		30	40	30			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			40	60			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	40	30			100
ESE		20	40	40			100

23MFPE07	MACHINE TOOL DRIVES AND CONTROL	SEMESTER

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

Course Objectives	1. To understand the fundamental concepts in machine tool design. 2. To be acquainted with different influencing factors, and the methods of controlling, the quality of products, in particular strength, rigidity and dimensional accuracy. 3. To know about various common techniques used in design of machine components	
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 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		
UNIT – V	**CONTROL SYSTEMS IN MACHINE TOOLS**	**9 Periods**
Machine tool control systems - Control Systems for Speed and Feed Changing - Adaptive Control Systems		
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****, McGraw Hill Education, 2017.*
2	*G.C. Sen and A. Bhattacharya,* ***Principles of Machine Tool,*** *New Central Book Agency, 2009.*
3	*D. K Pal, S. K. Basu,* ***Design of Machine Tools*** *, Oxford & IBH Publishing Co Pvt.Ltd, 2018.*
4	*N. Acherkan,* ***Machine Tool Design*** *Vol. 3 & 4, MIR Publishers, Moscow, 1968.*
5	*https://nptel.ac.in/courses/112105233*
6	*https://nptel.ac.in/courses/112106424*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Select the different machine tool mechanisms for real time applications.	K5
CO2	Design the Multi speed Gear Box and feed drives for industrial applications.	K4
CO3	Design the machine tool structures for manufacturing of components.	K3
CO4	Design the guide ways and power screws for various machine tools.	K3
CO5	Select the suitable control system specific to the machine tool.	K5

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	1
CO4	1	1	2	1	1
CO5	1	1	3	1	1
23MFPE07	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			30	40	30		100
CAT2			50		50		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			30	40	30		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			50		50		100
ESE			40	20	40		100

23MFPE08	SENSORS FOR INTELLIGENT MANUFACTURING	SEMESTER

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

Course Objectives	1. To familiarize with the basics of sensors in manufacturing. 2. To acquire knowledge in the concepts of condition monitoring. 3. To understand sensors in CNC machine tools and acoustic emission sensors for hi-tech manufacturing systems. 4. 4 To provide the knowledge on sensors used in manufacturing and inspection. 5. 5. To gain knowledge on advanced sensors in industrial automation.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction – Role of sensors in manufacturing automation – Operation principles of different sensors – Electrical, optical, acoustic, pneumatic, magnetic, Electro optical and vision sensors		
UNIT – II	**CONDITION MONITORING OF MANUFACTURING SYSTEMS**	**9 Periods**
Condition monitoring of manufacturing systems – Principles – Sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques.		
UNIT – III	**ACOUSTIC EMISSION SENSORS**	**9 Periods**
Acoustic emission – Principles and applications – Concepts of pattern recognition. Sensors for CNC Machine tools – linear and angular position and velocity sensors.		
UNIT – IV	**MACHINE VISION SENSORS**	**9 Periods**
Automatic identification techniques for shop floor control – Bar code scanners, radio frequency systems – Optical character and machine vision sensors.		
UNIT – V	**ADAPTIVE CONTROL OF MACHINE TOOLS**	**9 Periods**
Smart / intelligent sensors – Integrated sensors, Robot sensors, Micro sensors, Nano sensors- Adaptive control of machine tools.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Peter E. Orban, George K. Knopf , **Sensors and Controls for Intelligent Manufacturing**, Society of Photo Optical, 2001.*
2	*Sabrie Salomon, **Sensors and Control Systems in Manufacturing**, McGraw Hill Int. Edition, 2010*
3	*Randy Frank, **Understanding Smart Sensors**, Artech House, USA, 2011.*
4	*Regtien, P. P. L., **Sensors for mechatronics**, Elesevier, USA,2012.*
5	*Bradley, D. A., Dawson D., Burd, N. C. and Loader A. J.,**Mechatronics: Electronics in products and processes**, CRC Press, Florida, USA, 2010*
6	*Jacob Fraden, **Handbook of Modern Sensors Physics, Designs and Applications,** Springer - Verlag New York, 2004.*
7	*https://archive.nptel.ac.in/courses/112/103/112103293/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select the suitable sensors for manufacturing automation.	K4
CO2	Choose the advanced sensors for condition monitoring in shop floor.	K4
CO3	Use special type of sensors for hi-tech manufacturing systems.	K3
CO4	Apply advanced sensor based systems for identification and inspection functions in shop floor.	K3
CO5	Apply smart sensors for industrial automation.	K3

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	3	2	1
CO2	1	1	3	2	1
CO3	1	1	3	1	2
CO4	1	2	3	1	1
CO5	1	1	3	2	1
23MFPE08	1	1	3	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			100				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			40	60			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			100				100
ESE			60	40			100

23MFPE09	MEMS AND NEMS	SEMESTER

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

Course Objectives	1. To enlarge knowledge on recent development of science and technology of micro and nano systems. 2. To familiarize the fabrication and packaging of micro systems. 3. To understand the micro devices used in the recent developments. 4. To gain knowledge on synthesis of nano materials. 5. To familiarize the characterization of nano materials.	
UNIT – I	**MEMS AND MICROSYSTEMS**	**9 Periods**
Definition – Historical development – fundamentals – Properties, micro fluidics, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system, MEMS Simulation and Design tools - Behavioral modelling simulation tools and Finite element simulation tools.		
UNIT – II	**MATERIALS, FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING**	**9 Periods**
Substrates and wafers- Polymers for MEMS, Conductive polymers- Photolithography- Ion implantation - Diffusion process - Oxidation – Chemical vapor deposition, Sputtering - Deposition by epitaxy – Etching – Bulk and surface machining – LIGA process - Micro System packaging		
UNIT – III	**MICRO DEVICES**	**9 Periods**
Sensors – Classification – Signal conversion ideal characterization of sensors micro actuators, mechanical sensors – Displacement sensors, pressure and flow sensors - Sensitivity, reliability and response of micro-sensor - Applications of micro actuators.		
UNIT – IV	**SCIENCE OF SYNTHESIS OF NANO MATERIALS**	**9 Periods**
Classification of Nano structures – Effects of nano scale dimensions on various properties – Structural, Thermal, chemical, mechanical, magnetic, optical and electronic properties. Nano particles - Sol-Gel Synthesis - Plasma synthesis - Synthesis of carbon nano tubes- Fabrication methods – Top down Processes – Bottom up process.		
UNIT – V	**CHARACTERIZATION OF NANO MATERIALS**	**9 Periods**
Nano-processing systems – Nano measuring systems – Characterization – Analytical imaging techniques – Microscopy techniques- Diffraction techniques – Spectroscopy techniques - 3D surface analysis – Mechanical, Magnetic and thermal properties– Nano positioning systems.		
Contact Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45Periods**		

REFERENCES:

1	*M.H. Fulekar,* ***Nanotechnology: Importance and Applications,*** *Dreamtech Press, 2019.*
2	*DAS A,* ***An Introduction to Nanomaterials and Nanoscience****,CBS, 2020.*
3	*Thomas Varghese & K.M. Balakrshna,* ***Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials.*** *Atlantic; Reprint, 2021.*
4	*Choudhary K K,* ***Nanoscience and Nanotechnolog,*** *Narosa Publishing House Pvt. Ltd, 2016.*
5	*Jaume Verd, Jaume Segura,* ***Development of CMOS-MEMS/NEMS Device,*** *MDPI AG, 2019.*
6	*https://nptel.ac.in/courses/117105082*
7	*https://archive.nptel.ac.in/courses/118/104/118104008/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the micro/nano systems in manufacturing industries.	K3
CO2	Identify the materials and fabrication process for micro systems.	K3
CO3	Apply the micro and nano-scale devices in mechanical assemblies.	K4
CO4	Develop the nano materials for industrial applications.	K3
CO5	Analyze the nano materials using advanced microscopy.	K3

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	2	1	2	1	2
CO3	2	1	1	3	2
CO4	2	2	2	1	3
CO5	2	2	2	2	1
23MFPE09	2	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			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			60	40			100

23MFPE10	LEAN MANUFACTURING SYSTEMS AND IMPLEMENTATION	SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
NIL		3	0	0	3

Course Objectives	1. To understand the concepts of lean manufacturing 2. To acquire knowledge of design and value stream management 3. To familiarize the fundamental lean tools used in industries. 4. To familiarize the techniques of lean implementation in manufacturing industries. 5. To gain knowledge in lean metrics and lean sustenance.

UNIT – I	**LEAN MANUFACTURING**	**9 Periods**
Evolution of Lean - Traditional versus Lean Manufacturing - Business of Survival and Growth - Business Model Transformation - Ford Production System - Job Shop Concepts - Concept of Lean -Toyota's foray in Lean.		
UNIT – II	**DESIGN AND VALUE STREAM MANAGEMENT**	**9 Periods**
Definition VSM Types - Product Family Selection - Value Stream Manager - Current State Map, Process Box, Value Stream Icons - 3 MS - Muda, Mura, Muri - Types of Muda, Future State Map, Value Stream Plan, Process Stability - Loss Reduction - Major Losses Reduction .- Demand Stage, Market Dynamics, Customer Demand, PQ Analysis, PR Analysis; TAKT Time, Pitch, Finished Goods Stock, Cycle Stock, Buffer Stock, Safety Stock.		
UNIT – III	**FUNDAMENTAL LEAN TOOLS**	**9 Periods**
Flow Stage, Continuous Flow - Cell Layout - Line Balancing, Macro and Micro Motion, Analysis, Standardized Work - Concept of Kaizen - Steps involved in Kaizen Deployment - Industrial Engineering - Concepts and Fundamentals, Kanban Concepts, Types of Kanbans and Practical Application - Concept of Pull - Changeover Time Reduction - External and Internal - Single Minute Exchange of Die - Quick Die Change - Quality-Vendor, In Process and Customer, Line.		
UNIT – IV	**LEAN IMPLEMENTATION**	**9 Periods**
Concept of PPM - Pokayoke, Prevention and Detection Types, Maintenance - Preventive, Time Based and Condition Based; Human Development for Lean (Training and Involvement through Autonomous Maintenance) Leveling Stage of Lean Implementation, Production Leveling, Leveling Box, Concept of Water Spider		
UNIT – V	**LEAN METRICS AND LEAN SUSTENANCE**	**9 Periods**
Identify Lean Metrics - Steps involved in Goal Setting - Corporate Goals - Kaizen Cloud, identification in VSM - Lean Assessment, Cultural Change, Reviews, Recognition, Improving Targets and Benchmarks.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Ronald G. Askin , Jeffrey B. Goldberg* ***Research on Design and Management of Lean Production Systems****, Wiley; 1st Edition 2001*
2	*Akhilesh N. Singh ,* ***Lean Manufacturing Concepts****, Bibliophile South Asia, 2011.*
3	*Lonnie Wilson,* ***How to Implement Lean Manufacturing****, McGraw-Hill Education ,2009.*
4	*J. Paulo Davim,* ***Modern Manufacturing Engineering****, Springer, 2015.*
5	*https://nptel.ac.in/courses/110107130*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the production system for implementing lean principles.	K2
CO2	Apply lean concepts in manufacturing sector to face globalization and competitiveness	K3
CO3	Implement the lean tools against the targets for sustainable business growth	K4
CO4	Develop a roadmap for successful implementation of lean principles	K3
CO5	Identify and organize the elements of just in time manufacturing	K2

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	3	1	1
CO2	2	2	2	1	2
CO3	2	1	1	2	3
CO4	2	2	2	1	3
CO5	2	1	1	3	3
23MFPE10	2	1	2	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		30	40	30			100
CAT2		30	40	30			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	40	30			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	40	30			100
ESE		40	40	20			100

23MFPE11	HIGH SPEED MACHINING	SEMESTER

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

Course Objectives	1. To know the basics of HSM and identify its advantages. 2. To understand the HSM cutting mechanism and identify the process variables. 3. To enumerate the applications of metal working fluids. 4. To understand the cutting strategies of HSM. 5. To appreciate the invariability of HSM transitioning.	
UNIT – I	**INTRODUCTION TO HIGH SPEED MACHINING**	**9 Periods**
Overview of machining processes, evolution and significance of HSM, historical perspective and milestones, tool geometry and its impact on cutting forces, temperature effects in high-speed cutting, tool material selection.		
UNIT – II	**TOOLING AND MACHININE DYNAMICS IN HSM**	**9 Periods**
Selection of cutting tools for HSM, tool coatings and their role, optimal cutting parameters. Machine tool requirements for HSM, vibration control and damping techniques, impact of machine stiffness and rigidity.		
UNIT – III	**ADVANCES IN COOLING AND LUBRICATION FOR HSM**	**9 Periods**
Water-based metalworking fluids, properties of the fluids, influence of the emulsion type and particle-size in metalworking fluid, usages of graphite iron and ductile cast iron in engineered metalworking fluids, new metalworking fluid technology.		
UNIT – IV	**SURFACE FINISH AND QUALITY**	**9 Periods**
Strategies for achieving high-quality surface finish, cutting strategies for complex geometries, tool path programming, inspection and measurement techniques, Case studies.		
UNIT – V	**CHALLENGES AND ADVANCES IN HSM**	**9 Periods**
Common issues in HSM, troubleshooting and problem-solving, case studies and real-world examples, emerging technologies in HSM, industry trends and future developments.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Kapil Gupta and J Paulo Davim**, High-Speed Machining**, 1st Edition, Academic Press Inc., 2020, ISBN: 978-0-12-815020-7, DOI: https://doi.org/10.1016/C2017-0-02542-9*
2	*Schmitz Tony L, Smith Kevin S **, Machining Dynamics: Frequency Response to Improved Productivity**, Springer International Publishing, 2009, ISBN-10: 0-387-09644-2*
3	***Modern Metal Cutting: A Practical Handbook**, University of Michigan, Sandvik Coromant Publishers,2007, ISBN-13 - 978-9197229906*
4	***Proceedings of the International Conference on High-Speed Machining** (ICHSM), Nanjing University, China, Trans Tech Publications Limited,2014, ISBN-10 : **3038351423***
5	*https://nptel.ac.in/courses/112105233*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the need for adoption of HSM process.	K3
CO2	Describe the HSM cutting mechanism.	K2
CO3	Identify and control the process variables of HSM.	K3
CO4	Select the suitable lubricant for HSM.	K3
CO5	Analyze the challenges involved in HSM	K4

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	2	1
CO2	2	1	3	1	1
CO3	2	2	2	2	2
CO4	1	1	3	2	2
CO5	2	2	2	1	2
23MFPE11	2	2	2	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	60				100
CAT2			40	60			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		40	60				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			40	60			100
ESE		20	60	20			100

23MFPE12	SUPPLY CHAIN MANAGEMENT	SEMESTER

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

Course Objectives	1. To understand the complexity and key issues in supply chain management. 2. To describe logistics networks, distribution planning, routing design and scheduling models. 3. To familiarize with dynamics of supply chain and the role of information in supply chain. 4. To understand the issues related to strategic alliances, global supply chain management, procurement and outsourcing strategies.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Definition of Logistics and SCM: Evolution, Scope, Importance and Decision Phases – process viewof a supply chain - Supply chain flows- Examples of supply chains- Competitive and supply chainstrategies- Achieving strategic fit- Expanding strategic scope- Drivers of supply chain performance-Framework for structuring drivers–Obstacles to achieving fit.		
UNIT – II	**LOGISTICS MANAGEMENT**	**9 Periods**
Factors – Modes of Transportation - Design options for Transportation Networks-Routing andScheduling – Inbound and outbound logistics- Reverse Logistics – 3PL- Integrated Logistics. Concepts- Integrated Logistics Model – Activities - Measuring logistics cost and performance – Warehouse Management - Case Analysis.		
UNIT – III	**SUPPLY CHAIN NETWORK DESIGN**	**9 Periods**
Distribution in Supply Chain – Factors in Distribution network design –Design options-NetworkDesign in Supply Chain – Framework for network Decisions - Managing cycle inventory and safety.		
UNIT – IV	**SOURCING AND PRICING IN SUPPLY CHAIN**	**9 Periods**
Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management. In supply chain.		
UNIT – V	**COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN**	**9 Periods**
Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work. E-Business and SCM. Metrics for SC performance – CaseAnalysis.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Chopra, Kalra ,**Supply Chain Management**, Pearson Education India; Sixth edition, 2016*
2	*G. Srinivasan, **Quantitative Models In Operations And Supply Chain Management**, PHI Learning; 2nd edition, 2018*
3	*Mr. Vikash Kumar Vivek Kumar, Mr. Hari Bhagat, **The basics of supply chain management**, Bluerose Publishers Pvt. Ltd.; FIRST edition, 2021*
4	*Richard B. Chase , Ravi Shankar ,F. Robert Jacobs, **Operations and Supply Chain Management (SIE)**, 15th Edition, McGraw Hill Education, 2018*
5	*Joel D. Wisner, Keah-Choon Tan, G. Keong Leong, **Principles of Supply Chain Management: A Balanced Approach**, Cengage Learning India Pvt. Ltd.; 5th edition 2019.*
6	*https://nptel.ac.in/courses/110106045*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify and analyze supply chain problems in various business sectors.	K4
CO2	Devise strategies, plans and operations to solve supply chain problems and/or to improve supply chain efficiency.	K5
CO3	Apply information technology in e-business for corporate demand.	K3
CO4	Develop analytical and critical understanding & skills for planning, designing and operations of supply chain.	K5
CO5	Develop an understanding of basic concepts and role of Logistics and supply chain management in business.	K4

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	1	1
CO2	1	1	3	1	1
CO3	3	2	2	2	2
CO4	1	1	3	3	3
CO5	2	1	2	1	2
23MFPE12	1	1	2	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			30	40	30		100
CAT2			30	40	30		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			30	40	30		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			30	40	30		100
ESE			30	40	30		100

23MFPE13	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT	SEMESTER

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

Course Objectives	1. To acquire knowledge about design principles and possible methodology to accomplish feasibility in manufacturing environment. 2. To enhance specified design concepts and skill in material selection, form design and castings. 3. To analyze factors for selection of metals and alloys and relationship to manufacturing processes 4. To apply the concepts of design for manufacturing and assembly for product manufacturing. 5. To compare various manufacturing processes and assembly techniques required for product development.

UNIT – I	**INTRODUCTION**	**9 Periods**

General design principles for manufacturability - Evaluation of customer's requirements- Systematic working plan for the designer- Process capability - Geometric Dimensioning and Tolerancing- Assembly limits -Datum features - Tolerance stacks-Interchangeable part manufacture and selective assembly.

UNIT – II	**FACTORS INFLUENCING FORM DESIGN**	**9 Periods**

Materials choice - Influence of basic design, mechanical loading, material, production method, size and weight on form design- form design of welded members and forgings-case studies.

UNIT – III	**COMPONENT DESIGN – CASTING CONSIDERATION**	**9 Periods**

Form design of grey iron, steel, malleable iron and aluminium castings. Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores-case studies.

UNIT – IV	**COMPONENT DESIGN - MACHINING CONSIDERATION**	**9 Periods**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Identification of uneconomical design - Modifying the design - group technology -Computer Applications for DFMA- case studies.

UNIT – V	**DESIGN FOR ENVIRONMENT**	**9 Periods**

Introduction – Importance of DFE – Global issues – Regional and local issues– Design guidelines –Lifecycle assessment – EPS system - Responsible product assessment - Weighted sum assessment method- Design to minimize material usage –Design for disassembly – Design for recyclability – Design for remanufacture –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	*Harry peck,* ***Designing for Manufacture****, Pitman publishing, 2015.*
2	*Dickson, John. R, and Corroda Poly,* ***Engineering Design and Design for Manufacture and Structural Approach****, Field Stone Publisher, USA, 2013.*
3	*Graedel T. Allen By. B,* ***Design for the Environment****, Angle Wood Cliff, Prentice Hall. Reason Pub.2017.*
4	*Boothroyd, G,* ***Design for Assembly Automation and Product Design****, New York, Marcel Dekker, 2015.*
5	*Kevien Otto and Kristin Wood,* ***Product Design****, Pearson Publication, 2017.*
6	*https://nptel.ac.in/courses/107103012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate the feasibility of design features in manufacturing area and smart development in manufacturability.	**K4**
CO2	Develop new concepts and methods for re-design of castings and simplified machining process.	**K4**
CO3	Develop artifact and translate the concepts of economics in design, optimization of design and human factors approach in manufacturing.	**K4**
CO4	Understand the principles of selection of materials for product development.	**K2**
CO5	Remember the basic principles of designing for economical production-creativity in design.	**K1**

COURSE ARTICULATION MATRIX:

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	2	2
CO2	1	1	2	2	3
CO3	1	2	2	3	3
CO4	1	2	2	2	3
CO5	1	2	2	3	3
23MFPE13	1	2	2	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				100			100
CAT2	30	30		40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1				100			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30		40			100
ESE	20	20		60			100

23MFPE14	THEORY OF METAL FORMING	SEMESTER

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

Course Objectives	1. To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process. 2. To study the theory and practice of bulk forming processes. 3. To study the requirements of sheet metal forming. 4. To study the powder metallurgy and special forming processes and its requirements of powder metallurgy and special forming processes. 5. To study the surface treatment and metal forming applications.	
UNIT – I	**THEORY OF PLASTICITY**	**9 Periods**
Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress-strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.		
UNIT – II	**THEORY AND PRACTICE OF BULK FORMING PROCESSES**	**9 Periods**
Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.		
UNIT – III	**SHEET METAL FORMING**	**9 Periods**
Formability studies – Conventional processes – HERF techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application.		
UNIT – IV	**POWDER METALLURGY AND SPECIAL FORMING PROCESSES**	**9 Periods**
Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming.		
UNIT – V	**SURFACE TREATMENT AND METAL FORMING APPLICATIONS**	**9 Periods**
Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation –Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging- Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*B. L. Juneja.,* ***Fundamentals of Metal Forming Processes****, New Age Publishers; Second edition: 2018*
2	*Swapnil Prakash Raut, Priyank Madhukar Vartak,* ***Metal Forming Technology****, Tech-Neo Publications.2022.*
3	*Hingole R S .,****Advances In Metal Forming Expert System For Metal Forming****, Springer 2014*
4	*H S Shan .,* ***Manufacturing Processes : Casting Forming And Welding****, Cambridge University Press. 2017*
5	*Wang, Z. R., Hu, Weilong, Yuan, S. J., Wang, Xiaosong.,* ***Engineering Plasticity: Theory and Applications in Metal Forming****., Wiley., 2018.*
6	*https://nptel.ac.in/courses/112106153*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Outline tooling and equipments required for important metal forming processes.	K2
CO2	Analyze effect of parameters influencing metal forming and compare hot working and cold working with applications.	K3
CO3	Explain capabilities and applications of bulk metal forming processes and sheet metal work.	K4
CO4	Examine the process capabilities of powder metallurgy processes.	K4
CO5	Apply the knowledge of surface treatment on formed components	K3

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	1	1
CO2	1	1	3	2	2
CO3	1	1	2	1	2
CO4	1	2	2	1	2
CO5	1	1	3	1	1
23MFPE14	1	2	3	2	2

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

23MFPE15	NON-DESTRUCTIVE EVALUATION	SEMESTER

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

Course Objectives	1. To familiarize with the principles of nondestructive techniques and to introduce non-destructive evaluation in engineering applications. 2. To familiarize with various ultrasonic hardness tests. 3. To gain knowledge about X-ray radiography. 4. To acquire knowledge on penetrant and magnetic particle tests. 5. To educate students on Holography and applications of NDT.	
UNIT – I	**CONCEPTS OF NDT**	**9 Periods**
Relative merits and limitations of NDT Vs Conventional testing –Visual inspection, thermal inspection methods. Liquid penetrate Inspection		
UNIT – II	**LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS**	**9 Periods**
Characteristics of liquid penetrates - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.		
UNIT – III	**RADIOGRAPHY**	**9 Periods**
Sources of ray-X-ray production - properties of d and X rays - film characteristics - exposure charts - contrasts - operational characteristics of X ray equipment - applications.		
UNIT – IV	**ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES**	**9 Periods**
Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method – A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.		
UNIT – V	**THERMOGRAPHY**	**9 Periods**
Thermography - Principles, types, applications, advantages and limitations. Optical and Acoustical holography- Principles, types, applications, advantages and limitations. Case studies: weld, cast and formed components.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Barry Hull and Vernon John,* ***Non Destructive Testing*** *, MacMillan, 1988*
2	*American Society for Metals,* ***Metals Hand Book*** *, Vol.II, 1976*
3	*Hull., . ELBS Edition. 1991*
4	*ASM Metals Hand Book. Vol. (9).* ***Non-destructive Testing and Inspection****, 1988*
5	*C.Hellier,* ***Hand Book Non-Destructive Evaluation****, McGraw-Hill Professional,1st Edition,2001.*
6	*https://archive.nptel.ac.in/courses/113/106/113106070*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the difference in the different methods of nondestructive techniques.	K2
CO2	Apply the appropriate technique for a given application	K3
CO3	Analyze the defects formed by nondestructive techniques	K4
CO4	Demonstrate the knowledge about different acoustic flaw detection techniques and holography techniques.	K4
CO5	Familiarize with basic principles of electromagnetic NDT methods, X-ray and gamma ray radiography inspection process.	K3

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	1	3	1
CO2	1	1	1	3	2
CO3	1	1	1	2	2
CO4	1	2	2	2	2
CO5	1	1	1	3	1
23MFPE15	1	2	2	3	2

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

23MFPE16	GREEN MANUFACTURING	SEMESTER

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

Course Objectives	1. To familiarize students with the concept of sustainability manufacturing with tools and techniques 2. To gain knowledge on Quality initiatives towards green manufacturing. 3. To acquaint with the framework of recycling policies 4. To promote awareness on the environmental attributes of manufacturing 5. To inculcate knowledge on performing life cycle analysis	
UNIT – I	**SUSTAINABLE MANUFACTURING AND EMS**	**9 Periods**
Sustainable Manufacturing - Concepts and Methodologies to Help Promote Industrial Ecology - ISO L4000 series standards - Concepts of ISO 14001 - requirements of ISO 14001 – Environmental Management System benefits - Environmentally Conscious Manufacturing.		
UNIT – II	**GREEN MANUFACTURING**	**9 Periods**
Green Design and Quality Initiatives - Environmental Cost Accounting and Business Strategy - Accounting for an Environmentally Conscious Setting - The Development of Eco labeling Schemes		
UNIT – III	**RECYCLING**	**9 Periods**
Recycling as Universal Resource Policy - Innovation towards Environmental Sustainability in Industry - A Systematic Framework for Environmentally Conscious Design		
UNIT – IV	**ENVIRONMENTAL ATTRIBUTES OF MANUFACTURING**	**9 Periods**
Environmental Attributes of Manufacturing Processes - Environmental Decision Support Systems -Decision Models for Reverse Production System Design - Environmentally Sound Supply ChainManagement		
UNIT – V	**LIFE CYCLE ASSESSMENT**	**9 Periods**
Life Cycle Assessment - Multipath way and Cumulative Risk Assessment - Reclamation and Recycling of Waste		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 0 Periods**		

REFERENCES:

1	*Mrityunjay Singh, Tatsuki Ohji, Rajiv Asthana,* ***Green and Sustainable Manufacturing of Advanced Material****, , Elsevier 1st Edition - August 18, 2015*
2	*Besterfield, D.H., Besterfield, C.M., Besterfield, G.H. and Besterfield, M.S.,****Total Quality Management****, Pearson Education ,2015*
3	*S.Vinodh ,* ***Sustainable Manufacturing Concepts, Tools, Methods and Case Studies****,CRC Press; 1st edition, 2021*
4	*Dr. Kaliyan Mathiyazhagan, Dr. K. E. K. Vimal, Dr. Harish Kumar, Veronica Agarwal, Dr. Anbanandam Ramesh,* ***Lean and Green Manufacturing****, Springer; 1st edition, 2022*
5	*https://nptel.ac.in/courses/110104119*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Utilise tools and techniques of sustainable manufacturing	K3
CO2	Comprehend the green manufacturing tools.	K2
CO3	Analyse eco-friendliness of products considering recycling principles	K4
CO4	Evaluate the environmental attributes of manufacturing..	K3
CO5	Perform life cycle assessment and assess environmental impacts of manufacturing processes	K5

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	1	3
CO2	1	2	2	3	2
CO3	2	3	1	1	3
CO4	1	2	1	2	2
CO5	2	3	2	3	3
23MFPE16	1	2	2	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		30	40	30			100
CAT2			30	40	30		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	40	30			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			30	40	30		100
ESE		20	40	20	20		100

23MFPE17	VIBRATION CONTROL AND CONDITION MONITORING	SEMESTER

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

Course Objectives	1. To appreciate the basic concepts of vibration in damped and undamped systems. 2. To understand and implement techniques of vibration control. 3. To learn the vibration is undesirable in system structure. 4. To learn the fundamentals of control techniques of vibration levels and maintenance. 5. To learn to use the measuring instruments for analyzing the vibration levels in a body.	
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- Design of Information system, Selecting methods 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 parameters.		
UNIT – V	**DYNAMIC BALANCING AND ALIGNMENT 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: 0 Periods Total: 45 Periods**		

REFERENCES:

1	Giridhar P, Machinery vibration analysis and predictive maintenance, Elsevier publications 2012
2	Rao J S, Vibratory Condition Monitoring of Machines, Narosa Publishing House, 2000
3	Singiresu S.Rao, Mechanical vibrations, Addison - Wesley Publishing Co., 1995
4	Rao, B., Handbook of condition monitoring, Elsevier advanced technology, Oxford, 1996.
5	A Davis, Handbook of condition monitoring, Springer series, 1997.
6	https://nptel.ac.in/courses/112105232

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Derive equation of motion for systems under translational and rotational motions.	K4
CO2	Select vibration measuring instruments and techniques in the vibration control.	K3
CO3	Apply the techniques of vibration control in smart structures.	K3
CO4	Select the suitable technique for condition monitoring and maintenance.	K3
CO5	Perform static and dynamic balancing of machine components.	K4

COURSE ARTICULATION MATRIX:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	1	2	1	2	2
CO3	1	2	1	1	1
CO4	2	2	2	2	1
CO5	2	2	1	1	2
23MFPE17	2	2	2	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			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			60	40			100

23MFPE18	PRODUCT DESIGN AND DEVELOPMENT	SEMESTER

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

Course Objectives	1. To Understand the principles of generic development process; product planning; customer need analysis for new product design and development. 2. To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development. 3. To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development. 4. To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product. 5. To apply the concepts of economics principles; project management practices in development of new product.	
UNIT – I	**INTRODUCTION TO PRODUCT DESIGN AND IDENTIFICATION OF CUSTOMER NEED**	**9 Periods**
Need for IPPD - Strategic importance of Product development –Duration and Cost of Product Development – Challenges in Product Development - Product Development Processes and Organizations – Activities in Identifying Customer Needs		
UNIT – II	**PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING**	**9 Periods**
Plan and establish Target and Final product specifications – Activities of Concept Generation - Task - Concept Selection methodology – Concept Screening and Scoring - Concept Testing Methodologies.		
UNIT – III	**PRODUCT ARCHITECTURE , INDUSTRIAL DESIGN AND DESIGN FOR MANUFACTURE**	**9 Periods**
Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning - Industrial design -– DFM- Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors.		
UNIT – IV	**PROTOTYPING, ROBUST DESIGN AND INTELLECTUAL PROPERTY**	**9 Periods**
Prototype basics - Principles of prototyping - Planning for prototypes - Robust design – Seven step process of Robust Design through Design of Experiments- Need and Importance of Intellectual Property – Seven step process of preparing a patent document.		
UNIT – V	**PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS**	**9 Periods**
Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks baseline project planning - accelerating the project - project execution – postmortem project evaluation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Karl T.Ulrich, Steven D.Eppinger, Anita Goyal,* ***Product Design and Development****, McGraw – Hill Education (India) Pvt. Ltd, 4th Edition, 2012.*
2	*Kevin N Otto, Kristin L Wood, P****roduct Design – Techniques in Reverse Engineering and New Product Development,*** *Pearson Education, Inc, 2016 .*
3	*Stephen Rosenthal, Effective Product Design and Development, Business One Orwin,Homewood, 1992.*
4	*Stuart Pugh,* ***Total Design – Integrated Methods for successful Product Engineering****, Addison Wesley Publishing, Neyourk, NY, 1991.*
5	*https://archive.nptel.ac.in/courses/112/107/112107217/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the principles of generic development process.	K3
CO2	Set product specifications and generate, select, screen, test concepts for new product design and development.	K4
CO3	Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development	K3
CO4	Adopt Prototyping techniques and Design of Experiment principles to develop a robust design and document a new product for patent.	K2
CO5	Apply of the concepts of economics principles; project management practices in accelerating the new product development activity.	K4

COURSE ARTICULATION MATRIX:

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	2	3
CO2	1	2	3	2	1
CO3	2	1	2	3	2
CO4	3	2	1	2	1
CO5	1	3	2	2	2
23MFPE18	2	2	2	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			60	40			100
CAT2		30	40	30			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			60	40			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	40	30			100
ESE		20	40	40			100

23MFPE19	RELIABILITY AND QUALITY ENGINEERING	SEMESTER

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

Course Objectives	1. To demonstrate the approaches and techniques to assess and improve process and product quality and reliability. 2. To introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring. 3. To illustrate the basic concepts and techniques of modern reliability engineering tools. 4. To develop skills to analyses quality culture in companies. 5. To provide basic knowledge of quality and reliability in engineering.	
UNIT – I	**QUALITY CONCEPTS**	**9 Periods**
Quality objectives - Quality control - Quality Assurance - Quality systems, economics, Statistical tolerance - Quality loss functions.		
UNIT – II	**STATISTICAL PROCESS CONTROL**	**9 Periods**
Process variability - Control charts for variables and attributes, Moving average control charts, multi variant chart- Cumulative chart - demerit control chart - process capability studies.		
UNIT – III	**DESIGN OF EXPERIMENTS**	**9 Periods**
Factorial experiments - fractional replication - Taguchi methods - Use of orthogonal arrays – Response surface methodology- Cases.		
UNIT – IV	**RELIABILITY AND QUALITY MANAGEMENT**	**9 Periods**
Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – A priori and a posteriori concept - mortality curve – useful life – availability – maintainability – system effectiveness Reliability prediction and testing - Quality circles - Zero defects program - ISO 9000 and TQM - Total quality organization.		
UNIT – V	**RELIABILITY MANAGEMENT AND RISK ASSESSMENT**	**9 Periods**
Reliability testing – Reliability growth monitoring – Non-parametric methods – Reliability and life cycle costs – Reliability allocation – Replacement model-Definition and measurement of risk – risk analysis techniques – risk reduction resources – industrial safety and risk assessment.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	Douglas, C.Montgomery, Introduction to Statistical quality control, Second Edition John Wiley &Sons,2019.
2	Mangey Ram,Reailability engineering methods and application, CRC press, 2019.
3	Modarres, Reliability and Risk analysis, Maral Dekker Inc.,CRC Press, 2018.
4	Dale H.besterfield, Quality improvement, PHI, 2013.
5	D.R. Kiran, Total quality management, BS Publications,2017.
6	https://nptel.ac.in/courses/110105088

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Attain fundamental knowledge on the basic techniques of quality improvement.	K2
CO2	Use control charts to analyze for improving the process quality.	K4
CO3	Describe different sampling plans.	K4
CO4	Acquire and implement quality principles in industries.	K3
CO5	Understand the concepts of reliability and maintainability.	K2

COURSE ARTICULATION MATRIX:					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	1	2	2
CO2	1	1	2	2	2
CO3	1	1	2	2	3
CO4	1	1	2	2	3
CO5	1	2	2	3	3
23MFPE19	1	2	2	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	30	20	30		100
CAT2			20	40	40		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		20	30	20	30		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			20	40	40		100
ESE		20	20	30	30		100

23MFPE20	ADVANCES IN MANUFACTURING PROCESSES	SEMESTER

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

Course Objectives	1. To acquire the metallurgical concepts during solidification of metals and alloys in recent casting and welding processes. 2. To provide students with an understanding of skills relating to the modern manufacturing industry within both global and local contexts. 3. To acquire the knowledge on principles, operations and applications of different welding processes and analyze the effects of process parameters on the quality of weld products. 4. To learn the concepts of rapid product development, apply acquired knowledge to meet global challenges in changing design in time compressed mode.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Manufacturing and manufacturing systems- Manufacturing Trends and Challenges – Manufacturing Aspects, Selection and Classification- Description and Taxonomy of Manufacturing Processes.		
UNIT – II	**ADVANCED METAL CASTING PROCESSES**	**9 Periods**
Metal Casting basics, Gating and risering Design, Evaporative Pattern Casting Process (EPC) - Hybrid EPC and Vaccuum EPC, Ceramic Shell Investment Process- Shell moulding Process		
UNIT – III	**ADVANCED MACHINING PROCESSES**	**9 Periods**
Abrasive Flow Machining-Abrasive Jet Machining, Water Jet Machining, Ultrasonic Machining, Micro USM, Electric Discharge Machining, Die Sinker EDM and Wire Cut EDM, Electrochemical Machining, Electrochemical Discharge Machining, Electron Beam Machining, Ion Beam Machining, Laser Beam Machining		
UNIT – IV	**ADVANCED WELDING PROCESSES**	**9 Periods**
Submerged Arc Welding , Resistance Welding, Solid State Welding processes , Friction welding processes, Beam Welding , Diffusion Welding Processes		
UNIT – V	**OTHER ADVANCED PROCESSES**	**9 Periods**
High Energy rate forming processes, Rapid Prototyping Technology, Rapid Manufacturing, Microwave Processing of materials.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Carl sommer,* ***Nontraditional machining processes handbook*** *Advance Publishing Inc,2000*
2	*C K Chua, K F Leong, C S Lim,* ***Rapid Prototyping Principles and Applications****, World Scientific, New Delhi, 2010.*
3	*P.N.Rao,* ***Manufacturing Technology (Foundry, Forming and Welding)****, Second Edition, Tata McGraw Hill Pub.Co. Ltd, 2004.*
4	*John Campbell,****10 rules of casting****, Elsevier Publications, Boston,2004.*
5	*Serope Kalpak jian,* ***Manufacturing Engineering and Technology****, Third Edition, Addison Wesley Publishing Co.1995*
6	*https://archive.nptel.ac.in/courses/112/107/112107078/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Relate the casting methods for industrial production of components.	K4
CO2	Apply special welding process for specific applications.	K3
CO3	Analyse and simulate various industrial problems in advanced machining processes.	K5
CO4	Understand the major advancements in Manufacturing processes.	K2
CO5	Select appropriate process for production of a part/component that meet international standards of quality and time constraints..	K5

COURSE ARTICULATION MATRIX:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	3	2	2
CO2	1	1	3	2	2
CO3	1	1	3	2	3
CO4	1	1	3	2	3
CO5	1	2	3	3	3
23MFPE20	1	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			30	30	20		100
CAT2		30			70		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			30	30	20		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30			70		100
ESE		20	20	20	40		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	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: 0 Periods 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	20	30	40	10	-	-	100

Study 2/ Seminar 2/ Project 2							
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/	-	10	40	50	-	-	100

Project 2							
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**		

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.*

REFERENCES

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 andestimation 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 Period Practical: 0 Period 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 Period Practical: 0 Period 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 Period Practical: 0 Period 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 HEALTH 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 Period Practical: 0 Period 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 Period Practical: 0 Period 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

23MFOE15	COMPOSITE MATERIALS *(Common to all Branches)*						
ESE		20	40	40			100

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 Period Practical: 0 Period 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			60	40			100

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

/ Project 2							
ESE		40	40	20			100

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 /	20	20	35	15	10	-	100

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

Project 2							
ESE	25	20	25	20	10	-	100

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

23TEOE18	**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: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

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	**HDL PROGRAMMIN GLANGUAGES** *(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	**SYSTEM VERILOG MODELING**	**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

23MFACZ1	**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
23MFACZ1	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

23MFACZ2	**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.		
Lecture:30 Periods Tutorial: 0 Periods Practical: 0Periods 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
23MFACZ2	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

23MFACZ3	**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 163ehavior 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
23MFACZ3	-	-	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%

23MFACZ4	**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
23MFACZ4	**-**	**-**	**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%

23MFACZ5	**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: 0 Periods Practical: 0 Periods 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
23MFACZ5	**-**	**-**	**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%

23MFACZ6	**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
23MFACZ6	-	-	-	-	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%

23MFACZ7	**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	-	-	-
23MFACZ7	**-**	**-**	**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%

23MFACZ8	**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
23MFACZ8	**-**	**-**	**-**	**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%