GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore – 641 013

2023
CURRICULAM & SYLLABI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.E. APPLIED ELECTRONICS – FULL TIME

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION AND MISSION OF THE ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

VISION

The vision of ECE department is to become pioneer in higher learning and research and to produce creative solution to societal needs.

MISSION

- To provide excellence in education, research and public service
- To provide quality education and to make the students entrepreneur and employable.
- Continuous upgradation of techniques for reaching heights of excellence in a Global Perspective.

CHOICE BASED CREDIT SYSTEM
BRANCH: M.E. APPLIED ELECTRONICS- FULL TIME

PROGRAMME EDUCATIONAL OBJECTIVES :

PEO1: To critically evaluate the design and provide optimal solution to the problems in Advanced Signal Processing, Communications, Digital system Design, Embedded Systems and VLSI Design.

PEO2: To develop electronic systems using Modern engineering tools.

PEO3: To work professionally and ethically in Applied electronics and allied areas.

PROGRAM OUTCOMES

PO1: Ability to apply the knowledge of mathematics and engineering principles for developing problem solving attitude in field of Applied electronics for analysis and synthesis.

PO2: Ability to design and Interpret the data using modern tools in the domain of Applied electronics.

PO3: To work professionally and ethically in Applied electronics and allied areas for societal needs.

PO4: An ability to carry out research to solve the practical problems.

PO5: Ability to present a substantial technical report in the field of Applied electronics.

PO6: Students should be able to demonstrate a degree of mastery in the field of Applied electronics.

CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR CANDIDATES ADMITTED DURING 2023 ONWARDS
FIRST SEMESTER

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week /Credits			
							L	T	P	C
THEORY										
1	23AEFCZ1	RESEARCH METHODOLOGY AND IPR *(Common to all Branches)*	FC	40	60	100	3	0	0	3
2	23AEFC02	ADVANCED APPLIED MATHEMATICS *(Common to Applied Electronics & VLSI Design)*	FC	40	60	100	3	1	0	4
3	23AEPC01	ADVANCED DIGITAL SYSTEM DESIGN *(Common to Applied Electronics & VLSI Design)*	PC	40	60	100	3	0	0	3
4	23AEPC02	DSP ARCHITECTURES AND ALGORITHMS	PC	40	60	100	3	0	0	3
5	23AEPC03	STATISTICAL SIGNAL PROCESSING	PC	40	60	100	3	0	0	3
6	23AEPEXX	PROFESSIONAL ELECTIVE– I	PE	40	60	100	3	0	0	3
7	23AEACXX	AUDIT COURSE –I	AC	40	60	100	2	0	0	0
PRACTICAL										
8	23AEPC04	ADVANCED DIGITAL SYSTEM DESIGN LABORATORY	PC	60	40	100	0	0	4	2
		Total		**340**	**460**	**800**	**20**	**1**	**4**	**21**

SECOND SEMESTER

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23AEPC05	INDUSTRIAL IOT	PC	40	60	100	3	0	0	3
2	23AEPC06	EMBEDDED SYSTEM DESIGN	PC	40	60	100	3	0	0	3
3	23AEPEXX	PROFESSIONAL ELECTIVE–II	PE	40	60	100	3	0	0	3
4	23AEPEXX	PROFESSIONAL ELECTIVE–III	PE	40	60	100	3	0	0	3
5	23AEACXX	AUDIT COURSE-II	AC	40	60	100	2	0	0	0
THEORY WITH PRACTICAL COMPONENT										
6	23AEPC07	DIGITAL IMAGE PROCESSING AND ITS APPLICATIONS	PC	50	50	100	3	0	2	4
PRACTICAL										
7	23AEPC08	EMBEDDED SYSTEM DESIGN LABORATORY	PC	60	40	100	0	0	4	2
8	23AEEE01	MINI PROJECT	EEC	40	60	100	0	0	4	2
		Total		**350**	**450**	**800**	**17**	**0**	**10**	**20**

THIRD SEMESTER

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23AEPEXX	PROFESSIONAL ELECTIVE IV	PE	40	60	100	3	0	0	3
2	23AEOEXX	OPEN ELECTIVE	OE	40	60	100	3	0	0	3
PRACTICAL										
3	23AEEE02	INTERNSHIP/INDUSTRIAL TRAINING	EEC	100	-	100	-	-	**	2
4	23AEEE03	PROJECT PHASE –I	EEC	100	100	200	0	0	12	6
		Total		**280**	**220**	**500**	**6**	**0**	**12**	**14**

** 4 Weeks Internship/Industrial Training

FOURTH SEMESTER

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PRACTICAL										
1	23AEEE04	PROJECT PHASE-II	EEC	200	200	400	0	0	24	12
		Total		**200**	**200**	**400**	**0**	**0**	**24**	**12**

Total Credits: 67

PROFESSIONALELECTIVE (PE)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week /Credits			
							L	T	P	C
PROFESSIONAL ELECTIVE I										
1	23AEPE01	DIGITAL IC DESIGN *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
2	23AEPE02	ANALYSIS AND DESIGN OF ANALOG INTEGRATED CIRCUITS *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
3	23AEPE03	SEMICONDUCTOR DEVICE MODELING	PE	40	60	100	3	0	0	3
4	23AEPE04	SMART SENSORS	PE	40	60	100	3	0	0	3
5	23AEPE05	MULTIMEDIA COMPRESSION TECHNIQUES	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE II										
6	23AEPE06	ANALOG IC DESIGN *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
7	23AEPE07	EMI AND COMPATIBILITY	PE	40	60	100	3	0	0	3
8	23AEPE08	ADVANCED COMMUNICATION SYSTEMS	PE	40	60	100	3	0	0	3
9	23AEPE09	MEMS AND NEMS	PE	40	60	100	3	0	0	3
10	23AEPE10	SOFT COMPUTING AND OPTIMIZATION TECHNIQUES	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE III										
11	23AEPE11	MODELING AND SYNTHESIS WITH HDL	PE	40	60	100	3	0	0	3
12	23AEPE12	RF SYSTEM DESIGN	PE	40	60	100	3	0	0	3
13	23AEPE13	ADVANCED COMPUTER ARCHITECTURE AND PARALLEL PROCESSING	PE	40	60	100	3	0	0	3
14	23AEPE14	EMBEDDED PROCESSORS	PE	40	60	100	3	0	0	3
15	23AEPE15	BIO-MEDICAL IMAGE PROCESSING	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE IV										
16	23AEPE16	LOW POWER IC DESIGN *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
17	23AEPE17	VLSI SIGNAL PROCESSING (Common to Applied Electronics & VLSI Design)	PE	40	60	100	3	0	0	3
18	23AEPE18	ASIC DESIGN (Common to Applied Electronics & VLSI Design)	PE	40	60	100	3	0	0	3
19	23AEPE19	REAL TIME OPERATING SYSTEM	PE	40	60	100	3	0	0	3
20	23AEPE20	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	PE	40	60	100	3	0	0	3

LIST OF OPEN ELECTIVES

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEOE01	BUILDING BYE-LAW AND CODES OF PRACTICE	OE	40	60	100	3	0	0	3
2	23SEOE02	PLANNING OF SMART CITIES	OE	40	60	100	3	0	0	3
3	23SEOE03	GREEN BUILDING	OE	40	60	100	3	0	0	3
4	23EEOE04	ENVIRONMENT HEALTH AND SAFETY MANAGEMENT	OE	40	60	100	3	0	0	3
5	23EEOE05	CLIMATE CHANGE AND ADAPTATION	OE	40	60	100	3	0	0	3
6	23EEOE06	WASTE TO ENERGY	OE	40	60	100	3	0	0	3
7	23GEOE07	ENERGY IN BUILT ENVIRONMENT	OE	40	60	100	3	0	0	3
8	23GEOE08	EARTH AND ITS ENVIRONMENT	OE	40	60	100	3	0	0	3
9	23GEOE09	NATURAL HAZARD AND MITIGATION	OE	40	60	100	3	0	0	3
10	23EDOE10	BUSINESS ANALYTICS	OE	40	60	100	3	0	0	3
11	23EDOE11	INTRODUCTION TO INDUSTRIAL SAFETY	OE	40	60	100	3	0	0	3
12	23EDOE12	OPERATIONS RESEARCH	OE	40	60	100	3	0	0	3
13	23MFOE13	OCCUPATIONAL HEALTH AND SAFETY	OE	40	60	100	3	0	0	3
14	23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS	OE	40	60	100	3	0	0	3
15	23MFOE15	COMPOSITE MATERIALS	OE	40	60	100	3	0	0	3
16	23TEOE16	GLOBAL WARMING SCIENCE	OE	40	60	100	3	0	0	3
17	23TEOE17	INTRODUCTION TO NANO ELECTRONICS	OE	40	60	100	3	0	0	3
18	23TEOE18	GREEN SUPPLY CHAIN MANAGEMENT	OE	40	60	100	3	0	0	3

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
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)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week /Credits			
							L	T	P	C
1	23AEACZ1	ENGLISH FOR RESEARCH PAPER WRITING	AC	40	60	100	2	0	0	0
2	23AEACZ2	DISASTER MANAGEMENT	AC	40	60	100	2	0	0	0
3	23AEACZ3	VALUE EDUCATION	AC	40	60	100	2	0	0	0
4	23AEACZ4	CONSTITUTION OF INDIA	AC	40	60	100	2	0	0	0
5	23AEACZ5	PEDAGOGY STUDIES	AC	40	60	100	2	0	0	0
6	23AEACZ6	STRESS MANAGEMENT BY YOGA	AC	40	60	100	2	0	0	0
7	23AEACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	AC	40	60	100	2	0	0	0
8	23AEACZ8	SANSKRIT FOR TECHNICAL KNOWLEDGE	AC	40	60	100	2	0	0	0

SUMMARY OF CREDIT DISTRIBUTION

S.No.	Course Category	Credits per Semester				Total Credits	Total Credits in %
		I	II	III	IV		
1	FC	7				7	10.45
2	PC	11	12			23	34.33
3	PE	3	6	3		12	17.91
4	OE			3		3	4.48
5	AC	0	0				
6	EEC		2	8	12	22	32.83
Total		**21**	**20**	**14**	**12**	**67**	**100**

CATEGORYWISE CREDIT DISTRIBUTION

FUNDAMENTAL COURSE (FC)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week /Credits			
							L	T	P	C
THEORY										
1	23AEFCZ1	RESEARCH METHODOLOGY AND IPR *(Common to all Branches)*	FC	40	60	100	3	0	0	3
2	23AEFC02	ADVANCED APPLIED MATHEMATICS *(Common to Applied Electronics & VLSI Design)*	FC	40	60	100	3	1	0	4
			Total	**80**	**120**	**200**	**6**	**1**	**0**	**7**

PROFESSIONAL CORE (PC)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week /Credits			
							L	T	P	C
THEORY										
1	23AEPC01	ADVANCED DIGITAL SYSTEM DESIGN *(Common to Applied Electronics & VLSI Design)*	PC	40	60	100	3	0	0	3
2	23AEPC02	DSP ARCHITECTURES AND ALGORITHMS	PC	40	60	100	3	0	0	3
3	23AEPC03	STATISTICAL SIGNAL PROCESSING	PC	40	60	100	3	0	0	3
4	23AEPC04	ADVANCED DIGITAL SYSTEM DESIGN LABORATORY *(Common to Applied Electronics & VLSI Design)*	PC	60	40	100	0	0	4	2
5	23AEPC05	INDUSTRIAL IOT	PC	40	60	100	3	0	0	3
6	23AEPC06	EMBEDDED SYSTEM DESIGN *(Common to Applied Electronics & VLSI Design)*	PC	40	60	100	3	0	0	3
7	23AEPC07	DIGITAL IMAGE PROCESSING AND ITS APPLICATIONS	PC	50	50	100	3	0	2	4
8	23AEPC08	EMBEDDED SYSTEM DESIGN LAB	PC	60	40	100	0	0	4	2
			Total	**370**	**430**	**800**	**18**	**0**	**10**	**23**

PROFESSIONAL ELECTIVE (PE)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week /Credits			
							L	T	P	C
THEORY										
1	23AEPEXX	PROFESSIONAL ELECTIVE - I	PE	40	60	100	3	0	0	3
2	23AEPEXX	PROFESSIONAL ELECTIVE - II	PE	40	60	100	3	0	0	3
3	23AEPEXX	PROFESSIONAL ELECTIVE - III	PE	40	60	100	3	0	0	3
4	23AEPEXX	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	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23AEOEXX	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	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23AEACXX	AUDIT COURSE - I	AC	40	60	100	2	0	0	0
2	23AEACXX	AUDIT COURSE- II	AC	40	60	100	2	0	0	0
		Total		**80**	**120**	**200**	**4**	**0**	**0**	**0**

EMPLOYABLITY ENHANCEMENT COURSE (EEC)

S.No	Course Code	Course Title	Category	CA	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23AEEE01	MINI PROJECT	EEC	40	60	100	0	0	4	2
2	23AEEE02	INTERNSHIP/ INDUSTRIAL TRAINING	EEC	100	-	100	-	-	**	2
3	23AEEE03	PROJECT PHASE -I	EEC	100	100	200	0	0	12	6
4	23AEEE04	PROJECT PHASE-II	EEC	200	200	400	0	0	24	12
		Total		**440**	**360**	**800**	**0**	**0**	**40**	**22**

** 4 Weeks Internship/Industrial Training

23AEFCZ1	RESEARCH METHODOLOGY AND IPR *(Common to all branches)*	SEMESTER I

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

Course Objectives	• To impart knowledge on research methodology, Quantitative methods for problem solving, data interpretation and report writing • 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 Modeling 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 ANDREPORT 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 are search 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: anintroduction**",Juta Academic, 2nd edition, 2014*.
2	*Donald H.McBurney and Theresa White, "**Research Methods**", 9th Edition, Cengage Learning, 2013*
3	*RanjitKumar, "**Research Methodology: A Step by Step Guide for Beginners**", 5th Edition ,2019*
4	*Dr.C.R.Kothari and GauravGarg,"**Research Methodology: Methods and Trends**", Newage international publishers, 4th Edition ,2018*

COURSE OUTCOMES: Upon the completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate research question for conducting research.	K3
CO2	Analyze the quantitative data.	K4
CO3	Interpret research findings and give appropriate conclusions.	K2
CO4	Develop a structured content to write technical report.	K3
CO5	Summarize the importance of IPR and protect their research work through intellectual property.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	3	1	3
CO2	2	3	1	3	3	3
CO3	2	3	3	3	3	3
CO4	2	3	1	3	3	3
CO5	-	-	2	-	1	3
23AEFCZ1	**2**	**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	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

23AEFC02	**ADVANCED APPLIED MATHEMATICS** *(Common to Applied Electronics and VLSI Design)*	**SEMESTER I**

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

Course Objective	• To acquire knowledge with the foundations of vector space, inner product space, linear transformation, graph theory and linear programming problems mostly used in various applications in engineering and science.	
UNIT–I	**VECTOR SPACE**	**9+3 Periods**
Vector spaces– Subspaces – Linear combinations- Linear Span – Linear dependence – Linear independence – Basis and Dimensions.		
UNIT–II	**INNER PRODUCT SPACE**	**9+3 Periods**
Inner Products Space: Norms-Orthonormal basis, Gram Schmidt Orthogonalization Process-Orthogonal complement and Least square Approximations for linear system of equations. Hilbert spaces: Riesz Bases.		
UNIT–III	**LINEAR TRANSFORMATIONS**	**9+3 Periods**
Linear Transformation–Nullspace, Rangespace-dimension theorem-Matrix and representation of Linear transformation–Eigen values Eigen vectors of linear transformation Diagonalization by orthogonal transformation.		
UNIT–IV	**GRAPH THEORY**	**9+3 Periods**
Graphs and simple graphs, Incidence and Adjacency Matrices, Sub graphs-Vertex degrees and graphical sequences, walks, trails, paths, cycles-Trees: Characterizations of trees, Cayley's formula, Shortest path algorithms and problems.		
UNIT–V	**LINEAR PROGRAMMING PROBLEM**	**9+3 Periods**
Formulation–Graphical solution–Simplex method–Big-M method-Transportation and Assignment Models.		
Contact Periods: **Lecture:45Periods Tutorial:15Periods Practical:0Periods Total:60Periods**		

REFERENCES:

1	*Bronson, R.**, "Matrix Operation"**, Schaum' soutlineseries, McGrawHill, Newyork, 2011.*
2	*T.Veerarajan,**"Discrete Mathematics",** McGrawHillEducation(India)Pvt.Ltd.,2019.*
3	*TahaH.A.,**"Operations Research: Anintroduction"**, Ninth Edition, Pearson Education ,Asia, NewDelhi, 2012.*
4	*Andrews, L.C. and Philips.R.L., **"Mathematical Techniques for engineering and scientists"**, PrenticeHall of India, 2006.*
5	*O'NeilP.V., **"Advanced Engineering Mathematics"**, Cengage learning India private limited,(Thomson Asiapvtltd , Singapore) 2007.*

COURSEOUTCOMES: Upon the completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Obtain the knowledge of vector spaces and matrices	K3
CO2	Explain the fallouts of inner product space for linear system of equations	K3
CO3	Understand the concept of linear transformation	K3
CO4	Understand the basic concept of graph theory and algorithm to solve network problems	K3
CO5	Develop the knowledge of finding solutions of Linear Programming problems	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	1	-	-
CO2	2	1	-	1	-	-
CO3	2	1	-	1	-	-
CO4	2	1	-	1	-	-
CO5	2	1	-	1	-	-
23AEFC02	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	20%	50%	30%	-	-	-	100 %
CAT2	20%	50%	30%	-	-	-	100 %
Individual /Assignment 1/case study/seminar 1/Project 1	20%	50%	30%	-	-	-	100 %
Individual /Assignment 2/case study/seminar 2/Project 2	20%	50%	30%	-	-	-	100 %
ESE	20%	50%	30%	-	-	-	100 %

23AEPC01	ADVANCED DIGITAL SYSTEM DESIGN *(Common to Applied Electronics and VLSI Design)*	SEMESTER I

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

Course Objective	• To understand the design and modeling of digital circuits, design and analyse of synchronous and asynchronous sequential circuits and architectures of programmable devices and communication controllers.	
UNIT – I	**SYSTEM DESIGN USING VERILOG HDL**	**9 Periods**
Overview of Digital Design with Verilog HDL - Hierarchical Modeling Concepts - Basic Concepts - Modules and Ports - Language Constructs and Conventions - Gate Level Modeling - DataflowModeling - Behavioral Modeling –Switch Level Modeling - System Tasks –Functions and Compiler Directives - Realization of combinational circuits using Verilog.		
UNIT – II	**MODELING AND DESIGN**	**9 Periods**
Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis. Design of memories - ROM, single and dual port RAM - synchronous and asynchronous read - arithmetic circuit design - serial/parallel adder, subtractor, floating point adder/subtractor multiplier - sequential multiplier, array multiplier, signed Multiplier – ALU – Hardwired Control Design – Micro programmed Control Design.		
UNIT – III	**SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of clocked synchronous sequential circuits and modeling - State diagram, state table, stateassignment and reduction - Design of synchronous sequential circuits - Design of Iterative circuits - ASM Chart and realization using ASM - Realization of synchronous sequential circuits using Verilog.		
UNIT – IV	**ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of asynchronous sequential circuit – flow table reduction – Races - state assignment-transitiontable and problems in transition table- Design of asynchronous sequential circuit - Static, dynamic and Essential Hazards – Data synchronizers – Mixed operating mode asynchronous circuits - Realization ofasynchronous sequential circuits using Verilog.		
UNIT – V	**PROGRAMMABLE DEVICES AND CONTROLLER**	**9 Periods**
Programming logic device families – Designing a synchronous sequential circuit using PLA/PAL –Realization of finite state machine using PLD – FPGA –Memory controller – Processor control unit –Communication controllers: UART-I²C – VGA Controllers – USB.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charles H. Roth Jr, **"Fundamentals of Logic Design"**, Thomson Learning, 7th edition, 2014.*
2	*Nripendra N Biswas, **"Logic Design Theory"**, Prentice Hall of India, 2010.*
3	*Parag K. Lala, **"Digital system Design using PLD"**, B S Publications, 2003.*
4	*Morris Mano M, Charles R Kime, **"Logic and Computer Design Fundamentals"**, Pearson Education, 2015.*
5	*M. Morris R. Mano and Michael D. Ciletti, **"Digital Design: With an Introduction to the Verilog HDL"**, 5th edition, Pearson Education, 2013.*
6	*Samir Palnitkar, **"Verilog HDL – A Guide to Digital Design and Synthesis"**, Pearson, 2003.*

COURSE OUTCOMES: Upon the completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the design of digital circuits in various abstraction level using Verilog HDL programming.	K2
CO2	Gain knowledge on sequential modeling and design of digital systems.	K2
CO3	Design and analyse of synchronous sequential Circuits	K4
CO4	Design and analyse of asynchronous sequential Circuits	K4
CO5	Understand the architectures of programmable devices and communication controllers	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	1	-	2
CO2	3	3	-	1	-	2
CO3	3	3	-	2	-	2
CO4	3	3	-	2	-	2
CO5	3	3	-	1	-	2
23AEPC01	3	3	**-**	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	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual /Assignment 1/case study/seminar 1/Project 1		50%	30%	20%			100%
Individual /Assignment 2/case study/seminar 2/Project 2		50%	30%	20%			100%
ESE	30%	30%	20%	20%			100%

23AEPC02	DSP ARCHITECTURES AND ALGORITHMS	SEMESTER I

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

Course Objective	• To Understand the Fundamental blocks of TMS32007x Architecture and to implement various DSP Algorithms

UNIT – I	FUNDAMENTALS OF PROGRAMMABLE DSPs	9 Periods
Von Neumann ,Harvard Architecture, Modified Harvard and VLIW Architecture - Modified Bus Structures and Memory access in P-DSPs- Multiple access memory , Multi-ported memory, Pipelining -Special Addressing modes in P- DSPs - On chip Peripherals- Computational accuracy in DSP processor- MAC		
UNIT – II	**TMS320C67x DSP ARCHITECTURE**	**9 Periods**
TMS320 DSP Family Overview- TMS320C6000 DSP Family Overview- TMS320C67x DSP Features- TMS320C67x DSP Architecture - Central Processing Unit (CPU),Internal Memory ,Memory and Peripheral		
UNIT – III	**TMS320C67x CPU DATA PATHS AND CONTROL**	**9 Periods**
General-Purpose Register Files -Functional Units - Register File Cross -Memory, Load, and Store Paths- Data Address Paths -Control Register File- Instruction Operation and Execution- Parallel Operations- Conditional Operations- Resource Constraints- Addressing Modes- Instruction Compatibility		
UNIT – IV	**TMS320C67x PIPELINE AND INTERRUPTS**	**9 Periods**
Pipeline Operation- Pipeline Execution of Instruction Types- Functional Unit Constraints- Performance Considerations- Interrupts - Overview- Globally Enabling and Disabling Interrupts- Individual Interrupt Control- Interrupt Detection and Processing- Performance Considerations- Programming Considerations		
UNIT – V	**IMPLEMENTATION OF BASIC DSP ALGORITHMS**	**9 Periods**
Study of time complexity of DFT and FFT algorithm, Use of FFT for filtering long data sequence, IIR and FIR Filters, Interpolation, Decimation , Wavelet filter		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Digital Signal Processors, "**Architecture, Programming and Applications**" – B. Venkata Ramani and M. Bhaskar, TMH, 2004.*
2	***"Digital Signal Processing"** – Jonatham Stein, John Wiley, 2005*
3	*Avtar Singh and S. Srinivasan" **Digital Signal Processing – Implementations using DSP Microprocessors**", cengage Learning India Private Limited, Delhi 2012*
4	*Avtar Singh and S. Srinivasan "**Digital Signal Processing**", Thomson Publications, 2004.*
5	*Lapsley et al. S. Chand & Co "**DSP Processor Fundamentals, Architectures & Features** ", 2000.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Understand the Fundamentals of Programmable DSPs	K2
CO2	Understand various components of DSP Architecture	K2
CO3	In depth knowledge on CPU Data Paths and Control	K2
CO4	Understand various concepts Pipeline and Interrupts	K2
CO5	Implement various DSP Algorithms	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	1	1	1
CO2	3	3	2	1	1	1
CO3	3	3	2	1	1	1
CO4	3	3	2	1	1	1
CO5	3	3	2	1	1	1
23AEPC02	**3**	**3**	**2**	**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%	50%					100%
Individual /Assignment 1/case study/seminar 1/Project 1		50%	50%				100%
Individual /Assignment 2/case study/seminar 2/Project 2		50%	50%				100%
ESE	25%	50%	25%				100%

23AEPC03	STATISTICAL SIGNAL PROCESSING	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
Digital Signal Processing	PC	3	0	0	3

Course Objective	• To introduce the concepts of Random Signal Processing, Signal Modeling, Spectral and Linear Estimation, Adaptive filtering and Linear estimation.	
UNIT – I	**INTRODUCTION TO RANDOM SIGNAL PROCESSING**	**9 Periods**
Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Auto covariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes.		
UNIT – II	**SIGNAL MODELING**	**9 Periods**
Special types of Random Processes – ARMA, AR, MA – Yule-Walker equations- Linear Prediction of Signals-Forward and Backward Predictions, Solution to Prony's normal equation, Levinson Durbin Algorithm.		
UNIT – III	**SPECTRAL ESTIMATION**	**9 Periods**
Estimation of spectra from finite duration signals, Nonparametric methods - Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric method, AR(p)spectral estimation and detection of Harmonic signals, MUSIC algorithm		
UNIT – IV	**LINEAR ESTIMATION**	**9 Periods**
Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hopf Equation, FIR Wiener filter, Noise Cancellation, Causal IIR Wiener filter, Noncausal IIR Wiener filter, Discrete Kalman filter.		
UNIT – V	**ADAPTIVE FILTERS**	**9 Periods**
FIR adaptive filters – Adaptive filter based on steepest descent method- Widrow-Hopf LMS algorithm, Normalized LMS algorithm, Adaptive channel Equalization, Adaptive echo cancellation, Adaptive noise cancellation, RLS adaptive algorithm.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Monson H. Hayes, "**Statistical Digital Signal Processing and Modeling**", John Wiley and Sons, Inc, Singapore, 2002*.
2	*Dimitris G. Manolakis and Vinay K .Ingle, "**Applied Digital Signal Processing"**, Cambridge University Press, 2011.*
3	*T. Chonavel, "**Statistical Signal Processing Modelling and Estimation**", Springer London, 2012.*
4	*Umberto Spagnolini, "**Statistical Signal Processing in Engineering**", Wiley, 2018.*

COURSE OUTCOMES: Upon the completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the Basics of random signal processing and Estimation of the spectra of finite duration signal	K2
CO2	Design different Minimum Mean Square Error filters and model for prediction and Estimation	K2
CO3	Analyze differentspeech signal Processing technique	K2
CO4	Design LMSE Filters	K2
CO5	Designing adaptive filters for different applications	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	1
CO2	3	2	-	-	-	1
CO3	3	1	-	-	-	1
CO4	3	2	-	-	-	1
CO5	3	2	-	-	-	1
23AEPC03	**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	50%	50%					100%
CAT2	50%	50%					100%
Individual /Assignment 1/case study/seminar 1/Project 1	50%	50%					100%
Individual /Assignment 2/case study/seminar 2/Project 2	50%	50%					100%
ESE	50%	50%					100%

23AEPC04	ADVANCED DIGITAL SYSTEM DESIGN LABORATORY	SEMESTER I

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

Course Objective	• To model digital systems in HDL at different abstraction levels, identify, formulate, solve and analyze problems using digital logics and to familiarize with the implementation of design on FPGAs and ASIC.

LIST OF EXPERIMENTS:

Design, simulation and implementation on FPGAs:

1. Combinational and Sequential logic circuits based on Mealy and Moore's Machine Modelling.
2. Arithmetic circuits like serial/parallel adder/subtractor and multiplier - with and without pipelining
3. ALU architecture with suitable data path and control path circuits.
4. Vending machine/Traffic Light controller/ATM/Elevator control.

System Design on FPGAs:

5. LCD Interfacing / Keypad Interfacing.
6. Design MIPS 32-bit RISC processor and implement on FPGA.
7. Design a reconfigurable filter and verify its functionality on FPGA.
8. Design and implement the CORDIC algorithm on FPGA.

ASIC Design:

9. Perform digital design on combinational and sequential logic circuits from RTL to GDS

Contact Periods:

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

REFERENCES:

1	*Charles Roth Jr.H., "Fundamentals of Logic Design", Australia cengage learning, 7th edition, 2014.*
2	*Samir Palnitkar, "Verilog HDL-A guide to Digital Design and synthesis" 2nd edition Pearson, Education in South Asia 2013.*
3	*Clive Maxfield, "The design warrior guide to FPGA's, devices, Tools and flows", Elsevier, 2011.*
4	*Altera Corporation- "Standard Cell ASIC to FPGA Design Methodology and Guidelines", April 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	An ability to Model digital systems in HDL at different abstraction levels	K2
CO2	An ability to design with and without pipelining circuits.	K3
CO3	An ability to Identify and design Interfacing circuits.	K4
CO4	An ability to Solve and analyze problems using CORDIC algorithm.	K4
CO5	Familiarize with the implementation of design on FPGAs and ASIC circuits.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	1	1
CO2	3	3	3	3	1	2
CO3	3	3	2	3	1	2
CO4	3	3	2	3	1	2
CO5	3	3	2	3	1	2
23AEPC04	**3**	**3**	**2**	**3**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

23AEPC05	INDUSTRIAL IOT	SEMESTER II

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

Course Objective	• To get knowledge on recent trends of industry 4.0 and cloud computing and to design IOT systems for various applications.	
UNIT – I	**INTRODUCTION TO INDUSTRIAL 4.0**	**9 Periods**
Overview of Internet of Things and IIOT- Introduction to Industry 4.0 –Evolution - Design requirements, Drivers, Impacts and applications - Sustainability assessment of industries – Cyber security -Industrial Internet Systems - Cyber Physical Systems- Characteristics -Industrial Processes - Functional & Operational Viewpoint.		
UNIT – II	**INDUSTRIAL INTERNET OF THINGS**	**9 Periods**
IIOT Architecture – IIOT Requirements – IIOT Business Model: Categorization- Business opportunities- Reference Architecture of IIOT - key Technologies: Augmented Reality - Virtual Reality - Artificial Intelligence - Introduction to Sensors- Characteristics- Categories- Smart Sensor-Actuators.		
UNIT – III	**INDUSTRIAL DATA TRANSMISSION**	**9 Periods**
Introduction to Industrial Data Transmission- Field bus, Profi bus, Inter bus, Bit bus, Mod bus, Digital STROM- Communication protocols-Types:802.15.4, Zigbee, 6LoWPAN, HART,Z wave, Wi-Fi, RFID, NFC-Industrial Data Acquisition-PLC-SCADA		
UNIT – IV	**IoT ANALYTICS**	**9 Periods**
Introduction to IIoT -IIoT Analytics - Big Data Analytics - Software Defined Networks- Machine Learning and Data Science in Industries - Cloud & FOG Computing- Industrial IoT: Security.		
UNIT – V	**IIoT APPLICATION**	**9 Periods**
Industrial IoT- Application Domains: Healthcare Applications in Industries - Inventory Management and Quality Control -Plant Safety and Security - Smart factories and Smart Cities -Applications of UAVs in Industries.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	.*SudipMisra, Chandana Roy, Anandarup Mukherjee,* ***"Introduction to Industrial Internet of Tings and Industry 4.0****", CRC Press, 1st edition, 2021*
2	*Alasdair Gilchrist,* ***"Industry 4.0: The Industrial Internet of Things",****Apress, 2017.*
3	*ArshdeepBahga, Vijay Madisetti, "****Internet of Things-A hands-on approach****", Universities Press,2015.*
4	*Olivier Hersent, David Boswarthick, and Omar Elloumi, "****The Internet of Things: Key Applications and Protocols****", Wiley Publications-2011*

COURSE OUTCOMES: Upon the completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about advanced Industrial IOT systems	K1
CO2	Explain various protocols and data analytics used for Industrial IOT.	K2
CO3	Understand Industrial Data Transmission	K2
CO4	Apply IOT in big data analytics and in Cloud & FOG Computing	K3
CO5	Ability to analyze and apply industrial IoT to real.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	1	2
CO2	3	1	-	-	1	2
CO3	3	1	-	-	1	2
CO4	3	1	-	-	1	2
CO5	3	1	-	-	1	2
23AEPC05	3	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	30%	30%		40%			100%
CAT2	40%	50%		10%			100%
Individual /Assignment 1/case study/seminar 1/Project 1	30%	60%	10%				100%
Individual /Assignment 2/case study/seminar 2/Project 2	30%	30%		40%			100%
ESE	30%	30%	10%	30%			100%

23AEPC06	EMBEDDED SYSTEM DESIGN	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
MICROPROCESSORS AND MICROCONTROLLERS	PC	3	0	0	3

Course Objective	• To learn the basic concepts of embedded systems, program design and networks and exploit the architecture and applications of ARM CORTEX and PIC processor.	
UNIT – I	**EMBEDDED PROCESSOR**	**9 Periods**
Embedded Computers, Characteristics and Challenges of Embedded Computing System, Embedded system design process- Requirements, Specification, Architectural Design, Designing Hardware and Software Components, System Integration, Formalism for System Design- Structural Description, Behavioural Description, Design Example: Model Train Controller, Alarm Controller, Elevator Controller.		
UNIT – II	**PIC CONTROLLER**	**9 Periods**
PIC 16F877- architecture, memory technologies, timing circuits, power-up and reset, parallel ports, ADC, interrupt, PWM, counters and timers, instruction set and assembly language programming.		
UNIT – III	**INTERFACING WITH PIC**	**9 Periods**
Human and physical interfaces- switches to keyboard, LED display, liquid crystal display, Actuators and sensors, PWM, serial communication protocols (UART, I2C, SPI), programming interrupt, timers and counter.		
UNIT – IV	**ARM CORTEX M4**	**9 Periods**
Introduction to Cortex -M Processor family – Cortex M4 – Features - Architecture – Block Diagram – Operation modes and states – Registers - Memory System – Exceptions and Interrupts – Instruction Set – Low power		
UNIT – V	**INTERFACING WITH ARM CORTEX**	**9 Periods**
ARM Cortex STM32F controller – Configuring GPIO Ports – Switches and LEDs - LCD display Seven Segment LED Display – Matrix Keypad – ADC – DAC – Pulse Width Modulation – DMA - Serial Communication USART.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Marilyn Wolf, "**Computers as Components - Principles of Embedded Computing System Design**",Third Edition "Morgan Kaufmann Publisher,2012.*
2	*Tim Wilmshurst, **"Designing Embedded Systems with PIC microcontrollers-Principles and Applications"**, Newnes Publications, 2007.*
3	*Muhammad Ali Mazidi, Rolin McKinlay, Danny Causey, **"PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18"**, Prentice hall publications, 2007.*
4	*Martin Bates, "**Interfacing PIC microcontrollers-Embedded Design by Interactive Simulation"**, Newnes Publication, 2006.*
5	*Joseph Yiu, "**The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors"**, Newnes Third Edition, 2013.*
6	*Dr. Mark Fisher**, ARM Cortex M4 Cook Book**, Packt Publishing, 2016.*
7	*Andrew N. Sloss Dominic Symes Chris Wright, "**ARM System Developer's Guide Designing and Optimizing System Software**", 1st edition Elsevier Inc 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Exploit the basic concepts of embedded system.	K2
CO2	Interpret the Architecture and features of PIC Controller.	K2
CO3	Apply programming skill for interfacing with PIC Controller.	K2
CO4	Interpret the Architecture and features of ARM CORTEX controller.	K3
CO5	Apply programming skill for interfacing with ARM CORTEX processor.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2	1	-
CO2	3	1	2	2	1	-
CO3	3	1	2	2	1	-
CO4	3	1	2	2	1	-
CO5	3	1	2	2	1	-
23AEPC06	3	1	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	30%	30%	40%				100%
CAT2	30%	30%	40%				100%
Individual /Assignment 1/case study/seminar 1/Project 1	30%	30%	40%				100%
Individual /Assignment 2/case study/seminar 2/Project 2	20%	30%	50%				100%
ESE	30%	30%	40%				100%

23AEPC07	DIGITAL IMAGE PROCESSING AND ITS APPLICATIONS	SEMESTER II

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	2	4

Course Objective	• To Gain knowledge in Digital Image Fundamentals, Image Enhancement, Image Segmentation, Representation, Description, Image compression and in certain area of image processing Applications.	
UNIT - I	**DIGITAL IMAGE FUNDAMENTALS**	**9 Periods**
Representing Digital Images: Binary images, Gray scale images: Sampling and quantization, Spatial and Gray level resolution , Color images –Color models, Basics of color image processing-Basic relationship between Pixels: Neighbours of a Pixel, Adjacency, Connectivity, Regions and Boundaries, Distance measures. Image transforms: Discrete Fourier transforms, Discrete Wavelet transforms.		
UNIT – II	**IMAGE ENHANCEMENT IN SPATIAL AND FREQUENCY DOMAIN**	**9 Periods**
Spatial domain image Enhancement: Basic gray level transformations, Histogram processing, Enhancement using arithmetic & logical operators, Basics of spatial filtering Smothening spatial filters, Sharpening spatial filters. Frequency domain image Enhancement: Smothening frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering- Noise models.		
UNIT – III	**IMAGE SEGMNETATION, REPRESENTATION AND DESCRIPTION**	**9 Periods**
Image segmentation: Detection of Discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation, Segmentation by Morphological watersheds. Representation and Description: Representation, Boundary Descriptors, Regional Descriptors.		
UNIT – IV	**IMAGE COMPRESSION**	**9 Periods**
Fundamentals of image compression: Coding redundancy, Inter Pixel redundancy, Psychovisual redundancy, Fidelity Criteria-Image compression models-Elements of Information theory-Error free compression-Lossy compression-Image compression standards.		
UNIT – V	**IMAGE PROCESSING APPLICATIONS**	**9 Periods**
Object Recognition: Pattern and Pattern classes –Recognition based on Decision –theoretic methods – Structural methods –Medical imaging processing: Pattern classification and diagnostic decision – Measures of diagnostic accuracy – Applications: Contrast enhancement of mammograms – Detection of calcifications by region growing – Shape and texture analysis of tumours.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:30 Periods Total: 75 Periods**		

List of Experiments – 30 Periods
1. **Point-to-point transformation-**Thresholding an image and the evaluation of itshistogram. 2. **Histogram Equalization.** 3. **Geometric transformations-**Image rotation, scaling, and translation.Two-dimensional Fourier transform I. 4. **Two-dimensional Fourier Transform**. Harmonic content of an image using the discrete Fourier transform (DFT) and masking with DFT. 5. **Linear filtering using convolution.** 6. **Ideal filters in the frequency domain**-Effects of filtering low and high frequencies in an image. 7. **Non-Linear filtering using convolutional masks-**Effects of a median filter on an image corrupted with impulsive noise. 8. **Morphological operations I.** Erosion and dilation 9. **Entropy as a compression measure-**Entropy as a compression measurement to the DPCM compression measure. 10. **Edge detection-**Edge detectors and their operation in noisy images.

REFERENCES:

1	*Gonzalez R.C., Woods R.E., "**Digital Image Processing**", Fourth Edition, Pearson, 2017.*
2	*Sinha G. R, Patel, B. C., "**Medical Image Processing: Concepts And Applications**", Prentice Hall, 2014.*
3	*Anil K. Jain, '**Fundamentals of Digital Image Processing', Pearson, 2002.***

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to :		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of Digital Image Processing and concepts in Image Enhancement.	K3
CO2	Analyze the image using descriptors and representation schemes and segmentation algorithms.	K4
CO3	Apply the algorithms for object recognition, and Medical Image Processing.	K2
CO4	Understand the Image Compression Techniques	K3
CO5	Analyse the image Processing Applications	K4

COURSE ARTICULATION MATRIX									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	1	3	-	1
CO2	3	2	1	-	-	1	3	-	1
CO3	3	1	1	-	-	1	3	-	1
CO4	3	1	1	-	-	1	3	-	1
CO5	3	2	1	-	-	1	3	-	1
23AEPC07	**3**	**2**	**1**	-	-	**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	20	20	30	30			100
CAT2	20	20	30	30			100
CAT3	30	40	10	20			100
Assignment 1	25	25	25	25			100
Assignment 2	25	25	25	25			100
Assignment 3	25	25	25	25			100
Quiz1	33	33	34				100
Quiz 2	33	33	34				100
Quiz 3	33	33	34				100
Other mode of internal assessments, if any							
ESE	20	20	30	30			100

23AEPC08	EMBEDDED SYSTEM DESIGN LABORATORY	SEMESTER II

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

Course Objective	• This course enables to students to learn above the programming PIC controller and ARM Processor.

LIST OF EXPERIMENTS:

PIC controller:

1. Configuration of ports
2. Timer
3. Seven Segment display
4. I2C
5. LCD interface
6. Stepper Motor control.

ARM Processor:

1. GPIO Configuration
2. Timer
3. LCD interface
4. ADC and DAC
5. PWM Generation
6. Real Time Clock
7. Serial data transfer

Study of sensing elements using IOT.

Mini Project using PIC Controller or ARM processor

Contact Periods:

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

REFERENCES:

1	*Andrew N.Sloss Dominic Symes Chris Wright, "**ARM System Developer's Guide Designing and Optimizing System Software**", Elsevier Inc 2010.*
2	*Joseph Yiu ,"**The Definitive Guide to the ARM Cortex-M**" , Elsevier- Newness, 2014.*
3	*Kirk Zurell, "**C Programming for Embedded Systems**", CRC Press, 2000.*
4	*Dogan Ibrahim, "**Advanced PIC microcontroller projects in C**", Newnes publication, 2012.*
5	*Muhammad Ali Mazidi, Rolin McKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems"*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	An ability to apply programming skills in PIC Controller.	K2
CO2	An exposure to interfacing concepts of PIC controller.	K4
CO3	An ability to apply programming skills in ARM processor	K3
CO4	An exposure to interfacing concepts of ARM processor.	K3
CO5	An ability to apply controllers for real time applications.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	2	-	1
CO2	3	3	-	2	-	1
CO3	3	3	-	2	-	1
CO4	3	3	-	2	-	1
CO5	3	3	-	2	-	1
23AEPC08	3	3	-	2	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

23AEEE01	MINI PROJECT	SEMESTER II

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

COURSE OBJECTIVES:

- To identify, analyze, formulate and handle programming projects with a comprehensive andsystematic approach. In particular acquire practical knowledge within the chosen area of technology for technical project development.

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

COURSE OUTCOMES:

Upon completion of the course, students will be able to/have:		Bloom's Taxonomy Mapped
CO1	An exposure to take up real time problems and challenges.	K6
CO2	Hands-on experience on the technical topics	K4
CO3	Confidence to work on projects independently.	K4
CO4	Better presentation and communication skills	K5
CO5	An understanding of technical dissertation presentation and writing.	K5

COURSE ARTICULATION MATRIX						
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	1	2
CO2	3	3	2	3	2	3
CO3	1	3	2	3	3	3
CO4	1	3	2	3	3	3
CO5	1	3	2	3	3	3
23AEEE01	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

23AEEE02	INTERNSHIP/INDUSTRIAL TRAINING	SEMESTER III

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

***COURSE OBJECTIVES*:**

- To expose the students to work on real time challenges independently in industry and present their technical dissertation and writing.

Lecture : 0 Periods Tutorial : 0 Periods Practical : 160 Periods Total: 160 Periods

COURSE OUTCOMES: Upon completion of the course, the students will have:		**Bloom's Taxonomy Mapped**
CO1	An exposure to the processes of advanced electronics or other related industries	K6
CO2	An ability to take up real time challenges.	K4
CO3	Confidence to work on the project independently.	K4
CO4	Team work experience	K3
CO5	An understanding of technical dissertation presentation and writing.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	1	2
CO2	1	3	2	3	3	3
CO3	3	3	2	3	2	3
CO4	2	2	3	3	1	2
CO5	3	3	2	3	2	3
23AEEE02	3	3	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

23AEEE03	PROJECT PHASE I	SEMESTER III

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

COURSE OBJECTIVE:

- To expose the students to work on real time challenges independently and to present the technical dissertation and writing.

Lecture : 0 Periods Tutorial : 0 Periods Practical : 180 Periods Total: 180 Periods

COURSE OUTCOMES: Upon completion of the course, the students will have:		Bloom's Taxonomy Mapped
CO1	An exposure to take up real time problems and challenges.	K6
CO2	Hands-on experience on the technical topics	K4
CO3	Confidence to work on projects independently.	K4
CO4	Better presentation and communication skills	K5
CO5	An understanding of technical dissertation presentation and writing.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	1	2
CO2	1	3	2	3	3	3
CO3	3	3	2	3	2	3
CO4	1	1	1	1	3	3
CO5	3	3	2	3	2	3
23AEEE03	3	3	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

23AEEE04	PROJECT PHASE II	SEMESTER IV

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

COURSE OBJECTIVE:

- To expose the students to work on real time challenges independently to provide solution and present the technical dissertation and writing.

Lecture : 0 Periods Tutorial : 0 Periods Practical : 360 Periods Total: 360 Periods

COURSE OUTCOMES: Upon completion of the course, the students will have:		Bloom's Taxonomy Mapped
CO1	An exposure to take up real time problems and challenges and provide solution.	K6
CO2	Hands-on experience on the technical topics	K4
CO3	Confidence to work on projects independently.	K4
CO4	Better presentation and communication skills	K5
CO5	An understanding of technical dissertation presentation and writing.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	1	2
CO2	1	3	2	3	3	3
CO3	3	3	2	3	2	3
CO4	1	1	1	1	3	3
CO5	3	3	2	3	2	3
23AEEE04	3	3	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

23AEPE01	DIGITAL IC DESIGN	SEMESTER I

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

Course Objective	• To learn VLSI design methodology, MOS transistor principles, combinational and sequential logic circuit design with FET devices, arithmetic building blocks and memory architectures.	
UNIT - I	**OVERVIEW OF VLSI DESIGN METHODOLOGY**	**9 Periods**
VLSI Design Process - Architectural design - Logical design-Physical design - Layout styles - Full custom, Semicustom approaches, layout design rules: Need for design rules – Layer representations - CMOS nwell / pwell design rules – Design rule backgrounder-Layer assignments-SOI rules.		
UNIT – II	**MOS TRANSISTOR PRINCIPLES AND ADVANCED FET DEVICES**	**9 Periods**
MOSFET Transistor Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, CMOS Inverter - Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters. FinFETs – VI Characteristics – SuperFin Technology.		
UNIT – III	**COMBINATIONAL LOGIC CIRCUITS**	**9 Periods**
Static CMOS Design – Complementary CMOS, Ratioed Logic, Pass-Transistor Logic. Dynamic CMOS Design – Dynamic Logic: Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates.		
UNIT – IV	**SEQUENTIAL LOGIC CIRCUITS**	**9 Periods**
Timing metrics for sequential circuits, Static Latches and Registers, Dynamic Latches and Registers, Clock tree synthesis, Pipelines, Pulse and sense amplifier based Registers, Non-Bistable Sequential Circuits.		
UNIT – V	**ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES**	**9 Periods**
Data path circuits, Architectures for Adders, Multipliers, Shifters, Speed and Area Tradeoffs, Array Subsystems based on CMOS and FinFET design: SRAM, DRAM, ROM.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Jan M Rabaey, Anantha Chandrakasan, B Nikolic, "**Digital Integrated Circuits: A Design Perspective**", 2nd Edition, Prentice Hall of India, 2016.*
2	*Niel H.E. Weste, David Harris, Ayan Banerjee, "**CMOS VLSI Design- A circuits and Systems Perspective**", 3rd Edition, Pearson education, 2015.*
3	*Niraj K. Jha l Deming Chen , "**Nano electronic Circuit Design**", Springers, 2021.*
4	*Wayne Wolf, "**Modern VLSI Design**", PHI Learning Private Limited, New Delhi, 2011.*
5	*Sung-Mo Kang and Yusuf Leblebici, "**CMOS Digital Integrated Circuits**", McGraw Hill, 3rd Edition, 2016.*

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	1	-	1
CO2	3	2	-	1	-	1
CO3	3	2	-	1	-	2
CO4	3	2	-	1	-	2
CO5	3	2	-	1	-	2
23AEPE01	**3**	**2**	**-**	**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	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual /Assignment 1/case study/seminar 1/Project 1		50%	30%	20%			100%
Individual /Assignment 2/case study/seminar 2/Project 2		50%	30%	20%			100%
ESE	30%	30%	20%	20%			100%

23AEPE02	ANALYSIS AND DESIGN OF ANALOG INTEGRATED CIRCUITS *(Common to Applied Electronics & VLSI Design)*	SEMESTER I

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

Course Objective	• To explain, analyse and construct various analog integrated circuits.	
UNIT - I	**CIRCUIT CONFIGURATION FOR BIPOLAR IC**	**9 Periods**
Bipolar Current Mirrors-General Properties-Simple Current Mirror with beta helper-Simple current mirror with degeneration-Cascode Current Mirror-Wilson Current mirror-Bipolar Widlar Current Source-Bipolar Peaking Current Source-Supply Insensitive Biasing- Band-Gap-Referenced Bias Circuits in Bipolar Technology. Output Stages: Transfer Characteristics, Power Output and Efficiency of Emitter Follower and Class B Push-Pull stage.		
UNIT – II	**CIRCUIT CONFIGURATION FOR MOS IC**	**9 Periods**
MOS Current Mirrors-General Properties-Simple Current Mirror with beta helper-Simple current mirror with degeneration-Cascode Current Mirror-Wilson Current mirror-MOS Widlar Current Source-MOS Peaking Current Source- Band-Gap-Referenced Bias Circuits in CMOS Technology. Output Stages: Transfer Characteristics of Source Follower-CMOS Class AB Output Stage		
UNIT – III	**TWO STAGE OPERATIONAL AMPLIFIERS**	**9 Periods**
Basic Two-Stage MOS Operational Amplifiers: Common-Mode Rejection Ratio-Power-Supply Rejection Ratio-Effect of Overdrive Voltages-Layout Considerations - Two-Stage MOS Operational Amplifiers with Cascodes - MOS Telescopic-Cascode Operational Amplifiers - MOS Folded-Cascode Operational Amplifiers - MOS Active-Cascode Operational Amplifiers - Bipolar Operational Amplifiers- Frequency Response of Operational amplifiers.		
UNIT – IV	**PHASE LOCKED LOOPS**	**9 Periods**
Simple PLL: Phase detector- Basic PLL Topology-Dynamics of Simple PLL - Charge-Pump PLLs: Problem of Lock Acquisition-Charge Pump-Basic Charge-Pump PLL – Non-ideal Effects in PLLs - Jitter in PLLs - Delay-Locked Loops – Applications of PLL.		
UNIT – V	**NONLINEAR ANALOG CIRCUITS**	**9 Periods**
Analog Multiplier: Emitter Coupled pair as Multiplier-Gilbert Cell as Multiplier-Complete Analog Multiplier-Gilbert Multiplier Cell as Balanced Modulator and Phase Shifter. Noise: Sources of Noise-Noise Models of IC Components-Circuit Noise Calculations-Equivalent Input Noise Generator-Effect of Feedback on Noise Performance-Noise in Operation Amplifier-Noise Bandwidth-Noise Figure and Noise Temperature.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCE:

1	*Paul R. Gray, Paul J.Hurst, Stephen H.Lewis, and Robert G. Meyer, "**Analysis and Design of Analog Integrated circuits"**, Wiley, 5th Edition, 2009.*
2	*Behzad Razavi, "**Design of Analog CMOS Integrated circuits"**, McGraw Hill Education, 2nd Edition, 2016.*
3	*David Johns, Ken Martin, "**Analog Integrated circuit design"**, Wiley, 2nd Edition, 2013.*

4	*Sergio Franco, "**Design with Operational Amplifiers and Analog Integrated Circuits**" McGraw Hill Education, 4th Edition, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse the basic circuits required to build up Bipolar IC	K4
CO2	Analyse the basic circuits required to build up MOS IC	K4
CO3	Design and describe the characteristics of two stage Bipolar and MOS Operation amplifiers	K3
CO4	Analyse the various types of PLL circuit and explain their applications	K4
CO5	Discuss the construction and working of non-linear analog circuits and describe noise characteristics in analog circuits	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	1	-	1
CO2	3	1	-	1	-	1
CO3	3	1	-	1	-	1
CO4	3	1	-	1	-	1
CO5	3	1	-	1	-	1
23AEPE02	3	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 / Project1		50%	25%	25%			100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	25%	25%			100%
ESE	30%	40%	20%	10%			100%

23AEPE03	SEMICONDUCTOR DEVICE MODELING	SEMESTER I

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

Course Objective

- To acquire the fundamental knowledge on semiconductor theory, device modeling aspects of various semiconductor devices for electronic applications.

UNIT – I MOS CAPACITORS **9 Periods**

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Non equilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown.

UNIT – II MOSFET DEVICES **9 Periods**

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance,
MOSFET Degradation and Breakdown at High Fields.

UNIT – III CMOS DEVICE DESIGN **9 Periods**

CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Non scaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Non uniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length,
Extraction of Channel Length by C–V Measurements.

UNIT – IV BIPOLAR DEVICES **9 Periods**

n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current–Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Falloffat High Currents, Non ideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time- Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor.

UNIT – V MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS **9 Periods**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation.

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

REFERENCES:

1	*Yuan Taur and Tak H.Ning, "**Fundamentals of Modern VLSI Devices**", Cambridge. University Press,2016.*
2	*A.B. Bhattacharyya "**Compact MOSFET Models for VLSI Design**", John Wiley & Sons Ltd, 2009.*

3	*Ansgar Jungel, "**Transport Equations for Semiconductors**", Springer, 2009.*
4	*Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, "**Device Modeling for Analog and RFCMOS Circuit Design**", John Wiley & Sons Ltd, 2004.*
5	*Selberherr, S., "**Analysis and Simulation of Semiconductor Devices**", Springer-Verlag., 1984.*
6	*Behzad Razavi, "**Fundamentals of Microelectronics**" Wiley Student Edition, 2nd Edition, 2014 7.*
7.	*J P Collinge, C A Collinge, "**Physics of Semiconductor devices**" Springer, 2002.*
8.	*8. S.M.Sze, Kwok.K.NG, "**Physics of Semiconductor devices**", Springer, 2006.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Explore the properties of MOS capacitors.	K2
CO2	Analyze the various characteristics of MOSFET devices.	K2
CO3	Describe the various CMOS design parameters and theirimpact on performance of the device.	K2
CO4	Discuss the device level characteristics of BJT transistors.	K2
CO5	Identify the suitable mathematical technique for simulation.	K3

COURSE ARTICULATION MATRIX:

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	1
CO2	3	2	-	-	-	1
CO3	3	1	-	-	-	1
CO4	2	2	-	-	-	1
CO5	3	2	-	-	-	1
23AEPE03	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							100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40%	40%	20%				100%
ESE	40%	40%	20%				100%

23AEPE04	SMART SENSORS	SEMESTER I

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

Course Objective	• This course enables the students to learn the different types of sensors, smart sensors, interfacing sensors with MCU and their applications.	
UNIT – I	**DISPLACEMENT, FORCE AND PRESSURE SENSORS**	**9 Periods**
Definition, Classification and selection of sensors – Measurement of displacement using Potentiometer, LVDT and Optical Encoder – Measurement of force using strain gauge – Measurement of pressure using LVDT based diaphragm and piezoelectric sensor.		
UNIT – II	**TEMPERATURE, POSITION, FLOW AND LEVEL SENSORS**	**9 Periods**
Thermocouple and RTD – Concept of thermal imaging– Measurement of position using Hall effect sensors, Proximity sensors: Inductive and Capacitive – Use of proximity sensor as accelerometer and vibration sensor – Flow Sensors: Ultrasonic and Laser – Level Sensors: Ultrasonic and Capacitive.		
UNIT –III	**SMART SENSORS**	**9 Periods**
General Structure of smart sensors and its components – Characteristic of smart sensors: Self calibration, Self-testing and self-communicating – Application of smart sensors: Automatic robot control and automobile engine control.		
UNIT –IV	**INTERFACING SENSOR INFORMATION AND MCU**	**9 Periods**
Amplification and Signal Conditioning – Integrated Signal Conditioning – Digital conversion,MCU Control – MCUs for Sensor Interface, Techniques and System Consideration – Sensor Integration.		
UNIT – V	**APPLICATION FOR SMART SENSORS**	**9 Periods**
Automotive Protocols – Industrial Networks – Home Automation – MCU Protocols – Wireless Data Communications – RF Sensing, Telemetry. Standards: IEEE 1451, STIM, Smart Plug- and-Play.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45Periods**		

REFERENCES:

1	*D.Patranabis, -**Sensors and Transducers,** Second Edition, Prentice Hall of India, 2005.*
2	*Randy Frank, -**Understanding Smart Sensors**, Third Edition, Artech House Publishers,2013.*
3	*Jacob Fraden, "**Hand Book of Modern Sensors: physics, Designs and Applications**", 2015,3rd edition, Springer, New York.*
4	*Jon. S. Wilson, "**Sensor Technology Hand Book**", 2011, 1st edition, Elsevier, Netherland.*
5	*Sabrie Solomon, "**Sensors Handbook**," 2nd edition McGraw Hill, 1998.*
6	*Y.L. Lin, **"Smart Sensors and Systems",** Springer, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the displacement, force and pressure sensors.	K2
CO2	Exploit the temperature, position, flow and level sensors.	K2
CO3	Gain knowledge on smart sensors and their applications.	K2
CO4	Interface sensor information and MCU.	K3
CO5	Gain knowledge about communication for smart sensors.	K2

COURSE ARTICULATION MATRIX:						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	2	-	-
CO2	3	1	-	2	-	-
CO3	3	1	-	2	-	-
CO4	3	1	-	2	-	-
CO5	3	1	-	2	-	-
23AEPE04	3	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%	30%	50%				100%
CAT2	20%	30%	50%				100%
Individual /Assignment 1/case study/seminar 1/Project 1	20%	30%	50%				100%
Individual /Assignment 2/case study/seminar 2/Project 2	20%	30%	50%				100%
ESE	20%	30%	50%				100%

23AEPE05	MULTIMEDIA COMPRESSION TECHNIQUES	SEMESTER I

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

Course Objective	This course enables its students to learn above the • Various data coding techniques, audio compression techniques, image and video compression techniques.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Compression Techniques – Overview of information theory - Lossless and Lossy coding– Modeling and Coding - Taxonomy of compression techniques – Rate distortion theory - Huffman coding – Non-Binary Huffman Codes –Adaptive Huffman Coding – Applications of Huffman Coding.		
UNIT – II	**ARITHMETIC CODING AND DICTIONARY TECHNIQUES**	**9 Periods**
Introduction - Coding a sequence – Generating deciphering the tag – Generating a binary code – Uniqueness of arithmetic code – Algorithm, Integer implementation – Comparison of Huffman and Arithmetic coding – Applications -Static and Adaptive dictionary – LZ77, LZ78, LZW approach – Applications - Facsimile encoding – Run length coding – Comparison of MH, MR, MMR and JBIG - Scalar and Vector Quantization.		
UNIT – III	**AUDIO COMPRESSION**	**9 Periods**
Audio compression techniques - Frequency domain and filtering - Basic sub-band coding - Application to speech coding - G.722 - Application to audio coding - MPEG audio - Silence suppression - Speech compression techniques – Vocoders.		
UNIT – IV	**IMAGE COMPRESSION**	**9 Periods**
Predictive techniques - DPCM, DM - KL transform – Discrete cosine, Walsh, Hadamardtransform - JPEG, Wavelet based Compression – Quad Trees – EZW, SPIHT, JPEG 2000.		
UNIT – V	**VIDEO COMPRESSION**	**9 Periods**
Video signal representation – Motion compensation – MPEG standards - Motion estimationtechniques - H.261 family of standards - Motion video compression.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES

1	*Khalid Sayood, "**Introduction to Data Compression**", Morgan Kaufman, 2017.*
2	*Salomon D, "**Data Compression The Complete Reference**", Springer, 2015.*
3	*Jan Vozer, "**Video Compression for Multimedia**", AP Press, New York, 1995.*
4	*AlistarMoffat, "**Compression and Coding Algorithms**", Kluwer Academic Publishers, 2002*
5	*Salomon D, "**A Guide to Data Compression Methods**", Springer, 2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Code information using various Lossy and Lossless methods.	K2
CO2	Apply the concepts dictionary based coding techniques.	K3
CO3	Do various analysis on audio compression.	K3
CO4	Implement image and video compression	K2
CO5	Describe various video compression techniques	K2

COURSE ARTICULATION MATRIX:						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	1	-	1
CO2	3	-	2	1	-	1
CO3	3	-	2	1	-	1
CO4	3	-	2	1	-	1
CO5	3	-	2	1	-	1
23AEPE05	3	-	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	40%	40%	20%				100 %
CAT2	40%	40%	20%				100 %
Individual /Assignment 1/case study/seminar 1/Project 1		50%	50%				100 %
Individual /Assignment 2/case study/seminar 2/Project 2		50%	50%				100 %
ESE	40%	40%	20%				100%

23AEPE06	**ANALOG IC DESIGN** *(Common to Applied Electronics and VLSI Design)*	**SEMESTER II**

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

Course Objective	• To develop the skills to design analog VLSI circuits for a given specification.	
UNIT – I	**MOS DEVICE PHYSICS**	**9 Periods**
General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models- Long channel versus short channel devices. Single Stage Amplifiers – General considerations, Common Source Stage: CS stage with resistive load, CS stage with diode connected load, CS stage with current source load, Source Follower stage, Common Gate Stage, Cascode Stage.		
UNIT – II	**MOS AMPLIFIERS AND CURRENT MIRRORS**	**9 Periods**
Differential Amplifiers –single Ended and Differential Operation, Basic Differential Pair, Common mode response, Differential Pair with MOS loads, Gilbert Cell. Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.		
UNIT – III	**FREQUENCY AND NOISE CHARACTERISTICS OF MOS AMPLIFIERS**	**9 Periods**
Frequency Response of Amplifiers: Miller's effect, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage.-Noise: Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in cascade stage, Noise in current mirrors, Noise power trade-off, Noise bandwidth.		
UNIT – IV	**CMOS OPERATIONAL AMPLIFIERS**	**9 Periods**
Properties of feedback circuits – Effect of feedback on noise -Operational Amplifiers – General Considerations, One Stage Op Amps- design procedure, Two Stage Op Amps, Common-Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Concept of Stability and Frequency Compensation in Op. Amps- Basic PLL Topology- Dynamics of Simple PLL - Problem of Lock Acquisition- Charge Pump- Basic Charge-Pump PLL.		
UNIT – V	**D/A AND A/D CONVERTERS**	**9 Periods**
Ideal A/D and D/A converters, Quantization noise, Signed codes, Performance limitations. Nyquist Rate D/A converters: Decoder based Binary scaled, Current mode and hybrid D /A converters – Nyquist A/D Converters: Integrating type, Successive approximation type, Algorithmic type, Interpolating, Pipelined, Time interleaved A/D converters, High performance A/D converters.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Behzad Razavi, "**Design of Analog CMOS Integrated circuits"**, McGraw Hill Education, 2nd edition, 2016.*
2	*David Johns, Ken Martin, "**Analog Integrated circuit design"**, Wiley, 2nd edition, 2013.*
3	*Paul R. Gray, Paul J.Hurst, Stephen H.Lewis, and Robert G. Meyer, "**Analysis and Design of Analog Integrated circuits"**, Wiley, 5th edition, 2009.*
4	*R. Jacob Baker, "**CMOS Circuit Design, Layout, and Simulation**", Wiley, 3rd edition, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain and analyze the MOS device models for different configurations.	K3
CO2	Design various MOS amplifiers and Current mirror circuits,	K4
CO3	Discuss the effects of frequency on MOS amplifier characteristics	K3
CO4	Discuss the effects of feedback and noise in CMOS Operational amplifiers and explain the operation of PLL	K2
CO5	Reproduce and explain the operation of various Nyquist rate data converters	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	1	-	1
CO2	3	1	-	1	-	1
CO3	3	1	-	1	-	1
CO4	3	1	-	1	-	1
CO5	3	1	-	1	-	1
23AEPE06	3	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 / 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%

23AEPE07	EMI AND COMPATIBILITY	SEMESTER II

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

Course Objective	• The students will be able to gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility	
UNIT – I	**INTRODUCTION & SOURCES OF EM INTERFERENCE**	**9 Periods**
Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.		
UNIT – II	**EM SHIELDING**	**9 Periods**
Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures		
UNIT – III	**INTERFERENCE CONTROL TECHNIQUES**	**9 Periods**
Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing -Signal-line filters - Nonlinear protective devices.		
UNIT – IV	**EMC STANDARDS, MEASUREMENTS AND TESTING**	**9 Periods**
Need for standards - The international framework - Human exposure limits to EM fields –EMC measurement techniques - Measurement tools - Test environments.		
UNIT – V	**EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES**	**9 Periods**
Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Christopoulos C*, ***Principles and Techniques of Electromagnetic Compatibility***, *CRC Press, Second Edition, Indian Edition, 2013.*
2	*Paul C R,* ***Introduction to Electromagnetic Compatibility***, *Wiley India, Second Edition,2008.*
3	*Kodali V P,* ***Engineering Electromagnetic Compatibility***, *Wiley India, Second Edition,2010.*
4	*Henry W Ott,* ***Electromagnetic Compatibility Engineering***, *John Wiley & Sons Inc,Newyork,2009.*
5	*Scott Bennett W,* ***Control and Measurement of Unintentional Electromagnetic Radiation***, *JohnWiley & Sons Inc., Wiley Interscience Series, 2007.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Discuss the various sources of electromagnetic interference	K2
CO2	Explain the EMI mitigation techniques of shielding and grounding	K2
CO3	Recall the controlling mechanism of electro-magnetic interference.	K2
CO4	Explain the need for standards and EMC measurement methods	K2
CO5	Discuss about the EM compliance considerations in wireless systems.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	1	-	1
CO2	3	1	-	1	-	1
CO3	3	1	-	1	-	1
CO4	3	1	-	1	-	1
CO5	3	1	-	1	-	1
23AEPE07	**3**	**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%	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%

23AEPE08	ADVANCED COMMUNICATION SYSTEMS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
• Digital Communication, Wireless Communication	PE	3	0	0	3

Course Objective	• To acquire knowledge about the wireless channel characteristics, Diversity techniques, Massive MIMO, Millimeter Wave Communication, D2D and 5G.	
UNIT – I	**WIRELESS CHANNELS**	**9 Periods**
Radio wave propagation, Physical modeling for wireless channels, Path loss and Shadowing, outage probability under path loss and shadowing, time and frequency coherence, Statistical multipath channel models, narrowband fading models, wideband fading models, Discrete-time model, Space-time channel models.		
UNIT – II	**MIMO DIVERSITY AND SPATIAL MULTIPLEXING**	**9 Periods**
Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Spheredecoding, BLAST receivers and Diversity multiplexing trade - off.		
UNIT – III	**MASSIVE MIMO SYSTEM**	**9 Periods**
Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.		
UNIT – IV	**MILLIMETER WAVE COMMUNICATION AND DEVICE-to-DEVICE COMMUNICATION**	**9 Periods**
Millimeter-wave Communications – spectrum regulations, deployment scenarios, beam-forming, physical layer techniques, interference and mobility management. Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2Dstandardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications.		
UNIT – V	**TRANSMISSION AND DESIGN TECHNIQUES FOR 5G**	**9 Periods**
Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1.	*Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "**Millimeter WaveWireless Communications**", Prentice Hall Communications.*
2.	*Hamid Jafarkhani, "**Space - Time Coding: Theory and Practices**", Cambridge University Press2005.*
3.	*Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - "5G **Mobile Communications**", Springer,2017.*
4	*David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2005*
5	*Afif Osseiran, Jose F. Monserrat and Patrick Marsch, - "5G Mobile and Wireles Communications Technology", CambridgeUniversity Press, 2016.*

6	*Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "**New Directions inWireless Communication Systems from Mobile to 5G**", CRC Press.*
7	*Keith Q. T. Zhang, " **Wireless Communications: Principles, Theory and Methodology**" JohnWiley & Sons, 1st Edition, 2016.*
8	*Mischa Dohler, Jose F. Monserrat Afif Osseiran "5G **Mobile and Wireless CommunicationTechnology**", Cambridge University Press 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	To identify the various wireless channels	K2
CO2	To apply various Diversity techniques in Wireless Communication	K2
CO3	To differentiate MIMO and Massive MIMO concepts	K2
CO4	To understand Device to device communication and millimeter wave communication	K2
CO5	To understand the Design techniques to implement 5G	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
23AEPE08	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	50%	50%					100%
CAT2	50%	50%					
Individual /Assignment 1/case study/seminar 1/Project 1	50%	50%					
Individual /Assignment 2/case study/seminar 2/Project 2	50%		50%				100%
ESE	50%	50%					100%

23AEPE09	MEMS AND NEMS	SEMESTER II

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

Course Objective

- To familiarize the concepts of fabrication process of Microsystems, micro sensors, Micro actuators and quantum mechanics and Nano systems.

UNIT – I	OVERVIEW OF MEMS AND NEMS	9 Periods

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS, MEMS and NEMS – Applications, Devices and structures. Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT – II	MEMS FABRICATION TECHNOLOGIES	9 Periods

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials

UNIT – III	MICRO SENSORS	9 Periods

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor.

UNIT – IV	MICRO ACTUATORS	9 Periods

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.

UNIT – V	NANOSYSTEMS AND QUANTUM MECHANICS	9 Periods

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits .

Contact Periods:

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

REFERENCES:

1	*Chang Liu, **"Foundations of MEMS"**, Pearson education India limited, 2006.*
2	*Marc Madou, **"Fundamentals of Microfabrication",** CRC press 1997.*
3	*Sergey Edward Lyshevski, **"MEMS and NEMS: Systems, Devices, and Structures"** CRCPress, 2002.*
4	*Stephen D. Senturia, **"Micro system Design",** Kluwer Academic Publishers,2001*
5	*Tai Ran Hsu ,"**MEMS and Microsystems Design and Manufacture"** ,Tata Mcraw Hill, 2002.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Explain MEMS, NEMS and its applications	K2
CO2	Understand MEMS fabrication technologies	K2
CO3	Acquire knowledge on micro sensors	K2
CO4	Design micro actuators	K3
CO5	Outline Nano systems and Quantum mechanics	K3

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
23AEPE09	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	50%	20%	30%				100%
CAT2	50%	20%	30%				100%
Individual /Assignment 1/case study/seminar 1/Project 1	50%	40%	10%				100%
Individual /Assignment 2/case study/seminar 2/Project 2	50%	25%	25%				100%
ESE	50%	20%	30%				100%

23AEPE10	SOFT COMPUTING AND OPTIMIZATION TECHNIQUES	SEMESTER II

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

Course Objective

- To gain knowledge in neural networks, fuzzy logic, genetic algorithm, neuro- fuzzy modeling and the various conventional optimization techniques

UNIT–I	FUZZY LOGIC	9 Periods

Introduction to Fuzzy logic –Fuzzy sets and membership functions – Operations on Fuzzy sets-Fuzzy relations, rules, propositions, implications, and inferences – Defuzzification techniques -Fuzzy logic controller design-Some applications of Fuzzy logic.

UNIT –II	ARTIFICIAL NEURAL NETWORKS	9 Periods

Supervised Learning: Introduction and how brain works, Neuron as a simple computing element, The perceptron, Back propagation networks: architecture, multilayer perceptron, back propagation learning-input layer, accelerated learning in multilayer perceptron, The Hopfield network, Bidirectional associative memories(BAM),RBF Neural Network. Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self-Organizing Computational Maps: Kohonen Network.

UNIT –III	GENETIC ALGORITHM	9 Periods

Genetic algorithm – Introduction – biological background –traditional optimization and search techniques-Genetic basic concepts- operators–Encoding scheme–Fitness evaluation– crossover - mutation-Travelling Salesman Problem, Particle swam optimization, Ant colony optimization.

UNIT –IV	NEURO-FUZZY MODELING	9 Periods

Adaptive Neuro-Fuzzy Inference Systems (ANFIS) – architecture - Coactive Neuro-Fuzzy Modeling, framework, neuron functions for adaptive networks–Data Clustering Algorithms–Rule base Structure Identification –Neuro-Fuzzy Control –the inverted pendulum system.

UNIT –V	CONVENTIONAL OPTIMIZATION TECHNIQUES	9 Periods

Introduction to optimization techniques, Statement of an optimization problem, classification, Unconstrained optimization- gradient search method - Gradient of a function, steepest gradient-conjugate gradient, Newton's Method, Marquardt Method, Constrained optimization–sequential linear programming, Interior penalty function method, external penalty function method.

Contact Periods:

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

REFERENCES:

1. *George J. Klir and Bo Yuan,* ***"Fuzzy Sets and Fuzzy Logic-Theory and Applications",*** *Prentice Hall, 1995.*
2. *JamesA.Freeman and David.M.Skapura,* ***"Neural Networks Algorithms, Applications and Programming Techniques",*** *Pearson Edn., 2003.*
3. *S.Rajasekaran, G.A.Vijayalakshmi Pai,* ***"Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications ",*** *PHI Learning Pvt.Ltd., 2017.*
4. *Timothy J.Ross,* ***"Fuzzy Logic with Engineering Applications",*** *McGraw-Hill, 1997.*

5.	*Singiresu S. Rao,* ***"Engineering optimization Theory and practice"****, John Wiley & sons, inc, Fourth Edition, 2009*
6.	*J.S.R.Jang, C.T.Sunand, E.Mizutani,* ***"Neuro-Fuzzy and Soft Computing"****, PHI/Pearson Education, 2004.*
7.	*David. E.Goldberg,* ***"Genetic Algorithms in Search, Optimization and Machine Learning",*** *Addison wesley, 2009.*

COURSEOUTCOMES: Upon completion of the course, students will be able to/		**Bloom's Taxonomy Mapped**
CO1	Understand Fuzzy logic concepts	K2
CO2	Interpret the mathematical background of supervised learning and unsupervised learning in artificial neural networks	K3
CO3	Understand the mathematical background of Genetic algorithm	K2
CO4	Understand Neuro- fuzzy modeling	K2
CO5	Solve Unconstrained optimization and constrained optimization problems	K3

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
23AEPE10	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	40%	40%	20%				100%

23AEPE11	MODELING AND SYNTHESIS WITH HDL	SEMESTER III

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

Course Objective

- To understand the language features of Verilog HDL, levels of modeling and synthesis of combinational and sequential circuits in digital logic design.

UNIT – I INTRODUCTION TO LOGIC DESIGN WITH VERILOG	9 Periods

Overview of Digital Design with Verilog HDL - Hierarchical Modeling Concepts: Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block - Basic Concept- Modules and Ports: Module definition-port declaration-connecting ports-hierarchical name referencing. Tasks and Functions.

UNIT – II LEVELS OF MODELING	9 Periods

Gate Level Modeling: Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. Dataflow Modeling: Continuous assignments, delay specification, expressions, operators, operands, operator types. Behavioral Modeling: Structured procedures, initial and always, blocking and nonblocking statements, delay control, generate statement, event control, conditional statements, multiway branching, loops, sequential and parallel blocks.

UNIT – III DESIGN OF DIGITAL LOGIC USING HDL	9 Periods

Design of combinational logic: adders-multiplexers, de-multiplexers, encoders and decoders-comparators-multipliers - Design of Sequential logic: Flip-flops-synchronous and Asynchronous counters-shift registers-Universal shift register-FSM and LFSR. (Using various Levels of Modeling).

UNIT – IV LOGIC SYNTHESIS AND DESIGN FLOW	9 Periods

Logic Synthesis with verilog HDL-Synthesis Design flow, RTL and Test Bench Modeling Techniques and Timing and Path Delay Modeling, Timing Checks, Switch Level Modeling.

UNIT – V PROGRAMMABLE LOGIC DEVICES	9 Periods

Programmable logic devices, storage devices, programmable logic array- programmable array logic-programmability of PLDs and CPLDs.

Contact Periods:

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

REFERENCES:

1	Samir Palnitkar - Verilog HDL, 2nd edition, Pearson Education, 2003.
2	Michael D Ciletti - Advanced Digital Design with the VERILOG HDL, 2ND Edition,PHI, 2009.
3	Z Navabi - Verilog Digital System Design, 2nd Edition, McGraw Hill, 2005.
4	Stephen Brown and Zvonko Vranesic - Fundamentals of Digital Logic with Verilog, 2ndEdition, TMH, 2008.
5	Charles H Roth,. Larry L. Kinney - Fundamentals of Logic Design,2015

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Knowledge on logic design with Verilog HDL	K2
CO2	Explain different levels of modelling digital systems	K2
CO3	Understand Design of combinational logic with HDL	K3
CO4	Understand logic synthesis and design flow	K3
CO5	Knowledge on programmable logic devises	K2

COURSE ARTICULATION MATRIX:						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	-	-	-	-
CO2	3	2	-	2	-	-
CO3	3	2	-	2	-	-
CO4	3	2	-	2	-	-
CO5	2	2	-	-	-	-
23AEPE11	**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	20%	40%	40%				100%
CAT2	20%	40%	40%				100%
Assignment 1	10%	40%	50%				100%
Assignment 2	10%	40%	50%				100%
Quiz1	30%	30%	40%				100%
Quiz 2	30%	30%	40%				100%
ESE	20%	40%	40%				100%

23AEPE12	RF SYSTEM DESIGN	SEMESTER III

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

Course Objective	Upon completion of this course, the students will be familiar with: • Issues with RF components and design of micro strip line, RF Filters, RF amplifiers, Low Noise Amplifiers, RF Oscillators, Mixers and RF Front end components.	
UNIT – I	**RF ISSUES, MICROSTRIP LINE DESIGN**	**9 Periods**
Issues in RF system design - RF behavior of passive components: High Frequency Resistors – High Frequency Capacitors – High Frequency Inductors- Chip Resistors-Chip Capacitors-Surface Mounted Inductors- Micro strip Transmission line design –Short circuit transmission line – Open circuit transmission line-Quarter-wave Transmission Line-Sourced & Loaded Transmission Line-Scattering Parameters – Smith chart based Impedance Matching using Two-Discrete Components.		
UNIT – II	**RF FILTER DESIGN**	**9 Periods**
Basic Resonator and Filter configurations - Filter characteristics - Filter design based on Insertion Loss Method - Butterworth and Chebyshev filters - Prototype filter design and normalization - LPF, HPF, BPF and BSF - Filter Implementation – Kuroda's Identities - Micro strip realization of filters		
UNIT – III	**RF AMPLIFIER DESIGN**	**9 Periods**
Characteristics of RF Amplifiers – Transducer Power gain - Unilateral power gain - Available power gain - Stability - Stability Circles - Tests for unconditional stability - Single StageTransistor Amplifier Design: Design for maximum gain, Design for constant gain & Low noise amplifier design.		
UNIT – IV	**RF OSCILLATOR DESIGN**	**9 Periods**
Basic Oscillator Model - Negative Resistance oscillator - Feedback oscillator design: Hartley, Colpiit's and Clapp Oscillators for RF Systems-High Frequency oscillator: Fixed frequency Oscillator - Voltage controlled oscillator.		
UNIT – V	**MIXERS & RF FRONT END DESIGN**	**9 Periods**
Mixers: Basic Characteristics of Mixers - Single Ended mixer design, Single Balanced Mixer – Double Balanced Mixer - Image Reject Mixer. RF Front End and Tuner building blocks- RF directional couplers and hybrid couplers - Complete RF Tuner design considerations.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design – Theory and Applications",Prentice Hall, 2009.*
2	*David M. Pozar, "**Microwave Engineering**", John Wiley and Sons, 2009.*
3	*David M. Pozar, "**Microwave and RF Wireless Systems**", Wiley, 2001.*
4	*Harvey Lehpamer, "**Transmission System Design Handbook for Wireless Networks**", Artech House, 2002.*
5	*Stephan A Mass, "**Non-Linear Microwave and RF circuits**", Artech House, Second Edition,2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain issues of passive components at RF and analyze micro strip line	K2
CO2	Design RF filters for the filter configurations	K3
CO3	Design RF amplifiers for given specifications	K3
CO4	Design and explain various types of mixer circuits.	K3
CO5	Design and explain the RF front end components and mixers.	K3

COURSE ARTICULATION MATRIX:						
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	-	1
CO2	2	2	1	1	-	1
CO3	2	2	1	1	-	1
CO4	2	2	1	1	-	1
CO5	2	2	1	1	-	1
23AEPE12	**2**	**2**	**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 /Assignment 1/case study/seminar 1/Project 1	20%	50%	30%				100 %
Individual /Assignment 2/case study/seminar 2/Project 2	20%	50%	30%				100 %
ESE	20%	50%	30%				100 %

23AEPE13	ADVANCED COMPUTER ARCHITECTURE ANDPARALLEL PROCESSING	SEMESTER III

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

Course Objective	• To understand the difference between the pipeline and parallel concepts, various types of architectures and the importance of scalable architectures, memories and optimization of memory.	
UNIT - I	**COMPUTER DESIGN AND PERFORMANCE MEASURES**	**9 Periods**
Fundamentals of Computer Design – Parallel and Scalable Architectures – Multiprocessors –Multivector and SIMD architectures – Multithreaded architectures – Data-flow architectures - Performance Measures		
UNIT – II	**PARALLEL PROCESSING, PIPELINING AND ILP**	**9 Periods**
Instruction Level Parallelism and Its Exploitation - Concepts and Challenges - Overcoming DataHazards with Dynamic Scheduling – Dynamic Branch Prediction - Speculation - Multiple Issue Processors - Performance and Efficiency in Advanced Multiple Issue Processors		
UNIT – III	**MEMORY HIERARCHY DESIGN**	**9 Periods**
Memory Hierarchy - Memory Technology and Optimizations – Cache memory – Optimizations of Cache Performance – Memory Protection and Virtual Memory - Design of Memory Hierarchies		
UNIT – IV	**MULTIPROCESSORS**	**9 Periods**
Symmetric and distributed shared memory architectures – Cache coherence issues - Performance Issues – Synchronization issues – Models of Memory Consistency - Interconnection networks – Buses, crossbar and multi-stage switches.		
UNIT – V	**MULTI-CORE ARCHITECTURES**	**9 Periods**
Software and hardware multithreading – SMT and CMP architectures – Design issues – Casestudies – Intel Multi-core architecture – SUN CMP architecture – IBM cell architecture – hp architecture.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Kai Hwang, "**Advanced Computer Architecture**", McGraw Hill International, 2001.*
2	*William Stallings, "**Computer Organization and Architecture – Designing for Performance**", Pearson Education, Seventh Edition, 2006.*
3	*John P. Hayes, "**Computer Architecture and Organization**", McGraw Hill.*
4	*John L. Hennessey and David A. Patterson, "**Computer Architecture – A quantitative approach**", Morgan Kaufmann / Elsevier, 4th. edition, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the Computer design and its performance measures.	K2
CO2	Discuss the limitations and Applications of ILP.	K3
CO3	Identify issues related to memory hierarchy and suggest solutions	K2
CO4	Understand the different multiprocessor and its real time applications	K2
CO5	Illustrate various techniques used in multicore architecture	K2

COURSE ARTICULATION MATRIX:						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	3	-	1
CO2	3	1	-	3	-	1
CO3	3	1	-	3	-	2
CO4	3	1	-	3	-	2
CO5	3	1	-	3	-	2
23AEPE13	**3**	**1**	**-**	**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	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual /Assignment 1/case study/seminar 1/Project 1		50%	50%				100%
Individual /Assignment 2/case study/seminar 2/Project 2		50%	50%				100%
ESE	40%	40%	20%				100%

23AEPE14	EMBEDDED PROCESSORS	SEMESTER III

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

Course Objective	• To learn the basic concepts of MSP430 microcontroller and interfacingconcepts and also ARM processor and its instruction set.	
UNIT – I	**EMBEDDED SOFTWARE TOOLS**	**9 Periods**
Software development tools- editor, assembler, compiler, cross-compiler and simulator, Hardware development tools- development board, device programmer, in-circuit emulator and debuggers. Embedded C Programming, data types and variables, data type modifiers, storage Class modifiers, C statements, structures and operations, pointers, libraries, in-line assembly programming, optimizing and testing embedded C programs.		
UNIT – II	**MSP430 CONTROLLER**	**9 Periods**
MSP430 – Introduction to Architecture - Embedded C Programming in MSP430 – GPIO Pins & Configuration Timers, Capture, & PWM DAC- ADCs –Memory System-Flash Memory-DMA.		
UNIT – III	**INTERFACING WITH MSP430**	**9 Periods**
USCI Port –SPI mode - I2C Mode-UART Mode & RS232 Low Power Mode Operation- Interfacing- Input Devices-Output Devices-DC Motor-Stepper Motor- Alarm interface- AC Devices.		
UNIT – IV	**ARM PROCESSOR FUNDAMENTALS**	**9 Periods**
The RISC design philosophy-ARM design philosophy-Embedded system hardware- AMBA bus protocol, Embedded system software-Applications-ARM core data flow model-Registers- CPSR- Pipeline-Characteristics-ARM 3 stage Pipeline and 5 stage Pipeline-ARM instruction execution- Exceptions, Interrupts and Vector Table.		
UNIT – V	**ARM AND THUMB INSTRUCTION SET**	**9 Periods**
ARM Instruction-Data processing instructions, Branch instructions, Load Store instructions, SWI instruction-Loading Instructions-Conditional Execution. Thumb Instruction-Thumb Registers-ARM Thumb Interworking-Branch instruction, Data processing instruction, Single/multiple load store instruction, Stack instruction, SWI instruction.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCE

1	*Steven Barrett, Daniel Pack,* ***"Microcontroller Programming and Interfacing TI MSP430, Part 1"****, Morgan and Claypool, 2011.*
2	*Brock J. LaMeres,* ***"Embedded Systems Design Using the MSP430FR2355 LaunchPadTM",*** *Springer International Publishing, 2020.*
3	*John H. Davies,* ***"MSP430 Microcontrollers Basics",*** *Elsevier Limited 2008.*
4	*Andrew N. Sloss Dominic Symes Chris Wright, "****ARM System Developer's Guide Designing and Optimizing System Software****", 1st edition Elsevier Inc 2010.*
5	*Steve Furber,* ***"ARM system on chip architecture"****, Second Edition, Pearson Education, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the various embedded software tools.	K2
CO2	Exploit the fundamental blocks of MSP430 microcontroller.	K2
CO3	Interface Peripherals with MSP430 microcontroller.	K3
CO4	Exploit the basic concepts of ARM processor.	K2
CO5	Summarize the ARM and THUMB instruction set.	K3

COURSE ARTICULATION MATRIX:

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2	1	
CO2	3	1	2	2	1	
CO3	3	1	2	2	1	
CO4	3	1	2	2	1	
CO5	3	1	2	2	1	
23AEPE14	3	1	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	30%	30%	40%				100%
CAT2	30%	30%	40%				100%
Individual /Assignment 1/case study/seminar 1/Project 1	30%	30%	40%				100%
Individual /Assignment 2/case study/seminar 2/Project 2	20%	30%	50%				100%
ESE	30%	30%	40%				100%

23AEPE15	BIO-MEDICAL IMAGE PROCESSING	SEMESTER III

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

Course Objective	• This course aims to provide an insight to the Medical imaging modalities and reconstruction techniques.	
UNIT - I	**IMAGE CHARACTERISTICS AND QUALITY METRICS**	**9 Periods**
Real and mental images -Reflected, transmitted and emitted light images-noise-Signal to Noise Ratio-Contrast Optimum contrast-Sharpness-Transfer functions-Resolution-line pairs and MTF. Image quality metrics for digital systems-Global parameter assessment, Spatial frequency assessment, Image processing assessment, Observer assessment.		
UNIT – II	**RADIOGRAPHIC IMAGE**	**9 Periods**
Unsharpness-Geomentric,photographic,motional-identifying the causes of Unsharpness-Over and under penetration-Radiographic contrast -fogging-Graininess-mottle-Image artefacts-Distortion- foreshortening-elongation- Double images Image subtraction techniques-Digital subtraction.		
UNIT – III	**TOMOGRAPHIC IMAGING**	**9 Periods**
Over view of Computerized tomography as an image device-Scanner design-Reconstruction techniques-Reconstruction techniques-CT image quality-Other artefacts in CT-Multislice CT-CT Scanner Performance.		
UNIT – IV	**MAGNETIC RESONANCE IMAGING**	**9 Periods**
Basic principles of Magnetic Resonance Imaging-Block diagram of MR Scanner components- Common artefacts-image reconstruction-imaging equations-image quality-Resolution-Noise-Signal to Noise Ratio-Artefacts-Functional MRI.		
UNIT – V	**3D ULTRASOUND IMAGING**	**9 Periods**
Limitations of 3D Ultrasound imaging-3D Ultrasound scanning techniques-Reconstruction and 3D Ultrasound images-effects of errors in 3D image reconstruction-Viewing of 3D Ultrasound images- 3-D Ultrasound system performance.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Richard L. Van Metter, Jacob Beutel, Harold L. Kundel,* ***"Handbook of Medical Imaging, Volume"*** *1. Physics and Psychophysics, SPIE, 2000.*
2	*Chesney D. N., Chesney M. O. "****Radio graphic imaging****", CBS Publications, New Delhi, 1989*
3	*Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R****. Prince " MRI from Picture to proton"****, Cambridge University press, second edition, New York 2007.*
4	*Frederick W Kremkau****," Diagnostic Ultrasound Principles & Instruments"****, Saunders Elsevier,2005.*
5	*Jerry L. Prince, Jnathan M. Links****, "Medical Imaging Signals and Systems****"- Pearson Education Inc. 2014.*
6	*Peggy, W., Roger D. Ferimarch, "****MRI for Technologists"****, McGraw Hill, New York, second edition, 2000.*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to :		**Bloom's Taxonomy Mapped**
CO1	Assess the characteristics and quality of the image.	K2
CO2	Demonstrate Principles of Radiography.	K2
CO3	Explain the image acquisition using CT.	K3
CO4	Demonstrate the applications of magnetic field in the field of medicine.	K3
CO5	Explain the principles of 3D Ultrasound imaging.	K3

COURSE ARTICULATION MATRIX:						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2	1	-
CO2	3	1	2	2	1	-
CO3	3	1	2	2	1	-
CO4	3	1	2	2	1	-
CO5	3	1	2	2	1	-
23AEPE15	3	1	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	30%	50%	20%				100%
CAT2	30%	50%	20%				100%
Individual /Assignment 1/case study/seminar 1/Project 1	30%	50%	20%				100%
Individual /Assignment 2/case study/seminar 2/Project 2	30%	50%	20%				100%
ESE	30%	50%	20%				100%

23AEPE16	LOW POWER IC DESIGN *(Common to Applied Electronics & VLSI Design)*	SEMESTER IV

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

Course Objective	• To acquire knowledge in low power CMOS designs and optimization.	
UNIT – I	**INTRODUCTION TO LOW POWER DESIGN**	**9 Periods**
Physics of Power Dissipation in CMOS FET Devices-Sources of power consumption- -Basic Principles of Low Power Design. Sources of Power dissipation in Ultra Deep Submicron CMOS Circuits – Static, Dynamic and Short circuit components Effects of scaling on power consumption- Low power design flow- Normalized Figure of Merit – PDP& EDP.		
UNIT – II	**POWER DISSIPATION IN CMOS**	**9 Periods**
SPICE circuit simulation-Gate level Analysis, Architecture level Analysis, Data Correlation Analysis, Monte-Carlo Simulation, Probabilistic Power Analysis. Statistical Techniques - Estimation of Glitching Power - Sensitivity Analysis - Circuit Reliability - Power Estimation at the circuit level - High level Power Estimation - Information Theory based approaches - Estimation of maximum power.		
UNIT – III	**POWER OPTIMIZATION TECHNIQUES**	**9 Periods**
Circuit Level – Transistor and Gate Sizing, Equivalent Pin Ordering, Network Restructuring and Reorganization, Special Latches and Flip Flops, Low Power Digital Cell Library, Adjustable Device Threshold Voltage. Leakage current in deep sub micrometer transistors.		
UNIT – IV	**SPECIAL TECHNIQUES**	**9 Periods**
Gate Reorganization, Signal Gating, Logic Encoding, State Machine Encoding, Precomputational Logic. Architectural and System Level – Power and Performance Management, Switching Activity Reduction, Parallel Architecture with Voltage Reduction, Flow Graph Transformation. Advanced Techniques- Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits, Low power bus – low swing bus, charge recycling bus, delay balancing.		
UNIT – V	**LOW POWER MEMORIES**	**9 Periods**
Basics of ROM, Low power ROM Technology, Basics of SRAM-Memory Cell-Low Power SRAM Technology-Precharge and Equalization Circuit-Basics of DRAM-Low Power DRAM Technology. Conventional BiCMOS Logic- BiCMOS Logic Family-Low Voltage BiCMOS Logic family-Low Voltage BiCMOS Applications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Kaushik Roy and Sharat C Prasad ,"**Low Power CMOS VLSI circuit Design**", John Wiley and Sons, 2010.*
2	*Soudris, Dimitrios, Christrian Pignet, Goutis, Costas, "**Designing CMOS circuits for low power"**, Springer US, First Edition, 2011.*
3	*Gary B Yeap K, "**Practical Low Power Digital VLSI Design**", Springer US, First Edition 2010.*
4	*AjitPal , "**Low Power VLSI circuits and Systems**", Springer India, First Edition, 2014.*
5	*Jan M.Rabaey, Massoud Pedram, "**Low power Design methodologies**", SpringerUS, First Edition, 2014.*

OURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand low power design in CMOS	K2
CO2	Analyze various sources of power dissipation in CMOS circuits	K2
CO3	Reduce the power consumption by optimizing the circuit structures	K3
CO4	Design CMOS low power circuits using various special techniques.	K3
CO5	Understand low power memories	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	-	-	1
CO2	3	1	3	-	-	1
CO3	3	1	1	-	-	1
CO4	3	1	1	-	-	1
CO5	3	1	1	-	-	1
23AEPE16	3	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	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%

23AEPE17	**VLSI SIGNAL PROCESSING** *(Common to Applied Electronics & VLSI Design)*	**SEMESTER IV**

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

Course Objective	• To increase the performance of the DSP systems in terms of power consumption, speed and area	
UNIT – I	**INTRODUCTION TO DSP SYSTEMS,PIPELINING AND PARALLEL PROCESSING OF FIRFILTERS**	**9 Periods**
Introduction to DSP systems - Typical DSP algorithms, Data flow and Dependence graphs - Critical path- Loop bound- Iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.		
UNIT – II	**RETIMING, ALGORITHMIC STRENGTH REDUCTION, RANK ORDER FILTERS**	**9 Periods**
Retiming – Definitions and properties, Unfolding – An algorithm for Unfolding- properties of unfolding- Sample period reduction and parallel processing application, Systolic Architecture Design-Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, Rank-order filters, Odd- Even merge-sort architecture, Parallel rank-order filters		
UNIT – III	**FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS**.	**9 Periods**
Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters, Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power-of- 2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, Combined pipelining and parallel processing of IIR filters- Low-power IIR Filter design using pipelining and parallel processing- Pipelined Adaptive digital filters.		
UNIT – IV	**BIT-LEVEL ARITHMETIC ARCHITECTURES**	**9 Periods**
Scaling and Round off Noise Computations -Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.		
UNIT – V	**NUMERICAL STRENGTH REDUCTION, CLOCKING STYLES, SYNCHRONOUS, ASYNCHRONOUS AND WAVE PIPELINING**	**9 Periods**
Numerical strength reduction – subexpression elimination - multiple constant multiplication- iterative matching, synchronous pipelining and clocking styles - clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining, Asynchronous pipelining, Programmable Digital signal processors.		
Contact Periods: **Lecture: 45 Periods Tutorial: - 0 Periods Practical: -0 Periods Total: 45 Periods**		

REFERENCES:

1	*Keshab K. Parhi, " **VLSI Digital Signal Processing Systems, Design and implementation** ", Wiley, Interscience, 2007.*
2	*U. Meyer – Baese, " **Digital Signal Processing with Field Programmable Gate Arrays**", Springer, Second Edition, 2004.*

3	*Kung S. Y, H. J. While House, T. Kailath, "**VLSI and Modern Signal Processing**", Prentice Hall,1985.*
4	*Jose E. France, Yannis Tsividis"**Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing**", Prentice Hall, 1994.*
5	*Medisetti V. K, "**VLSI Digital Signal Processing**", IEEE Press (NY), USA,1995.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Increase the performance of the FIR filter structures in terms of power consumption, speed and area.	K3
CO2	Reduce the complexity of DSP algorithms in VLSI hardware.	K3
CO3	Increase the performance of the IIR filter structures in terms of power consumption, speed and area.	K3
CO4	Improve the performance of bit level architectures in DSP systems.	K2
CO5	Understand clocking styles, wave pipelining and complexity reduction in computations.	K1

COURSE ARTICULATION MATRIX

COs/POs	**P01**	**P02**	**P03**	**P04**	**P05**	**P06**
CO1	2	3	-	1	-	-
CO2	2	3	-	1	-	-
CO3	2	3	-	1	-	-
CO4	2	3	-	1	-	-
CO5	2	1	-	-	-	-
23AEPE17	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	20%	40%	40%				100%
CAT2	20%	40%	40%				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%	40%	40%				100%

23AEPE18	**ASIC DESIGN** *(Common to Applied Electronics & VLSI Design)*	**SEMESTER IV**

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

Course Objective	• To Design and acquire knowledge on principles of ASIC design flow, fundamentals of logic cells and concepts of various programming technology, high level ASIC design synthesis and ASIC Construction.	
UNIT – I	**FUNDAMENTALS OF ASICs, CMOS LOGIC AND ASIC LIBRARY DESIGN**	**9 Periods**
Types of ASICs - Design flow-CMOS Transistors CMOS Design Rules - Combinational Logic Cell - Sequential Logic cell - Data path Logic Cell -Transistors as Resistors -Transistor Parasitic Capacitance -Logical effort - Library Cell Design-Library Architecture.		
UNIT – II	**PROGRAMMABLE ASICs**	**9 Periods**
Anti fuse - Static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA - Altera FLEX - Altera MAX DC and AC inputs and outputs - Clock and Power inputs - Xilinx I/O blocks.		
UNIT – III	**PROGRAMMABLE ASIC INTERCONNECT, DESIGN SOFTWARE AND LOW LEVEL DESIGN ENTRY**	**9 Periods**
Actel ACT - Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX - Design Systems - Logic Synthesis - Half gate ASIC - Schematic entry - Low level design language - PLA tools - EDIF-CFI design representation.		
UNIT – IV	**LOGIC SYNTHESIS - SIMULATION AND TESTING**	**9 Periods**
Verilog and Logic Synthesis -VHDL and Logic Synthesis - Types of Simulation - Boundary Scan Test - Fault simulation - Automatic Test Pattern Generation.		
UNIT – V	**ASIC CONSTRUCTION**	**9 Periods**
System partition - FPGA partitioning - Partitioning methods - Floor planning - placement - Physical Design Flow - Global Routing - Detailed Routing - Special Routing - Circuit extraction – DRC.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Smith M.J.S.,"**Application Specific Integrated Circuits**", Addison, Wesley Longman Inc., 1997.*
2	*Farzad Nekoogar and Faranak Nekoogar, "**From ASICs to SoCs - A Practical Approach**", Prentice Hall, 2003.*
3	*Wayne Wolf, "**FPGA-Based System Design**", Prentice Hall, 2004.*
4	*Rajsuman R., "**System-on-a-Chip Design and Test**", Santa Clara, CA, Artech House Publishers, 2000.*
5	*Nekoogar F.,"**Timing Verification of Application-Specific Integrated Circuits**", Prentice Hall, 1999*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design sequential and combinational logic cells and analyze Programmable ASICs	K2
CO2	Explain the memory technologies and architecture of Programmable ASIC s.	K2
CO3	Understand the ASIC interconnects and design entry.	K3
CO4	Explain and execute the Logic synthesis of ASIC	K3
CO5	Construct an ASIC using the described methods.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	1	-	2
CO2	3	3	-	1	-	2
CO3	3	3	-	2	-	2
CO4	3	3	-	2	-	2
CO5	3	3	-	1	-	2
23AEPE18	3	3	-	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	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%

23AEPE19	REAL TIME OPERATING SYSTEM	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
• Operating System.	PE	3	0	0	3

Course Objective	• The students will be able to acquire knowledge about the basic concepts of Real time Operating System, various uniprocessor and multiprocessor scheduling mechanisms and Real time communication protocols and databases.	
UNIT – I	**INTRODUCTION TO REAL TIME OPERATING SYSTEM**	**9 Periods**
Introduction to Real time computing Concepts, Example of real time applications-Structure of a real time system-Characterization of real time systems and tasks- Hard and Soft timing constraints -Design challenges- Performance metrics -Prediction of Execution time: Source code analysis, Micro - architecture level analysis, Cache and pipeline issues –Programming Languages for Real -Time System.		
UNIT – II	**REVIEW OF RTOS**	**9 Periods**
Real time OS-Threads and Tasks-Structure of Microkernel-Time Services-Scheduling Mechanisms Communication and Synchronization-Event Notification and Software interrupt.		
UNIT – III	**TASK SCHEDULING AND ALGORITHMS**	**9 Periods**
Task assignment and Scheduling -Task allocation algorithms- Single processor and Multiprocessor task scheduling- Clock driven and Priority based scheduling algorithms –Fault tolerant Scheduling.		
UNIT – IV	**REAL TIME PROTOCOLS**	**9 Periods**
Real Time Communication Network-Topologies and architecture issues-protocols-contension based, token based, polled bus, deadline-based protocol, Fault tolerant routing.RTP and RTCP.		
UNIT – V	**REAL TIME DATABASES**	**9 Periods**
Real time Databases-Transaction priorities-Concurrency control issues-Disk scheduling algorithms-Two phase approach to improve predictability		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical: 0Periods Total: 45 Periods**		

REFERENCES:

1	*Jane W.S. Liu, **"Real Time Operating Systems"**, Pearson Education India, 2000.*
2	*Philip A. Laplante and Seppo J. Ovaska, **"Real Time Operating Systems Design and Analysis: Tools for the Practitioner"** IV Edition IEEE Press, Wiley. 2013.*
3	*C.M. Krishna, Kang G. Shin – **" Real Time Operating Systems"**, International Edition, McGraw Hill Companies, Inc., New York, 2013*
4	Abraham Silberschatz, Peter B. Galvin, Greg Gagre, **"Operating System concepts"**, 8thedition, Wiley, 2008.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain various real time operating system and its design challenges.	K2
CO2	Reproduce and explain the operation of various threads and Tasks	K2
CO3	Design and analyze various real time task scheduling algorithms.	K3
CO4	Illustrate the different real time communication protocols.	K2
CO5	Describe the concept of real time database.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	-	-
CO2	2	-	3	1	-	-
CO3	2	-	3	1	-	-
CO4	2	-	3	1	-	-
CO5	2	-	3	1	-	-
23AEPE19	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	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%

23AEPE20	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	SEMESTER IV

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

Course Objective

• Study heuristic search techniques, Machine Learning, supervised and deep learning algorithms

UNIT – I	PROBLEM SOLVING	9 Periods

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems –adversarial search – constraint satisfaction problems (CSP).

UNIT – II	PROBABILISTIC REASONING	9 Periods

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT – III	SUPERVISED LEARNING	9 Periods

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model– Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.

UNIT – IV	ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING	9 Periods

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging,boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT – V	NEURAL NETWORKS	9 Periods

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

Contact Periods:

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

REFERENCES:

1	*Dan W. Patterson, "**Introduction to Artificial Intelligence and Expert Systems**", Pearson Education,2007*
2	*Stuart Russell and Peter Norvig, "**Artificial Intelligence – A Modern Approach**", FourthEdition, Pearson Education, 2021.*
3	*Kevin Night, Elaine Rich, and Nair B., "**Artificial Intelligence**", McGraw Hill, 2008*
4	*Patrick H. Winston, "**Artificial Intelligence**", Third Edition, Pearson Education, 2006*
5	*Deepak Khemani, "**Artificial Intelligence**", Tata McGraw Hill Education, 2013(http://nptel.ac.in/)*
6	*Christopher M. Bishop, "**Pattern Recognition and Machine Learning**", Springer, 2006.*
7	*Tom Mitchell, "**Machine Learning**", McGraw Hill, 3rd Edition,1997.*
8	*Charu C. Aggarwal, "**Data Classification Algorithms and Applications**", CRC Press, 2014*

9	*Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "**Foundations of MachineLearning**", MIT Press, 2012.*
10	*Ian Goodfellow, Yoshua Bengio, Aaron Courville, "**Deep Learning**", MIT Press, 2016*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Use appropriate search algorithms for problem solving	K2
CO2	Apply reasoning under uncertainty	K2
CO3	Build supervised learning models	K2
CO4	Build ensembling and unsupervised models	K3
CO5	Build deep learning neural network models	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	-	-
CO2	2	-	3	1	-	-
CO3	2	-	3	1	-	-
CO4	2	-	3	1	-	-
CO5	2	-	3	1	-	-
23AEPE20	**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	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%	30%	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 Objective	• 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 Objective	• To have an exposure on planning of smart cities with consideration of the recent challenges and to address the importance of sustainable development of urban area.	
UNIT – I	**SMART CITIES DEVELOPMENT POTENTIALS AND CHALLENGES**	**9 Periods**
Perspectives of Smart Cities: Introduction and Overview - Implementation Challenges - Methodological issues - Spatial distribution of startup cities – Re imagining postindustrial cities - Implementation Challenges for Establishing Smart Urban Information and Knowledge Management System.		
UNIT – II	**SUSTAINABLE URBAN PLANNING**	**9 Periods**
Optimising Green Spaces for Sustainable Urban Planning - 3D City Models for Extracting Urban Environmental Quality Indicators - Assessing the Rainwater Harvesting Potential - The Strategic Role of Green Spaces - Monitoring Urban Expansion.		
UNIT – III	**ENERGY MANAGEMENT AND SUSTAINABLE DEVELOPMENT**	**9 Periods**
Alternatives for Energy Stressed Cities - Social Acceptability of Energy - Efficient Lighting - Energy Management - Urban Dynamics and Resource Consumption - Issues and Challenges of Sustainable Tourism - Green Buildings: Eco-friendly Technique for Modern Cities.		
UNIT – IV	**MULTIFARIOUS MANAGEMENT FOR SMART CITIES**	**9 Periods**
Assessment of Domestic Water Use Practices - Issue of Governance in Urban Water Supply - Assessment of Water Consumption at Urban Household Level - Water Sustainability - Socio-economic Determinants and Reproductive Healthcare System - Problems and Development of Slums.		
UNIT – V	**INTELLIGENT TRANSPORT SYSTEM**	**9 Periods**
Introduction to Intelligent Transport Systems (ITS) - The Range of ITS Applications -Network Optimization - Sensing Traffic using Virtual Detectors - Vehicle Routing and Personal route information - The Smart Car - Commercial Routing and Delivery - Electronic Toll Collection - The Smart Card - Dynamic Assignment - Traffic Enforcement. Urban Mobility and Economic Development.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

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

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

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

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

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

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

Course Objective	• 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 Objective	• 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*	**Rememberin g (K1) %**	**Understandin g (K2) %**	**Applyin g (K3) %**	**Analyzin g (K4) %**	**Evaluatin g (K5) %**	**Creatin g (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 Objective	• To understand the Earth's climate system, changes and their effects on the earth, identifying the impacts, adaptation, mitigation of climate change and for gaining knowledge on clean technology, carbon trading and alternate energy sources.	
UNIT – I	**EARTH'S CLIMATE SYSTEM**	**9 Periods**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification- Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies – Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.		
UNIT – II	**OBSERVED CHANGES AND ITS CAUSES**	**9 Periods**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large-Scale Variability –Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol –UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.		
UNIT – III	**IMPACTS OF CLIMATE CHANGE**	**9 Periods**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios –Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.		
UNIT – IV	**CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES**	**9 Periods**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry –Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) – Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.		
UNIT – V	**CLEAN TECHNOLOGY AND ENERGY**	**9 Periods**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology –Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Biofuels– Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0Periods Practical: 0 Periods Total:45 Periods**		

REFERENCES

1	***"Impacts of Climate Change and Climate Variability on Hydrological Regimes",*** *Jan C. Van Dam, Cambridge University Press, 2003.*
2	*IPCC fourth assessment report - The AR4 synthesis report, 2007*
3	*IPCC fourth assessment report –Working Group I Report****, "The physical sciencebasis",****2007*
4	*IPCC fourth assessment report - Working Group II Report, "****Impacts, Adaptation and Vulnerability****", 2007*
5	*IPCC fourth assessment report – Working Group III Report"* ***Mitigation of Climate Change",*** *2007*
6	***"Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change,*** *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., IPCC Secretariat, Geneva, 2008.*

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

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

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

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

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

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

REFERENCES:

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

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

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

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

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

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

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

REFERENCES

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

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

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

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

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

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

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

REFERENCES

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

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

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

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

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

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

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

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

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

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

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

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

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

Course Objectives	• To apprehend the fundamentals of business analytics and its life cycle. • To gain knowledge about fundamental business analytics. • To study modeling for uncertainty and statistical inference. • To apprehend analytics the usage of Hadoop and Map Reduce frameworks. • 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	• Summarize basics of industrial safety. • Describe fundamentals of maintenance engineering. • Explain wear and corrosion. • Illustrate fault tracing. • 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	• Solve linear programming problem and solve using graphical method. • Solve LPP using simplex method. • Solve transportation, assignment problems. • Solve project management problems. • 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 HEATH AND SAFETY** *(Common to all Branches)*

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

Course Objectives	• To gain knowledge about occupational health hazard and safety measures at work place. • To learn about accident prevention and safety management. • 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	• To understand the costing concepts and their role in decision making. • To acquire the project management concepts and their various aspects in selection. • To gain the knowledge in costing concepts with project execution. • To develop knowledge of costing techniques in service sector and various budgetary control techniques. • 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
ESE		20	40	40			100

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

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

Course Objectives	1. To summarize the characteristics of composite materials and effect of reinforcement in composite materials. 2. To identify the various reinforcements used in composite materials. 3. To compare the manufacturing process of metal matrix composites. 4. To understand the manufacturing processes of polymer matrix composites. 5. To analyze the strength of composite materials.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement on overall composite performance.		
UNIT – II	**REINFORCEMENT**	**9 Periods**
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isosteresconditions.		
UNIT – III	**MANUFACTURING OF METAL MATRIX COMPOSITES**	**9 Periods**
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing- Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering–Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving- Properties and applications.		
UNIT – IV	**MANUFACTURING OF POLYMER MATRIX COMPOSITE**	**9 Periods**
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.		
UNIT – V	**STRENGTH ANALYSIS OF COMPOSITES**	**9 Periods**
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 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 / Project 2			60	40			100
ESE		40	40	20			100

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

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

Course Objective	• 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*	**Rememberin g (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	35	10	-	-	100
CAT2	15	25	25	20	15	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	25	20	20	35	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	20	20	35	15	10	-	100
ESE	25	20	25	20	10	-	100

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

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

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

REFERENCES:

1	*Vladimi V.Mitin, Viatcheslav A. Kochelap and Michael A.Stroscio,* ***"Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications"****, Cambridge University Press, 1st Edition, 2007.*
2	*Vinod Kumar Khanna,* ***"Introductory Nanoelectronics: Physical Theory and Device Analysis"****, Routledge, 1st Edition, 2020.*
3	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
4	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*
5	*Vladimi V.Mitin,* ***"Introduction to Nanoelectronics"****, Cambridge University Press, South Asian Edition, 2009.*
6	*Peter L. Hagelstein, Stephen D. Senturia and Terry P. Orlando, "****Introductory Applied Quantum Statistical Mechanics"****, Wiley, 2004.*
7	*A. F. J. Levi,* ***"Applied Quantum Mechanics"****, 2nd Edition, Cambridge, 2012.*

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

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

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

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

PRE REQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objective	• 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 Objective	• 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 Objective	• 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)*

PRE REQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• 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 Objective	• 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 Objective	• 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)*

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

Course Objective	• 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 Objective

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

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

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

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

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

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

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

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

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

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

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

Contact Periods:

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

REFERENCES:

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

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

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

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

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

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

Course Objective

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

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

REFERENCES:

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

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

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
23AEOE26	**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	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 PROCESSORS *(Common to all Branches)*

PRE REQUISITES	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*	**Rememberin g (K1) %**	**Understandin g (K2) %**	**Applying (K3) %**	**Analyzin g (K4) %**	**Evaluatin g (K5) %**	**Creatin g (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 PROGRAMMING LANGUAGES** *(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	-
23VLOE30	**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 Objective	• 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 Objective	• 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)*

PRE REQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• 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

23AEACZ1	**ENGLISH FOR RESEARCH PAPER WRITING** *(Common to All Branches)*

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

Course Objective	• 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	*rt 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
23AEACZ1	**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

23AEACZ2	**DISASTER MANAGEMENT** *(Common to all branches)*

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

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

REFERENCES:

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

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

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23AEACZ2	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

23AEACZ3	**VALUE EDUCATION** *(Common to all Branches)*

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

Course Objectives	• Value of education and self- development • Requirements of good values in students • 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 153ehavior 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
23AEACZ3	**-**	**-**	**3**	**-**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberin g (K1) %**	**Understandi ng (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluatin g (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%

23VLACZ4	**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
23AEACZ4	**-**	**-**	**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%

23VLACZ5	**PEDAGOGY STUDIES** *(Common to all Branches)*

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

Course Objectives	• To understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. • 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
23AEACZ5	**-**	**-**	**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%

23AEACZ6	STRESS MANAGEMENT BY YOGA (Common to all Branches)

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

Course Objectives	• To create awareness on the benefits of yoga and meditation. • 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
23AEACZ6	**-**	**-**	**-**	**-**	**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%

23AEACZ7	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** *(Common to all Branches)*

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

Course Objectives	• To familiar with Techniques to achieve the highest goal in life. • 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	-	-	-
23AEACZ7	**-**	**-**	**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%

23VLACZ8	**SANSKRIT FOR TECHNICAL KNOWLEDGE** *(Common to all Branches)*

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

Course Objectives	• To get a working knowledge in illustrious Sanskrit, the scientific language in the world. • Learning of Sanskrit to improve brain functioning. • Enhancing the memory power. • 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: 30 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
23AEACZ8	**-**	**-**	**-**	**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%