GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution affiliated to Anna University)

Coimbatore – 641 013

2023

REGULATIONS

CURRICULAM & SYLLABI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.E. VLSI DESIGN – FULL TIME

GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution affiliated to Anna University)

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VISION AND MISSION OF THE INSTITUTION

VISION

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

MISSION

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

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

1. To provide excellence in education, research and public service.
2. To provide quality education and to make the students entrepreneur and employable.
3. Continuous up gradation of techniques for reaching heights of excellence in a Global Perspective.

CHOICE BASED CREDIT SYSTEM

BRANCH: M.E. VLSI DESIGN- FULL TIME

PROGRAMME EDUCATIONAL OBJECTIVES:

PEO 1: Acquire in depth knowledge in the field of VLSI design to meet the current challenges using advanced technology.

PEO 2: Apply the acquired research skills using modern CAD tools in the field of VLSI Design through reflective, independent, innovative and continuous learning ideas.

PEO 3: Apply the learnt engineering ideas for social issues by maintaining professional values and ethical attitude.

PROGRAM OUTCOMES

PO1: To acquire an in-depth knowledge in the field of VLSI Design including wider and global perspective with an ability to evaluate and analyse the existing methods for enhancement.

PO2: To design, analyse and develop complex VLSI circuits using appropriate analytical methods and modern tools towards industry standards with an understanding of its limitations.

PO3: To acquire professional code and conduct, ethics of research and scholarship by considering the research outcomes to the community for sustainable development goals.

PO4: An ability to independently carryout research/investigation and development work to solve practical problems.

PO5: An ability to write and present a substantial technical report / document.

PO6: Students should be able to demonstrate a degree of mastery in VLSI Design through engineering ideas for social issues and industrial problems.

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	23VLFCZ1	Research Methodology and IPR*(Common to all branches)*	FC	40	60	100	3	0	0	3
2	23VLFC02	Advanced Applied Mathematics *(Common to Applied Electronics and VLSI Design)*	FC	40	60	100	3	1	0	4
3	23VLPC01	Advanced Digital System Design*(Common to Applied Electronics and VLSI Design)*	PC	40	60	100	3	0	0	3
4	23VLPC02	Digital IC Design*(Common to Applied Electronics and VLSI Design)*	PC	40	60	100	3	0	0	3
5	23VLPC03	Device Modeling	PC	40	60	100	3	0	0	3
6	23VLPEXX	Professional Elective – I	PE	40	60	100	3	0	0	3
7	23VLACXX	Audit Course-I	AC	40	60	100	2	0	0	0
PRACTICAL										
8	23VLPC04	Digital IC and 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 Name	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
THEORY										
1	23VLPC05	Analog IC Design *(Common to Applied Electronics and VLSI Design)*	PC	40	60	100	3	0	0	3
2	23VLPC06	System on Chip Design	PC	40	60	100	3	0	0	3
3	23VLPEXX	Professional Elective - II	PE	40	60	100	3	0	0	3
4	23VLPEXX	Professional Elective - III	PE	40	60	100	3	0	0	3
5	23VLACXX	Audit Course-II	AC	40	60	100	2	0	0	0
THEORY WITH PRACTICAL COMPONENT										
6	23VLPC07	Scripting Languages and Verification	PC	50	50	100	3	0	2	4
PRACTICAL										
7	23VLPC08	Analog and Mixed Signal Laboratory	PC	60	40	100	0	0	4	2
8	23VLEE01	Mini Project	EEC	60	40	100	0	0	4	2
Total				**370**	**430**	**800**	**17**	**0**	**10**	**20**

THIRD SEMESTER

Sl. No.	Course Code	Course Name	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
THEORY										
1	23VLPEXX	Professional Elective - IV	PE	40	60	100	3	0	0	3
2	23VLOEXX	Open Elective	OE	40	60	100	3	0	0	3
PRACTICAL										
3	23VLEE02	Internship/Industrial Training	EEC	100	-	100	-	-	**	2
4	23VLEE03	Project - I	EEC	60	40	100	0	0	24	12
Total				**240**	**160**	**400**	**6**	**0**	**24**	**20**

** 4 Weeks Internship/Industrial Training

FOURTH SEMESTER

Sl.No	Course Code	Course Name	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
PRACTICAL										
1	23VLEE04	Project - II	EEC	60	40	100	0	0	48	24
Total				60	40	100	**0**	**0**	**48**	**24**

Total Credits: 85

PROFESSIONAL ELECTIVE (PE)

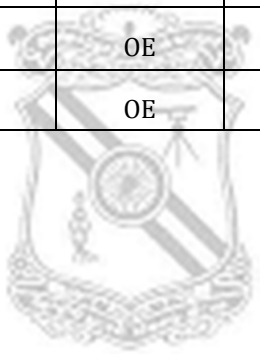
Sl.No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
PROFESSIONAL ELECTIVE I										
1	23VLPE01	VLSI DESIGN AUTOMATION	PE	40	60	100	3	0	0	3
2	23VLPE02	VLSI INTERCONNECTS AND ITS DESIGN TECHNIQUES	PE	40	60	100	3	0	0	3
3	23VLPE03	ANALYSIS AND DESIGN OF ANALOG INTEGRATED CIRCUITS *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
4	23VLPE04	MIXED SIGNAL CIRCUITS	PE	40	60	100	3	0	0	3
5	23VLPE05	QUANTUM CIRCUIT DESIGN	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE II										
6	23VLPE06	LOW POWER IC DESIGN *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
7	23VLPE07	VLSI ARCHITECTURE FOR IMAGE AND VIDEO PROCESSING	PE	40	60	100	3	0	0	3
8	23VLPE08	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	PE	40	60	100	3	0	0	3
9	23VLPE09	POWER MANAGEMENT AND CLOCK DISTRIBUTION	PE	40	60	100	3	0	0	3
10	23VLPE10	QUANTUM DOT CELLULAR AUTOMATA NANOTECHNOLOGY	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE III										
11	23VLPE11	EMBEDDED SYSTEMS DESIGN AND IOT	PE	40	60	100	3	0	0	3
12	23VLPE12	TESTING AND TESTABILITY	PE	40	60	100	3	0	0	3
13	23VLPE13	HARDWARE SECURITY	PE	40	60	100	3	0	0	3
14	23VLPE14	RECONFIGURABLE ARCHITECTURE FOR VLSI	PE	40	60	100	3	0	0	3
15	23VLPE15	VLSI RF CIRCUIT DESIGN	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE IV										
Sl.No.	**Course Code**	**Course Title**	**Category**	**CA Marks**	**End Sem Marks**	**Total Marks**	**Hours/Week**			
							L	**T**	**P**	**C**
16	23VLPE16	VLSI SIGNAL PROCESSING *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
17	23VLPE17	DESIGN OF SEMICONDUCTOR MEMORIES	PE	40	60	100	3	0	0	3
18	23VLPE18	VLSI FOR WIRELESS COMMUNICATION	PE	40	60	100	3	0	0	3
19	23VLPE19	ASIC DESIGN *(Common to Applied Electronics & VLSI Design)*	PE	40	60	100	3	0	0	3
20	23VLPE20	VLSI FOR IOT SYSTEMS	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
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

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



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	23VLACZ1	ENGLISH FOR RESEARCH PAPER WRITING	AC	40	60	100	2	0	0	0
2	23VLACZ2	DISASTER MANAGEMENT	AC	40	60	100	2	0	0	0
3	23VLACZ3	VALUE EDUCATION	AC	40	60	100	2	0	0	0
4	23VLACZ4	CONSTITUTION OF INDIA	AC	40	60	100	2	0	0	0
5	23VLACZ5	PEDAGOGY STUDIES	AC	40	60	100	2	0	0	0
6	23VLACZ6	STRESS MANAGEMENT BY YOGA	AC	40	60	100	2	0	0	0
7	23VLACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	AC	40	60	100	2	0	0	0
8	23VLACZ8	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	8.23
2	PC	11	12			23	27.05
3	PE	3	6	3		12	14.11
4	OE			3		3	3.52
5	AC	0	0				
6	EEC		2	14	24	40	47.05
Total		21	20	20	24	85	100

CATEGORY WISE 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
1	23VLFCZ1	Research Methodology and IPR*(Common to all branches)*	FC	40	60	100	3	0	0	3
2	23VLFC02	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
1	23VLPC01	Advanced Digital System Design*(Common to Applied Electronics & VLSI Design)*	PC	40	60	100	3	0	0	3
2	23VLPC02	Digital IC Design*(Common to Applied Electronics & VLSI Design)*	PC	40	60	100	3	0	0	3
3	23VLPC03	Device Modeling	PC	40	60	100	3	0	0	3
4	23VLPC04	Digital IC and System Design Laboratory*(Common to Applied Electronics & VLSI Design)*	PC	60	40	100	0	0	4	2
5	23VLPC05	Analog IC Design *(Common to Applied Electronics & VLSI Design)*	PC	40	60	100	3	0	0	3
6	23VLPC06	System on Chip Design	PC	40	60	100	3	0	0	3
7	23VLPC07	Scripting Languages and Verification	PC	50	50	100	3	0	2	4
8	23VLPC08	Analog and Mixed Signal Laboratory	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
1	23VLPEXX	Professional Elective – I	PE	40	60	100	3	0	0	3
2	23VLPEXX	Professional Elective - II	PE	40	60	100	3	0	0	3
3	23VLPEXX	Professional Elective - III	PE	40	60	100	3	0	0	3
4	23VLPEXX	Professional Elective - IV	PE	40	60	100	3	0	0	3
Total				160	240	400	12	0	0	12

OPEN ELECTIVE (OE)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
1	23VLOEXX	Open Elective	OE	40	60	100	3	0	0	3
Total				40	60	100	3	0	0	3

AUDIT COURSE (AC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
1	23VLACXX	Audit Course-I	AC	40	60	100	2	0	0	0
2	23VLACXX	Audit Course-II	AC	40	60	100	2	0	0	0
Total				80	120	200	4	0	0	0

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/ Week/ Credits			
							L	T	P	C
1	23VLEE01	Mini Project	EEC	60	40	100	0	0	4	2
2	23VLEE02	Internship/Industrial Training	EEC	100	-	100	-	-	**	2
3	23VLEE03	Project - I	EEC	60	40	100	0	0	24	12
4	23VLEE04	Project - II	EEC	60	40	100	0	0	48	24
Total				280	120	400	0	0	76	40

** 4 Weeks Internship/Industrial Training

23VLFCZ1	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 AND REPORT WRITING**	**9 Periods**
Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables , Relation between frequency distributions and other graphs, preparing data for analysis. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.		
UNIT – IV	**INTELLECTUAL PROPERTY**	**9 Periods**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
UNIT – V	**PATENT RIGHTS**	**9 Periods**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Stuart Melville and Wayne Goddard, "**Research methodology: an introduction**", Juta Academic, 2nd edition, 2014.*
2	*Donald H.McBurney and Theresa White, "**Research Methods**", 9th Edition, CengageLearning, 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**", New age international publishers, 4th Edition, 2018*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate research question for conducting research.	K3
CO2	Analyze qualitative and 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
23VLFCZ1	**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%

23VLFC02	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 foundation of vector spaces, 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 – Null space, Range space - 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	**LINEARPROGRAMMING PROBLEM**	**9+3 Periods**
Formulation – Graphical solution – Simplex method –Big-M method- Transportation and Assignment Models.		
Contact Periods: **Lecture: 45Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60Periods**		

REFERENCES

1	*Bronson,R.,**"Matrix Operation"**, Schaum 'soutlineseries,McGrawHill, Newyork, 2011.*
2	*T. Veerarajan, **"Discrete Mathematics",** McGraw Hill Education (India) Pvt. Ltd., 2019.*
3	*Taha H.A., **"Operations Research: An introduction"**, Ninth Edition, Pearson Education, Asia, New Delhi, 2012.*
4	*Andrews, L.C. and Philips. R. L., **"Mathematical Techniques for engineering and scientists"**, PrenticeHallof India,2006.*
5	*O'Neil P.V., **"Advanced Engineering Mathematics"**, Cengage learning India private limited, (Thomson Asia pvt ltd, Singapore) 2007.*

COURSE OUTCOMES: Upon 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	-	-
23VLFC02	**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 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%

23VLPC01	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 - Dataflow Modeling - 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, state assignment 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-transition table and problems in transition table- Design of asynchronous sequential circuit - Static, dynamic and essential Hazards – Data synchronizers – Mixed operating mode asynchronous circuits - Realization of asynchronous 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 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
23VLPC01	**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%	30%	20%	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50%	30%	20%	-	-	100%
ESE	30%	30%	20%	20%	-	-	100%

23VLPC02	DIGITAL IC 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 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**		

REFERENCE :

1	*Jan M Rabaey, AnanthaChandrakasan, 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 SystemsPerspective"**, 3rd Edition, Pearson education, 2015.*
3	*Niraj K. Jha l Deming Chen , **"Nanoelectronic 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 OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain design methodology and layout design rules	K2
CO2	Discuss the MOS transistor principles	K2
CO3	Design CMOS combinational logic circuits with FET devices	K4
CO4	Design CMOS sequential logic circuits with FET devices	K3
CO5	Design the architectures for arithmetic building blocks and memory	K3

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
23VLPC02	**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 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%

23VLPC03	**DEVICE MODELING**	**SEMESTER I**

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

Course Objective	• To gain knowledge about the basic concepts of MOSFET and its characteristics and noise modeling.	
UNIT – I	**MOSFET DEVICE PHYSICS**	**9 Periods**
Band theory of solids, carrier transport mechanism, MOS capacitor - surface potential accumulation, depletion, inversion, electrostatic potential and charge distribution, threshold voltage, polysilicon work function, interface states and oxide traps, drain current model, sub- threshold characteristics.		
UNIT – II	**MOSFET MODELING**	**9 Periods**
Basic modeling, SPICE Level-1, 2 and 3 models, Short channel effects, Advanced MOSFET modeling, RF modeling of MOS transistors, Equivalent circuit representation of MOS transistor, High frequency behavior of MOS transistor and AC small signal modeling.		
UNIT – III	**NOISE MODELING**	**9 Periods**
Noise sources in MOSFET, Flicker noise modeling, Thermal noise modeling, model for accurate distortion analysis, nonlinearities in CMOS devices and modeling, calculation of distortion in analog CMOS circuit.		
UNIT – IV	**BSIM MOSFET MODELING**	**9 Periods**
Gate dielectric model, Enhanced model for effective DC and AC channel length and width, Threshold voltage model, Channel charge model, Mobility model, Source/drain resistance model, I-V model, gate tunneling current model, substrate current models, Capacitance models, High speed model, RF model, Noise model, Junction diode models, Layout-dependent parasitics model.		
UNIT – V	**FinFET and GAA FET MODEL**	**9 Periods**
Fin Field Effect Transistor : I-V characteristics of FinFET, device capacitances, parasitic effects of extension regions, performance of simple combinational gates and amplifiers, novel circuits using FinFETs and Gate-All-Around FET(GAA FET) device.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Trond Ytterdal, Yuhua Cheng, Tor A. Fjeldly and Wayne Wolf,* ***"Device Modeling for Analog and RF CMOS Circuit Design",*** *John Wiley & Sons Ltd., 2003.*
2	*B. G. Streetman and S. Banarjee,* ***"Solid State Electronic Devices",*** *Prentice-Hall of India Pvt. Ltd, New Delhi, India, 2005.*
3	*A. B. Bhattacharya,* ***"Compact MOSFET Models for VLSI Design",*** *John Wiley & Sons Inc., 2009.*
4	*P. Colinge,* ***"FinFETs and Other Multi-Gate Transistors"****, Springer, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of MOSFET and its characteristics.	**K2**
CO2	Understand MOSFET modeling and analyze its characteristics.	**K3**
CO3	Discuss on Noise modeling in MOSFET and CMOS devices.	**K3**
CO4	Understand BSIM MOSFET models.	**K3**

CO5	Explain the characteristics of Fin FET and GAA FET modeling.	**K2**

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	2	-	1
CO2	3	3	-	2	-	2
CO3	3	3	-	1	-	2
CO4	3	3	-	1	-	2
CO5	3	3	-	2	-	2
23VLPC03	**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	30%	40%	30%	-	-	-	100%

23VLPC04	**DIGITAL IC AND SYSTEM DESIGN LABORATORY**	**SEMESTER I**

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

Course Objective	• To design and analyze the digital CMOS circuits and familiarize with the implementation of design on FPGAs and ASIC.

LIST OF EXPERIMENTS:

Digital IC Laboratory:

1. Performance analysis of CMOS inverter
   i. Plot VTC curve and plot dV_{out} vs. dV_{in}. Determine transition voltage and gain.
      - Calculate V_{IL}, V_{IH}, NM_H, NM_L.
   ii. Plot VTC with varying V_{DD} and varying device ratio.
      - Perform transient analysis with no load and with load and determine t_{pHL}, t_{pLH}, 20%-to- 80% t_r and 80%-to-20% t_f.
      - Perform AC analysis with fanout 0 and fanout 1.

Design the following using MOS/FinFET devices and analyse the performance:

2. Combinational and sequential logic circuit(s)
3. SRAM and DRAM

Layout and analysis:

4. Layout for any architecture and find the RC delay.
5. Design the high performance circuit using Transmission gates.

Design, simulation and implementation on FPGAs:

6. Combinational and Sequential logic circuits based on Mealy and Moore's Machine Modelling.
7. Arithmetic circuits like serial/parallel adder/subtractor and multiplier - with and without pipelining
8. ALU architecture with suitable data path and control path circuits.
9. LCD Interfacing / Keypad Interfacing
10. MIPS 32-bit RISC processor
11. Reconfigurable filter

ASIC Design:

- 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**

REFERENCE :

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	*Altera Corporation- "**Standard Cell ASIC to FPGA Design Methodology and Guidelines"**, April 2009.*
4	*Charles Roth Jr.H., "**Fundamentals of Logic Design"**, Australia cengage learning, 7th edition, 2014.*
5.	*Charles Roth Jr.H., "**Fundamentals of Logic Design"**, Australia cengage learning, 7th edition, 2014.*
6.	*Samir Palnitkar, "**Verilog HDL-A guide to Digital Design and synthesis" 2nd edition Pearson**, Education in South Asia 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design and analyze the digital circuits	K4
CO2	Hands on experience on VLSI based experiments using simulation and synthesis tools	K3
CO3	Work on the layout of the digital circuits	K3
CO4	Implement the design on FPGAs	K3

CO5	Explore on ASIC design flow	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	3	2	2
CO2	3	3	-	3	1	2
CO3	3	2	-	3	2	2
CO4	3	2	-	3	2	2
CO5	3	2	-	3	2	2
23VLPC04	**3**	**2**	**-**	**3**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

23VLPC05	**ANALOG IC DESIGN** *(Common to Applied Electronics and VLSI Design)*	**SEMESTER II**

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	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 and analyze the effects of frequency on MOS amplifier characteristics	K3
CO4	Discuss the effects of feedback and noise in CMOS Operation 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	2	-	1	-	1
CO2	3	2	-	1	-	1
CO3	3	1	-	1	-	1
CO4	3	2	-	1	-	1
CO5	3	2	-	1	-	1
23VLPC05	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 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%

23VLPC06	**SYSTEM ON CHIP DESIGN**	**SEMESTER II**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
DIGITAL ELECTRONICS	PC	**3**	**0**	**0**	**3**

Course Objective	• To design power optimized combinational and sequential logic networks and acquire knowledge on FPGA based design and Floor planning methods.	
UNIT – I	**LOGIC GATES**	**9 Periods**
Introduction - Combinational logic functions - Static complementary gates - Switch logic - Alternative gate circuits – Low power gates - Delay through resistive interconnect - Delay through inductive interconnect.		
UNIT – II	**COMBINATIONAL LOGIC NETWORKS**	**9 Periods**
Introduction - Standard cell - Based layout – Simulation - Combinational network delay - Logic and interconnect design - Power optimization - Switch logic networks - Combinational logic testing.		
UNIT – III	**SEQUENTIAL MAC**	**9 Periods**
Introduction - Latches and Flip-Flops - Sequential systems and Clocking disciplines - Sequential system design - Power optimization - Design validation - Sequential testing.		
UNIT – IV	**SUBSYSTEM DESIGN**	**9 Periods**
Introduction - Subsystem design principles - Combinational shifters – Adders, ALUs, Multipliers. High-Density Memory. Field Programmable Gate Arrays – Role of FPGA, Types of FPGA, FPGA vs Custom VLSI, FPGA based system design - Programmable Logic Arrays.		
UNIT – V	**FLOOR-PLANNING**	**9 Periods**
Introduction – Floor planning methods – Block Placement and Channel Definition, Global Routing, Switchbox Routing, Power Distribution, Clock Distributions, Floor-planning tips, Design Validation – Off Chip Connections – Packages, I/O Architecture, PAD Design.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Wayne Wolf, "**Modern VLSI Design – System – on – Chip Design",** Prentice Hall, 3rd Edition 2008.*
2	*Wayne Wolf, "**Modern VLSI Design – IP based Design",** Prentice Hall, 4th Edition, 2015.*
3	*Joseph Yiu, "**System-on-Chip Design with Arm Cortex-M Processors",** ARM Education Media, 2019.*
4	*Youn-Long Steve Lin, "**Essential Issues in SOC Design: Designing complex systems-on-chip"**, Springer, 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the fundamental factors of System On Chip.	K2
CO2	Impart knowledge on optimization of power in combinational logic machines	K3
CO3	Impart knowledge on optimization of power in sequential logic machines	K3
CO4	Design subsystem design, FPGA and PLA network.	K4
CO5	To acquire knowledge on floor planning methods for system design	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	-	2	1	-

CO2	2	2	-	2	1	-
CO3	2	1	-	3	1	-
CO4	2	3	-	3	1	-
CO5	2	3	-	3	1	-
23VLPC06	**2**	**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	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%

23VLPC07	SCRIPTING LANGUAGES AND VERIFICATION	SEMESTER II

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

Course Objective	• To introduce the basics of various scripting languages such as PERL, TCL, SYSTEM VERILOG and verification techniques, Universal Verification Methodology (UVM) test bench environment and write scripts for automation.	
UNIT – I	**PERL BASICS**	**9 Periods**
History and Concepts of PERL - Scalar Data - Arrays and List Data - Control structures - Hashes - Basics I/O - Regular Expressions - Functions - Miscellaneous control structures - Formats-Advanced PERL-Directory access - File and Directory manipulation - Process Management - Packages and Modules.		
UNIT – II	**TCL BASICS**	**9 Periods**
An Overview of TCL and Tk -Tcl Language syntax - Variables – Expressions -Lists - Control flow – procedures - Errors and exceptions - String manipulations-Advanced TCL-Accessing files- Basics of Tk.		
UNIT – III	**SYSTEM VERILOG**	**9 Periods**
Introduction to System Verilog – Literal values-data Types – Arrays - Data Declarations-attributes-operators – expressions - procedural statements and control flow. Processes in System Verilog – Task and functions - assertions.		
UNIT – IV	**VERIFICATION TECHNIQUES**	**9 Periods**
Introduction to Verification - Testing Vs Verification - Verification Technologies - Functional Verification- Code coverage -Functional coverage. Test bench – Linear Test bench - Linear Random Test bench - Self-checking Test bench - Regression - RTL Formal Verification.		
UNIT – V	**UNIVERSAL VERIFICATION METHODOLOGY**	**9 Periods**
Introduction to UVM - Verification components - Transaction level modeling - Developing reusable verification components - Using Verification components and functional coverage -Register classes.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods**		

LIST OF EXPERIMENTS: Practical: 30 Periods

1. Test Bench generation using HDL based Simulators
2. Test Pattern generation
3. Scan Chain insertion
4. Test Bench generation for Combinational and Sequential circuits using PERL script
5. Compilation and Simulation of design modules and test bench modules using TCL script
6. Verification of DUT by developing a system Verilog test bench

REFERENCES:

1	*Larry Wall, Tom Christiansen, John Orwant, "**Programming PERL**", Oreilly Publications, Fourth Edition, 2012.*
2	*Christian B Spear, "**SystemVerilog for Verification: A guide to learning the Test bench language***

	***features**", Springer publications, Third Edition, 2012.*
3	*John K. Ousterhout, Ken Jones,"**Tcl and the Tk Toolkit**", Pearson Education, Second Edition, 2010.*
4	*Ray Salmei, "**The UVM Primer:A Step-by-Step Introduction to the Universal Verification Methodology**", First Edition, Boston Light Press, 2013.*
5	*Vanessa R. Copper, "**Getting started with UVM: A Beginner's Guide**", Verilab Publishing, First Edition, 2013.*
6	*B.Razavi, "**Design of Analog CMOS Integrated Circuits**", McGraw Hill, 2nd edition, 2011.*
7	*David A. Johns and Ken Martin, "**Analog Integrated Circuit Design**", Wiley India, 2nd edition, 2013*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Develop PERL scripts for VLSI design automation	K2
CO2	Develop TCL scripts for VLSI design automation	K2
CO3	Develop SYSTEM VERILOG scripts for VLSI design automation	K2
CO4	Understand the verification methodology of VLSI circuits.	K2
CO5	Design UVM test bench.	K3

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	2	-
CO2	3	-	2	-	-	-
CO3	3	-	2	-	-	-
CO4	3	3	1	-	2	-
CO5	3	3	1	-	2	-
23VLPC07	**3**	**3**	**2**	**2**	**2**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40%	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%

23VLPC08	ANALOG AND MIXED SIGNAL LABORATORY	SEMESTER II

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

Course Objective	• To design and analyze the analog circuits, mixed signal circuits and hardware-software co-design

LIST OF EXPERIMENTS:

ANALOG IC LABORATORY:

Design and characterization of the following analog circuits

- Common source amplifier with Resistive/diode/current source load & Common gate amplifier:
  - Transfer Characteristics (Vin vs Vout)
  - Frequency Response (Vin vs Frequency)
  - Layout analysis
- Differential amplifier & differential to single-ended circuit :
  - Transfer Characteristics (Vin vs Vout)
  - Frequency Response (Vin vs Frequency)
- Basic/cascode current mirror
- Voltage mode buffer :
  - Transfer Characteristics (Vin vs Vout)
  - Frequency Response (Vin vs Frequency)
- Design of operational amplifier

Mixed Signal Circuits:

- A/D&D/ACircuits
- Sample and Hold
- PLL

Hardware-softwareco-design

- MAC unit
- Image enhancement/sharpening
- Edge Detection
- CORDIC

Software/Tools Required: HDL simulation software, HDL synthesis and implementation tool, Analog/mixed signal design simulator

Contact Periods:

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

REFERENCE :

1	*Behzad Razavi, "**Design of Analog CMOS Integrated circuits**", McGraw Hill Education, 2nd edition, 2016.*
2	*Luciano Lavagno , Igor L. Markov , Grant Martin , Louis K. Scheffer "**Electronic Design Automation for IC Implementation, Circuit Design, and Process Technology: Circuit Design, and Process Technology**", CRC Press; 2nd edition, 2016*
3	*Paul R. Gray and Robert G. Meyer, "**Analysis and Design of Analog Integrated circuits**", Wiley, 5th edition, 2009.*
4	*Giovanni De Micheli , Rolf Ernst Morgon,"**Reading in Hardware/Software Co-Design**" Kaufmann*

	Publishers,2001

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design analog circuit using CMOS for a given design specification	K4
CO2	Study the mixed signal circuits	K4
CO3	Acquire practical knowledge on hardware-software co-design	K3
CO4	Use EDA tools for analog design	K3
CO5	Measure and analyze various parameters in the design	K4

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	2	1	2
CO2	3	3		1	1	2
CO3	3	3	1	2	1	2
CO4	3	3	1	2	1	2
CO5	3	3	1	2	1	2
23VLPC08	3	3	1	2	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

23VLEE01	MINI PROJECT	SEMESTER II

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

COURSEOBJECTIVE:

- To identify, analyze, formulate and handle programming projects with a comprehensive and systematic 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, the students will be able to:		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
23VLEE01	**3**	**3**	**2**	**3**	**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

23VLEE02	INTERNSHIP/INDUSTRIAL TRAINING	SEMESTER III

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

COURSEOBJECTIVE:

- 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 VLSI 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
23VLEE02	**3**	**3**	**2**	**3**	**2**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

23VLEE03	PROJECT - I	SEMESTER III

PRE REQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	24	12

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: 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.	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
23VLEE03	**3**	**3**	**2**	**3**	**2**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

23VLEE04	PROJECT - II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C

NIL	EEC	**0**	**0**	**48**	**24**

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: 720 Periods Total: 720 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
23VLEE04	**3**	**3**	**2**	**3**	**2**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

23VLPE01	VLSI DESIGN AUTOMATION	SEMESTER I

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

Course Objective	• To gain knowledge in VLSI Design methodologies, CAD tools, design trade off in partitioning, placement and floor planning in VLSI Design Automation and the different global routing Algorithm.	
UNIT – I	**VLSI DESIGN METHODOLOGIES**	**9 Periods**
Introduction - VLSI Design Cycle - New trends in VLSI design Cycle- Physical Design – New trends in physical design cycle – Design styles - VLSI Design Automation Tools - Algorithmic graph theory and computational complexity - Tractable and intractable problems.		
UNIT – II	**PARTITIONING AND PLACEMENT**	**9 Periods**
Partitioning – Problem formulation – Group migration Algorithms – KL,FM Algorithms, Placement – Simulation based algorithm – Simulated annealing, Force directed algorithm, Partition based algorithms – Breuer's Algorithm, Terminal propagation Algorithm, Floor planning – Slicing floor plan, Constrained Based Floor planning – Pin assignment.		
UNIT – III	**ROUTING**	**9 Periods**
Routing - Grid routing – Maze routing Algorithms, Global routing – Shortest path based Algorithm, Steiner free based Algorithm, Detailed routing – Left edge Algorithm, Greedy channel Routing – Over the cell routing, clock routing.		
UNIT – IV	**SIMULATION**	**9 Periods**
Simulation – Gate level modeling and Simulation – Switch level modeling and simulation – Switch level modeling and simulation - Combinational Logic Synthesis – Binary decision diagrams – Two level logic Synthesis.		
UNIT – V	**MODELING AND SYNTHESIS**	**9 Periods**
High level synthesis – Hardware models – Internal representation – Allocation assignment and scheduling – High level transformation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*N.A Sherwani, "**Algorithms for VLSI Physical Design Automation**", Kluwer Academic Publishers, 2007.*
2	*S.H. Gerez, "**Algorithms for VLSI Design Automation**", John Wiley & Sons, 2008.*
3	*S. K. Lim, "**Practical Problems in VLSI Physical Design Automation**", Springer, 2008.*
4	*A. B. Kahng, J. Lienig, I. L. Markov, J. Hu, "**VLSI Physical Design: From Graph Partitioning to Timing Closure**", Springer 2011.*
5	*C. J. Alpert, D. P. Mehta, S. S. Sapatnekar, "**Handbook of Algorithms for Physical Design Automation**", Auerbach Publications, 2008.*
6	*Sait.S.M. and Youssef.H., "VLSI Physical Design Automation", World Scientific, 2004.*
7	*Micheli.G.D., "Synthesis and Optimization of Digital Circuits", Tata McGraw Hill, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will have	Bloom's Taxonomy

		Mapped
CO1	Understand VLSI Design methodologies & CAD tools	K2
CO2	Analyze the design trade off in various partitioning, placement and floor planning in VLSI Design Automation	K4
CO3	Analyze the different global routing Algorithms	K4
CO4	Demonstrate simulation in Gate level modeling, Switch level modeling and examine logical synthesis	K3
CO5	Understand modeling and synthesis	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	1	-	1
CO2	3	3	-	1	-	1
CO3	3	3	-	1	-	1
CO4	3	3	-	1	-	1
CO5	3	3	-	1	-	1
23VLPE01	**3**	**3**	**-**	**1**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	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%

23VLPE02	**VLSI INTERCONNECTS AND ITS DESIGN TECHNIQUES**	**SEMESTER I**

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

Course Objective	• To gain knowledge on VLSI Interconnects, Transmission line parameters of VLSI interconnects, understand the cross talk analysis and novel solutions in interconnects	
UNIT – I	**PRELIMINARYCONCEPTS OF VLSI INTERCONNECTS**	**9 Periods**
Interconnects for VLSI applications-Copper interconnections –Method of images- Method of moments- Even and Odd capacitances- Transmission line equations- Miller's theorem- Resistive interconnects as Ladder network Propagation modes in Micro strip interconnects- Slow wave propagations - Propagation delay.		
UNIT – II	**PARASITICRESISTANCES,CAPACITANCE AND INDUCTANCES**	**9 Periods**
Parasitic resistances, capacitances and inductances- Approximate formulas for inductances- Green's function method: using method of images and Fourier integral approach- Network Analog method- Inductance extraction using fast Henry- Copper interconnections for Resistance modeling.		
UNIT – III	**INTERCONNECTION DELAYS**	**9 Periods**
Metal insulator semiconductor Micro strip line- Transmission line analysis for single level interconnections- Transmission line analysis for parallel multilevel interconnections- Analysis of crossing interconnections- Parallel interconnection models for Micro strip line- modeling of lossy parallel and crossing interconnects- High frequency losses in Micro strip line- Expressions for interconnection delays- Active interconnects.		
UNIT – IV	**CROSS TALK ANALYSIS**	**9 Periods**
Lumped capacitance approximation- Coupled multi conductor MIS Micro strip line model for single level interconnects- Frequency domain level for single level interconnects- Transmission line level analysis of parallel multi level interconnections.		
UNIT – V	**NOVEL SOLUTIONS FOR PROBLEMS IN INTERCONNECTS**	**9 Periods**
Optical interconnects – Carbon Nano tubes, Graphenes, Copper wires.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*H B Bakog Lu, Circuits, **"Interconnections and packaging for VLSI**", Addison Wesley publishing company.*
2	*J A Davis, J D Meindl, **"Interconnect technology and design for Gigascale integration",** Kluwer academic publishers.*
3	*Nurmi J, Tenhumen H, Isoaho J, Jantsch A,**"Interconnect Centric design for advanced SOC and NOC",** Springer.*
4	*C K Cheng, J Lillis, S Lin, N Chang, **"Interconnect analysis and synthesis",** Wiley inter-science.*
5	*Askok K Goel, **"High speed VLSI interconnections",** Wiley inter science, second edition, 2007.*
6	*Askok K Goel, **"High speed VLSI interconnections",** Wiley interscience, second edition, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students willbe able to		**Bloom's Taxonomy Mapped**
CO1	Gain Basic knowledge on VLSI Interconnects	K2
CO2	Examine Transmission line parameters of VLSI interconnects	K3
CO3	Examine interconnection delays	K3
CO4	Explain cross talk analysis in Interconnects	K2
CO5	Understand the novel solutions in Interconnects	K2

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	1	-	1
CO2	2	2	-	1	-	1
CO3	2	2	-	1	-	1
CO4	2	2	-	1	-	1
CO5	2	2	-	1	-	1
23VLPE02	**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	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%

23VLPE03	ANALYSIS AND DESIGN OF ANALOG INTEGRATED CIRCUITS *(Common to Applied Electronics and 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**		

REFERENCES:

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	K4
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	2	-	1	-	1
CO2	3	2	-	1	-	1
CO3	3	2	-	1	-	1
CO4	3	2	-	1	-	1
CO5	3	2	-	1	-	1
23VLPE03	**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 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%

23VLPE04	MIXED SIGNAL CIRCUITS	SEMESTER I

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

Course Objective	• To gain knowledge on sampling circuits, sample and hold architectures, D-A and A-D converter architectures	
UNIT – I	**SAMPLE-AND-HOLD ARCHITECTURES**	**9 Periods**
Introduction to Data conversion and Processing**-** Sampling Switches-MOS, Diode Switches-Improvements in MOS Switch Performance-Conventional Open-Loop and Closed-Loop Architecture, Open-Loop Architecture with Miller Capacitance, Multiplexed-Input Architectures, Recycling Architecture, Switched-Capacitor Architecture, Current-Mode Architecture.		
UNIT – II	**DIGITAL-TO-ANALOG CONVERTER ARCHITECTURES**	**9 Periods**
Basic principles-General Considerations-Performance Metrics-Reference Multiplication and Division, Resistor-Ladder DAC Architectures-Ladder architecture with switched subdivider, Intermeshed ladder architecture, Current-Steering Architectures, R2R network based architectures, Segmented Architectures.		
UNIT – III	**ANALOG-TO-DIGITAL CONVERTER ARCHITECTURES**	**9 Periods**
General Considerations- Performance Metrics- Flash Architectures, Two-Step Architectures, Interpolative and Folding Architectures, Pipelined Architectures, Successive Approximation Architectures, Interleaved Architectures.		
UNIT – IV	**DATA CONVERSION SYSTEMS**	**9 Periods**
Amplifiers- Open-Loop Amplifiers, Closed-Loop Amplifiers, Operational Amplifiers, Gain Boosting Techniques. Comparators- Bipolar Comparators, CMOS Comparators, BiCMOS Comparators.		
UNIT – V	**OFFSET CANCELLATION AND CALIBRATION TECHNIQUES**	**9 Periods**
Comparator Offset Cancellation- Input, Output and multistage Offset Storage, Comparators using Offset-Cancelled Latches, OpAmp Offset Cancellation. Calibration Techniques- DAC and ADC Calibration Techniques.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*BehzadRazavi,"**PrinciplesofDataConversionSystemDesign**", JohnWiley&Sons,2011.*
2	*SundaramNatarajan,"**MicroelectronicsAnalysis&design"**,McGrawHill2006*
3	*R.Jbaker,"**CMOSmixedsignalcircuitdesign**",Wileyinterscience,2nd edition,2009.*
4	*B.Razavi,"**DesignofAnalogCMOSIntegratedCircuits**",McGrawHill,2nd edition,2011.*
5	*DavidA. Johns and Ken Martin, "**Analog Integrated Circuit Design**",WileyIndia,2nd edition,2013*

COURSE OUTCOMES: Upon completion of the course, the students will have a/an:		**Bloom's Taxonomy Mapped**
CO1	Basic knowledge of sampling circuits and Sample & Hold architectures	K2
CO2	In-depth knowledge in digital to analog converter architectures	K3
CO3	In-depth knowledge in analog to digital converter architectures	K3
CO4	Knowledge on various blocks of data conversion systems	K2
CO5	Knowledge in various offset cancellation techniques and Calibration techniques	K2

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
23VLPE04	**3**	**3**	**-**	**2**	**-**	**2**

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%

23VLPE05	QUANTUM CIRCUIT DESIGN	SEMESTER I

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

Course Objective	• To gain knowledge on Quantum Computation, Quantum Information, Quantum Circuits and Quantum cryptography	
UNIT – I	**INTRODUCTION**	**9 Periods**
Quantum Computation vs Classical Computation - Mathematics and Quantum Mechanics Preliminaries - Linear Algebra - Unitary Matrices - Tensor Product - Pauli Matrices - Notions of Quantum Information - Quantum state – Dirac Notation - Superpostition - Entanglement - Bell State - Probabilities and Measurements.		
UNIT – II	**QUANTUM GATES AND CIRCUITS**	**9 Periods**
Qubits - Quantum Gates - Single Qubit Gates - Multiple Qubit Gates - Quantum GatesActing on One Qubit - Bloch sphere Representation - Circuit Models - Design of Quantum Circuits.		
UNIT – III	**QUANTUM ALGORITHM AND IMPLEMENTATION**	**9 Periods**
Deutsch's Algorithm - Deutsch-Jozsa Algorithm - Bernstein-Vazirani Algorithm - Quantum Fourier Transform - Shor's Factoring Algorithm - Grover's Search Algorithm.		
UNIT – IV	**QUANTUM ERROR CORRECTION AND SIMULATION**	**9 Periods**
Quantum error correction - Fault-tolerant Computation - Computational Complexity. Analysis of Error Correction Simulation.		
UNIT – V	**QUANTUM CRYPTOGRAPHY**	**9 Periods**
No Cloning Theorem - Private Key Cryptography - Quantum Key Distribution - BB84 protocol - B92 protocol - EPR protocol - Secured Quantum Key Distribution - Post Quantum Cryptography.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Michael A Nielsen and Isaac L Chuang,* ***"Quantum Computation and Quantum Information",*** *Cambridge University Press, 2010.*
2	*Phillip Kaye, Raymond Laflamme and Michele Mosca, "****An Introduction to Quantum Computing****", Oxford University Press, 2007.*
3	*Eleanor Rieffel and Wolfgang Polak,* ***"Quantum Computing A Gentle Introduction",*** *The MIT Press, 2011.*
4	*George F Viamontes, Igor L Markov and John P Hayes, "****Quantum Circuit Simulation",*** *Springer, 2009.*
5	*Chris Bernhardt,* ***"Quantum Computing for Everyone",*** *The MIT Press, 2019.*

COURSE OUTCOMES: Upon completion of this course, students will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand Quantum Computation and Quantum Information	K2
CO2	Explain the Quantum gates and design of Quantum circuits	K3
CO3	Develop and simulate Quantum algorithms	K3
CO4	Explain Quantum error correction and Fault-tolerant computation	K2
CO5	Explain Quantum Cryptography and Key distribution	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
23VLPE05	**3**	**2**	**-**	**1**	**-**	**1**

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%

23VLPE06	LOW POWER 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 acquire knowledge in low power CMOS design 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.*

COURSE 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
23VLPE06	**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%

23VLPE07	VLSI ARCHITECTURE FOR IMAGE AND VIDEO PROCESSING	SEMESTER II

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

Course Objective	• To acquire knowledge on image and video processing algorithms and design VLSI architectures.	
UNIT – I	**IMAGE PROCESSING ALGORITHMS AND ARCHITECTURES**	**9 Periods**
Image Processing Tasks - Low level Image Processing Operations - intermediate level operations Image processor architecture: Requirements and Classification - Uni and Multi processors - MIMD systems - SIMD systems - Pipelines - Design aspects of real time low level image processors - Design method for special architectures.		
UNIT – II	**3D IMAGE PROCESSING**	**9 Periods**
Overview of 3D image - Types and characteristics of 3D image processing - Examples of 3D image processing, Continuous and digitized images, Models of image operations, Algorithm of image operations - Smoothing filter - Difference filter - Differential features of a curved surface - Region growing.		
UNIT – III	**PIPELINED, 2D AND 3D IMAGE PROCESSING ARCHITECTURES**	**9 Periods**
Architecture of a cellular logic processing element - Second decomposition in data path and control -Real time pipeline for low level image processing - Design aspects of Image Processing architectures -Implementation of Low level 2D and 3D and Intermediate level algorithms.		
UNIT – IV	**VIDEO PROCESSING ALGORITHMS**	**9 Periods**
Introduction to Video Processing, Video Sampling and Interpolation, Motion Detection and Estimation Algorithms, Video Enhancement and Restoration, Video Stabilization and Mosaicing-Video Segmentation - MPEG-4 Visual and Fast Motion Estimation Algorithms.		
UNIT – V	**VIDEO PROCESSING ARCHITECTURES**	**9 Periods**
General design space evaluation - Design space motion estimation architectures - Motion estimation architectures for MPEG-4 - Design Tradeoffs - VLSI Implementation search engine I and Search engine II.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Peter M. Kuhn, "**Algorithms, Complexity Analysis and VLSI Architectures for MPEG-4 Motion Estimation**", Springer, 2010.*
2	*Pieter Jonker, "**Morphological Image Processing: Architecture and VLSI design**", Springer, First Edition,1992.*
3	*Sid Ahmed M.A., **"Image Processing - Theory, Algorithm and Architectures**", McGraw Hill, 2009.*
4	*A.MuratTekalp, "**Digital Video Processing**", Pearson Education, Noida, 2010.*
5	*Junichiro Toriwaki · Hiroyuki Yoshida, "**Fundamentals of Three-Dimensional Digital Image***

COURSE OUTCOMES: Upon completion of the course, the students will have an ability to		**Bloom's Taxonomy Mapped**
CO1	Analyze various architectures to realize Image processing algorithms	K2
CO2	Explain the 3D image processing algorithms	K2
CO3	Explain the Pipelined image processing algorithms	K2
CO4	Explore various processing techniques of Image and Video signals and design different architectures for Image and Video signal processing.	K3
CO5	Discuss on Video processing architectures.	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
23VLPE07	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	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%

23VLPE08	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	SEMESTER II

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

Course Objective	To understand signal propagation, transmission line issues, power considerations, clock distribution and system design	
UNIT – I	**SIGNAL PROPAGATION ON TRANSMISSION LINES**	**9 Periods**
Transmission line equations-wave solution- wave vs. Circuits-Characteristic impedance -wave propagation-reflection and bounce diagrams. Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections. PCB layer stack ups and layer/Cu thicknesses- cross-sectional analysis tools- Z_o and T_d equations for micro strip and stripline. Reflection and terminations for logic gates, fan-out-logic switching-reflection coefficient- skin-effect-dispersion		
UNIT – II	**MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK**	**9 Periods**
Multi-conductor transmission-lines-coupling physics- per unit length parameters -Near and far-end cross-talk- minimizing cross-talk (stripline and microstrip) Differential signaling- termination-balanced circuits -S-parameters-Lossy and Lossles models.		
UNIT – III	**NON-IDEAL EFFECTS**	**9 Periods**
Non-ideal signal return paths – gaps -BGA fields- via transitions - Parasitic inductance and capacitance-Transmission line losses –Rs-tanδ - Routing parasitic- Common-mode current- Differential-mode current - Connectors.		
UNIT – IV	**POWER CONSIDERATIONS AND SYSTEM DESIGN**	**9 Periods**
SSN/SSO -DC power bus design-layer stack up- SMT decoupling-Logic families-power consumption and system power delivery-Logic families and speed Package types and parasitic-SPICE- IBIS models -Bit streams- PRBS and filtering functions of link-path components - Eye diagrams -jitter - inter-symbol interference Bit-error rate -Timing analysis.		
UNIT – V	**CLOCK DISTRIBUTION AND CLOCK OSCILLATORS**	**9 Periods**
Timing margin- Clock slew- low impedance drivers- terminations-Delay Adjustments- Cancelling parasitic capacitance-Clock jitter.		
Contact Periods: **Lecture: 45 Period Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*H. W. Johnson and M. Graham, "**High-Speed Digital Design**": A Handbook of Black Magic, Prentice Hall, 1993.*
2	*Douglas Brooks, "**Signal Integrity Issues and Printed Circuit Board Design**", Prentice Hall PTR , 2003.*
3	*S. Hall, G. Hall, and J. McCall, "**High-Speed Digital System Design**": A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.*
4	*Eric Bogatin , "**Signal Integrity – Simplified**" , Prentice Hall PTR, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand signal propagation on transmission lines and cross talk	K1
CO2	Understand multi-conductor transmission lines and cross talk	K2
CO3	Explain non ideal effects in transmission lines	K3
CO4	Understand power considerations and system design	K2
CO5	Explain clock distributions	K1

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	-	-
23VLPE08	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 Assessment 1 /Case Study 1/ Seminar 1 / Project1	30%	40%	30%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30%	40%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23VLPE09	POWER MANAGEMENT AND CLOCK DISTRIBUTION	SEMESTER II

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

Course Objective	• To learn and design various circuits related to power management and clock distribution.

UNIT – I	VOLTAGE AND CURRENT REFERENCES	9 Periods
Current Mirrors, Self Biased Current Reference, startup circuits, VBE based Current Reference, VT Based Current Reference, Band Gap Reference, Supply Independent Biasing, Temperature Independent Biasing, PTAT Current Generation, Constant Gm Biasing.		
UNIT – II	**LOW DROP OUT REGULATORS**	**9 Periods**
Analog Building Blocks, Negative Feedback, Performance Metrics, AC Design, Stability, Internal and External Compensation, PSRR – Internal and External compensation circuits.		
UNIT – III	**OSCILLATOR FUNDAMENTALS**	**9 Periods**
General considerations, Ring oscillators, LC oscillators, Colpitts Oscillator, Jitter and Phase noise in Ring Oscillators, Impulse Sensitivity Function for LC & Ring Oscillators, Phase Noise in Differential LC Oscillators.		
UNIT – IV	**CLOCK DISTRIBUTION CIRCUITS**	**9 Periods**
PLL Fundamental, PLL stability, Noise Performance, Charge-Pump PLL Topology, CPPLLBuilding blocks, Jitter and Phase Noise performance, DLL fundamentals.		
UNIT – V	**CLOCK AND DATA RECOVERY CIRCUITS**	**9 Periods**
CDR Architectures, Trans Impedance Amplifiers and Limiters, CMOS Interface, Linear HalfRate CMOS CDR Circuits, Wide capture Range CDR Circuits.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Gabriel.a. Rincon-Mora, "Voltage References from Diode to Precision Higher Order Band gap circuits", John Wiley & Sons Inc, 2002.*
2	*Gabriel.a. Rincon-Mora, "Analog IC Design with Low-Dropout Regulators", Mcgraw-Hill Professional Pub, 2009.*
3	*BehzadRazavi, "Design of Analog CMOS Integrated Circuits", Tata Mcgraw Hill, 2001*
4	*Floyd M. Gardner ,"Phase Lock Techniques" John Wiley& Sons, Inc 2005.*
5	*MichielSteyaert, Arthur H.M. Van Roermund, Herman Casier, "Analog Circuit Design: High Speed Clock and Data Recovery, High-Performance Amplifiers Power Management", Springer, 2008.*
6	*Behzadrazavi, "Design of Integrated Circuits for Optical Communications", McGraw Hill, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design voltage and current reference circuits for a given specification.	K3
CO2	Recognize the concepts of low drop out regulators.	K2
CO3	Choose oscillator topology and handle noises in oscillator circuits.	K3
CO4	Design clock distribution circuits.	K3
CO5	Design clock generation circuits in the context of high speed I/Os, High speed Broad	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	
23VLPE09	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
CAT3	30	30	40				100
Assignment 1	20	30	50				100
Assignment 2	20	30	50				100
Assignment 3	20	30	50				100
Quiz1	50	50					100
Quiz 2	50	50					100
Quiz 3	50	50					100
ESE	30	30	40				100

23VLPE10	QUANTUM DOT CELLULAR AUTOMATA NANOTECHNOLOGY	SEMESTER II

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

Course Objective	• To understand quantum dot cellular automata nanotechnology basics, terminology, design of digital circuits and transforms.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Emerging Nanotechnologies-Electronics beyond Moore's law – Limitations of CMOS Technology – Alternatives to MOSFET and Challenges – Emerging Transistor based Devices – IC Technology beyond CMOS Era-USDM and Quantum Computing – QCA modeling approach.		
UNIT – II	**QCA TERMINOLOGY**	**9 Periods**
QCA Basics – SchrÖdinger's equation in quantum wires – Quantum boxes – Non-zero angular momentum states – Spherical quantum dots – Tiny quantum dots – Cuboidal dots - Dots of arbitrary shape – Approaches to pyramidal dots – Matrix approaches – Transport through dot arrays - Crossovers in QCA – Convergence tests – Efficiency – Tool for QCA Simulation.		
UNIT – III	**DESIGN OF BASIC DIGITAL CIRCUITS IN QCA**	**9 Periods**
Logic Primitives in QCA – Clocking in QCA – Role and Types – Design of Logic Gates and Multiplexer in QCA – Design of a One-Bit Full-Adder – Flip-Flop in QCA.		
UNIT – IV	**DESIGN OF ADDERS AND MULTIPLIERS IN QCA**	**9 Periods**
Design of Ripple Carry Adder (RCA) and Prefix Adders in QCA – Design of 16-bit Hybrid Adder in QCA – Layout Level Implementation of adders and comparisons. Introduction to Multipliers – Design of Multiplier in QCA – The Baugh-Wooley Multiplier for 2's Complement Numbers – Design of Baugh-Wooley Multiplier in QCA.		
UNIT – V	**TRANSFORM IN QCA**	**9 Periods**
Discrete Hadamard Transform Computation in QCA – Basics of Discrete Hadamard Transform – Mathematical Formulation of DHT Computation – QCA Realization – Performance of a Full-Parallel Addition Strategy – Applications of Quantum Dot Cellular Automata Technology.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Paul Harrison, Alex Valavanis, "* ***Quantum Wells, Wires and Dots: Theoretical and Computational Physics of Semiconductor Nanostructures****" 4th Edition, Wiley, 2016.*
2	*K.Sridharan, Vikramkumar Pudi, "****Design of Arithmetic Circuits in Quantum Dot Cellular Automata Nanotechnology – Studies on Computational Intelligence****", Springer International Publishing, 2015.*
3	*Fabrizio Lombardi, Jing Huang, "****Design and Test of Digital cirucits by Quantum-Dot Cellular Automata****", Artech House, 2007.*
4	*Kasper.E and Paul. D, "****Silicon Quantum Integrated circuits-Silicon-Germanium Heterostructure Devices: Basics and Realizations****", Springer-Verlag Berlin Heidelberg, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basics of QCA	K2
CO2	Describe the QCA terminology	K2
CO3	Design basic Digital Circuits in QCA	K3
CO4	Design of adders and multipliers in QCA	K3
CO5	Discuss the transform in QCA	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	2	-
CO2	3	1	-	-	2	-
CO3	3	3	-	3	2	2
CO4	3	3	-	3	2	2
CO5	3	1	-	-	2	-
23VLPE10	3	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%	30%	20%	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50%	30%	20%	-	-	100%
ESE	30%	30%	20%	20%	-	-	100%

23VLPE11	EMBEDDED SYSTEM DESIGN AND IOT	SEMESTER III

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

Course Objective	• To learn the basic concepts of ARM CORTEX processor and IOT.	
UNIT – I	**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 characteristics.		
UNIT – II	**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.		
UNIT – III	**APPLICATIONS AND CASE STUDIES**	**9 Periods**
Applications of Embedded systems – Case study of embedded system (using ARM/cortex) for monitoring, controlling and industrial automation–Smart Card–Engine Control Unit - Digital still camera -Video accelerator.		
UNIT – IV	**IOT DESIGN METHODOLOGY**	**9 Periods**
Overview of Internet of Things – Physical Design - IoT System Management with NETCONF-YANG, SNMP - IoT design methodology - Specifications - Integration and Application Development.		
UNIT – V	**IIOT AND CASE STUDIES OF IOT**	**9 Periods**
IIOT Architecture – IIOT Requirements - IIoT Business Model: Categorization- Business opportunities - Reference Architecture of IIoT – Case Studies illustrating IOT design- Home Automation – Smart Cities - Environment – Agriculture.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Joseph Yiu, "**The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors"**, Newnes Third Edition, 2013.*
2	*Andrew N. Sloss Dominic Symes Chris Wright, "**ARM System Developer's Guide Designing and Optimizing System Software**", 1st edition Elsevier Inc 2010.*
3	*Dr. Mark Fisher**, ARM Cortex M4 Cook Book**, Packt Publishing, 2016.*
4	*ArshdeepBahga, Vijay Madisetti, "**Internet of Things-A hands-on approach**", Universities Press, 2015.*
5	*Sudip Misra, Chandana Roy, Anandarup Mukherjee, **"Introduction to Industrial Internet of Tings and Industry 4.0**", CRC Press, 1st edition, 2021*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the Architecture and features of ARM CORTEX processor.	K2
CO2	Apply programming skill for interfacing with ARM CORTEX processor.	K3
CO3	Relate the applications and case studies of embedded system.	K2
CO4	Discuss the advanced IOT design specifications.	K2
CO5	Analyze and apply IOT to real time applications.	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	
23VLPE11	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 Assessment 1/ Case Study 1/ Seminar 1/ Project 1	20%	30%	50%	-	-	-	100%
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20%	30%	50%	-	-	-	100%
ESE	30%	30%	40%	-	-	-	100%

23VLPE12	TESTING AND TESTABILITY	SEMESTER III

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

Course Objective	• To gain knowledge on fault modeling, testing and test vector generation in combinational and sequential logic circuits and get exposure to testability approaches, various fault diagnosis methods in logic circuits.	
UNIT – I	**FAULT MODELING AND SIMULATION IN COMBINATIONAL AND SEQUENTIAL CIRCUITS**	**9 Periods**
Basics of Testing: Fault models, Combinational logic and fault simulation - Test generation for Combinational Circuits - Classification of sequential ATPG methods - Fault collapsing and simulation.		
UNIT – II	**FUNCTIONAL TESTING AND DELAY FAULT TESTING**	**9 Periods**
Universal test sets: Pseudo-exhaustive and iterative logic array testing - Clocking schemes for delay fault testing - Testability classifications for path delay faults - Test generation and fault simulation for path and gate delay faults.		
UNIT – III	**CMOS TESTING**	**9 Periods**
Testing of static and dynamic circuits - Fault diagnosis: Fault models for diagnosis, Cause-effect diagnosis - Effect-cause diagnosis.		
UNIT – IV	**DESIGN FOR TESTABILITY**	**9 Periods**
Scan design - Partial scan - Use of scan chains - Boundary scan - DFT for other test objectives - Memory Testing – SOC testing – Core level test – Core test access – Core test wrapper.		
UNIT – V	**BUILT-IN SELF-TEST**	**9 Periods**
Pattern Generators - Estimation of test length - Test points to improve testability - Analysis of aliasing in linear compression - BIST methodologies - BIST for delay fault testing.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*N. Jha& S.D. Gupta, "**Testing of Digital Systems**", Cambridge, 2003.*
2	*W. W. Wen, "**VLSI Test Principles and Architectures Design for Testability**", Morgan Kaufmann Publishers. 2006.*
3	*Michael L. Bushnell &Vishwani D. Agrawal," **Essentials of Electronic Testing for Digital,memory & Mixed signal VLSI Circuits**", Kluwar Academic Publishers, 2000.*
4	*P. K. Lala," **Digital circuit Testing and Testability**", Academic Press, 1997.*
5	*M. Abramovici, M. A. Breuer, & A.D. Friedman, "**Digital System Testing and Testable Design**", Computer Science Press, 1990.*
6	*A.L.Crouch, "**Design Test for Digital IC's and Embedded Core systems",** Beijing China Electric Power Press, 2010.*

COURSE OUTCOMES: On completion of the course, the students will have		**Bloom's Taxonomy Mapped**
CO1	Basic knowledge on fault modeling, testing and test generation in combinational & sequential .logic circuits	K3
CO2	Exposure to functional testing and delay fault testing	K4
CO3	Understanding of various test generation methods for static & dynamic CMOS circuits and the various fault diagnosis methods in logic systems	K2
CO4	Identify the Design for Testability methods for combinational & sequential circuits.	K2
CO5	Recognize the BIST techniques for improving testability.	K2

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2	2	-
CO2	3	-	2	-	-	-
CO3	3	-	2	-	-	-
CO4	3	3	1	-	2	-
CO5	3	3	1	-	2	-
23VLPE12	**3**	**3**	**2**	**2**	**2**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN							
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%

23VLPE13	HARDWARE SECURITY	SEMESTER III

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

Course Objective	• To acquire knowledge about the broader aspects of Hardware Security services, understand the different hardware attacks and chipper techniques, hardware side channel analysis and physical unclonable functions	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction - Need of Hardware security - Security vs Hardware Trust - Attacks, Vulnerabilities and Countermeasures - Conflict between security and Test/Debug-Overview of Cryptology-Symmetric cryptography – Cryptanalysis - Modular Arithmetic and more Historical Ciphers - Stream Ciphers.		
UNIT – II	**CIPHER TECHNIQUES**	**9 Periods**
Data Encryption Standard (DES) - Internal structure of DES - Security of DES - Implementation in Software and Hardware - DES Alternatives - Advanced Encryption Standard (AES) - Introduction to public key cryptography.		
UNIT – III	**HARDWARE ATTACKS**	**9 Periods**
Hardware Trojan – Hardware Trojans in FPGA Designs - Trojan taxonomy - Effect of Hardware Trojan on Circuit Reliability – Countermeasures against Hardware Trojans – Trojan detection techniques – Classification of Trojan detection – Challenges in Trojan detection.		
UNIT – IV	**SIDE CHANNEL ANALYSIS**	**9 Periods**
Introduction to Side Channel Analysis - Types of Side Channel Attacks - Power Attacks - Simple Power Analysis - Timing Attack - Fault Attacks - Cache Attacks - Scan Chain Based Attacks.		
UNIT – V	**PHYSICAL UNCLONABLE FUNCTIONS**	**9 Periods**
Introduction – Classification – Properties - Practical Realization – Delay based and Memory based PUF - PUF Quality Metrics - Security Analysis - Applications - Introduction to Hardware Intellectual Property protection and piracy.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*C. Paar, and Jan Pelz, Springer-Verlag Berlin Heidelberg,* ***"Understanding Cryptography****: A Textbook for Students and Practitioners"*, *Springer, 2010.*
2	*Debdeep Mukhopadhyay and Rajat Subhra Chakraborty,* ***"Hardware Security: Design, Threats, and Safeguards"****, CRC Press,2015*
3	*Swarup Bhunia and Mark Tehranipoor,* ***"Hardware security: a hands-on learning approach"*** *Morgan Kaufmann, 2018.*
4	*Mohammad Tehranipoor and Cliff Wang,* ***"Introduction to Hardware Security and Trust"****, Springer, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the scope and significance of various security mechanisms and services applicable hardware security	K2
CO2	Interpret hardware attacks and techniques.	K2
CO3	Explain about different techniques of block and Stream ciphers.	K2
CO4	Discuss the different side channel analysis.	K3
CO5	Identify and reproduce the different classifications of physical unclonable functions.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	1	-	-	1
CO2	2	1	1	-	-	1
CO3	2	1	1	-	-	1
CO4	2	1	1	-	-	1
CO5	2	1	1	-	-	1
23VLPE13	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	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%

23VLPE14	RECONFIGURABLE ARCHITECTURE FOR VLSI	SEMESTER III

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

Course Objective	• To understand the concepts of reconfigurable architectures, management and apply optimization techniques to increase the performance of the processor for different applications.	
UNIT – I	**RECONFIGURABLE ARCHITECTURES AND SYSTEMS**	**9 Periods**
Computational Fabric, Array and Interconnects, Extending logic, Configuration, Architectures- Fine and Coarse grained with and without processors. Systems PAM, VC, Splash, Prism, CAL, Cloning, Accelerating Technology– Teramac, Reconfigurable Supercomputing- Cray, SRC, Silicon Graphics, CMX.		
UNIT – II	**RECONFIGURATION MANAGEMENT**	**9 Periods**
Configuration Architectures, Managing the Reconfiguration Process, Reducing Configuration Transfer time, Computing Models and System Architectures- Computing C for Spatial Computing, Operating System Support for Reconfigurable Computing- Flexible Binding, Scheduling, Preemption Communication, Synchronization.		
UNIT – III	**IMPLEMENTATION ISSUES ON RECONFIGURABLE PLATFORMS**	**9 Periods**
Structural Mapping Algorithms, Integrated Mapping Algorithms, Mapping Algorithms for Heterogeneous Resources. FPGA Placement- FPGA Placement Problem, Clustering Simulated Annealing for Placement, Partition-based Placement, Analytic Placement. Data path Composition- Fundamentals, Impact of Device Architecture, Interface to Module Generators, Mapping, Placement, Compaction.		
UNIT – IV	**APPLICATION DEVELOPMENT**	**9 Periods**
Retiming, Re-pipelining, and C-slow Retiming- Configuration Bit stream Generation- Downloading Mechanisms, Instance-specific Design, Partial Evaluation, Precision Analysis for Fixed-point Computation, Hardware/Software Partitioning.		
UNIT – V	**CASE STUDIES OF FPGA APPLICATIONS**	**9 Periods**
SPIHT Image Compression, Automatic Target Recognition Systems on Reconfigurable Devices, Multi-FPGA Systems, Network Packet Processing in Reconfigurable Hardware Bioinformatics Applications - Dynamic Programming Algorithms- Seed-Based Heuristics. Profiles, HMMs and Language Models. Bioinformatics FPGA Accelerators.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Hauck & DeHon . "**Reconfigurable Computing, 1st Edition-The Theory and Practice of FPGA-Based Computation**", Elsevier India Private Limited, New Delhi, 2011.*
2	*Gokhale, Maya B., Graham, Paul S., "**Reconfigurable Computing -Accelerating Computation with FieldProgrammable Gate Arrays**" Springer Publications, 2007.*
3	*Joao Cardoso and Michael Hübner, "**Reconfigurable Computing: From FPGAs to Hardware/Software Codesign**", Springer Publications, 2011.*
4	*CliveMaxfield, "**The Design Warrior's Guide to FPGAs: Devices, Tools and Flows**", Newnes, Elsevier, 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts of architecture reconfigure ability, programmable logic devices and optimization of the RCS architecture	K2
CO2	Study the redundant functionality of the management and implementation.	K2
CO3	Design various algorithms for FPGA placement and Data Composition.	K3
CO4	Apply optimization techniques to increase the performance of the processor.	K3
CO5	Develop the different applications with reconfigurable devices	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3		2			3
CO2	2		2			3
CO3	3		2			3
CO4	3		2			3
CO5	3		2			3
23VLPE14	**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	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%

23VLPE15	VLSI RF CIRCUIT DESIGN	SEMESTER III

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

Course Objective	• To gain knowledge in designing RFIC, IC design using Passive components, RF Amplifiers and RF Mixers designs.	
UNIT – I	**RFIC DESIGN**	**9 Periods**
Lower frequency analog design and microwave design versus radio frequency integrated circuit design - Impedance levels for microwave and low-Frequency analog design- Noise - Linearity and distortion in RF Circuits -Dynamic range –Filtering issue.		
UNIT – II	**REVIEW OF TECHNOLOGY**	**9 Periods**
Small -signal model of bipolar transistor -High frequency effects - Noise in bipolar transistors - Base shot noise-Noise sources in the transistor model - Bipolar transistor design considerations-CMOS transistor.- Impedance matching - Tapped capacitors and inductors - Concept of mutual inductance - Tuning a transformer-Bandwidth of an impedance transformation network- Quality factor of an LC resonator.		
UNIT – III	**DESIGN OF PASSIVE CIRCUIT ELEMENTS IN IC TECHNOLOGIES**	**9 Periods**
Technology backend and metallization in IC technologies - Sheet resistance and skin effect –Parasitic capacitance and inductance-Current handling in metal lines-Design of inductors and transformers-Characterization of inductor-Layout of spiral inductors-On-chip transmission lines-High frequency measurements of on-chip passives and common De-Embedding techniques-packaging.		
UNIT – IV	**LNAAND POWER AMPLIFIER**	**9 Periods**
Basic amplifiers - Amplifiers with feedback - Noise in amplifiers - Linearity in amplifiers - Differential pair and other differential amplifiers-Low-voltage topologies for LNAs and the use of on-chip transformers -DC bias networks - Temperature effects - Broad band LNA design. Power amplifier: Power capability -Efficiency calculations - Matching considerations - Class A,B,C.D.E.F,G,H and S amplifiers -Summary of amplifier classes for RF Integrated circuits- AC load line-Matching to achieve desired power-Packaging -effects and implications of non-linearity - Linearization techniques - CMOS power amplifier example.		
UNIT – V	**MIXERS**	**9 Periods**
Mixing with nonlinearity-Basic mixer operation-Controlled trans conductance mixer-Double-balanced mixer - Mixer with switching of upper quad - Analysis of switching modulator-Mixer noise -Linearity – Improving isolation - Image reject and single -Sideband mixers-Alternative mixer designs –General design comments-CMOS mixers.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*John Rogers and Calvin Plett, "**Radio Frequency Integrated Circuit Design",** Artech House, 2002.*
2	*Stephan A Mass, "**Non-Linear Microwave and RF circuits"**, Artech House, 2003.*
3	*FerriLosee, "**RFSystems, Components and Circuits handbook",** Artechhouse,2002.*
4	*Larson LE ,"**RF and Microwave Circuit for Wireless Applications",** Artech House, 1997*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Detailed Knowledge in designing RF IC	K2
CO2	Understand the concepts of transistors	K2
CO3	An ability to design integrated circuits using Passive components	K3
CO4	Detailed Knowledge on RF Amplifiers Designs.	K3
CO5	Ability to design RF Mixers	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
23VLPE15	**3**	**2**	**-**	**-**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23VLPE16	VLSI SIGNAL PROCESSING	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, SYNCHRONOUS, WAVE AND ASYNCHRONOUSPIPELINING**	**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	*KungS.Y,H.J.While House,T. Kailath, "**VLSI and Modern Signal Processing**", PrenticeHall,1985.*

4	*Jose E. France, Yannis Tsividis "**Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing**", Prentice Hall, 1994.*
5	*MedisettiV.K,"**VLSI Digital Signal Processing**", IEEEPress (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	-	-	-	-
23VLPE16	**2**	**3**	**-**	**1**	**-**	**-**

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	20%	40%	40%	-	-	-	100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20%	40%	40%	-	-	-	100%
ESE	20%	40%	40%	-	-	-	100%

23VLPE17	DESIGN OF SEMICONDUCTOR MEMORIES	SEMESTER IV

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

Course Objective	• To acquire knowledge about architecture and operations of different semiconductor memories, VLSI Testing techniques and packing technologies.	
UNIT – I	**RANDOM ACCESS MEMORY TECHNOLOGIES**	**9 Periods**
Static Random Access Memory(SRAMs):SRAM cell structure - MOS SRAM architecture - MOS SRAM cell and Peripheral Circuit Operation - Bipolar SRAM technologies - Silicon On Insulator (SOI) technology - Advanced SRAM architectures and technologies - Application specific SRAMs - CMOS DRAM - DRAMs Cell Theory and Advanced cell structures - BiCMOS DRAMs - Soft error failure in DRAMs - Advanced DRAM designs and Architecture - Application specific DRAMs.		
UNIT – II	**NON VOLATILE MEMORIES**	**9 Periods**
Masked Read Only Memories (ROMs): High density ROMs - Programmable Read Only Memories (PROMs) - Bipolar PROMs - CMOS PROMs - Erasable (UV) Programmable Read Only Memories (EPROMs) - Floating Gate EPROM cell - One Time Programmable (OTP) EPROMs - Electrically Erasable PROMs (EEPROMs) - EEPROM technology and architecture - Nonvolatile SRAM - Flash memories (EPROMs or EEPROM) - Advanced flash memory architecture.		
UNIT – III	**ADVANCED MEMORY AND HIGH–DENSITY MEMORY PACKAGING TECHNOLOGIES**	**9 Periods**
Ferroelectric Random Access Memories (FRAMs) - Gallium Arsenide (GaAs) FRAMs - Analog Memories - Magneto Resistive Random Access Memories (MRAMs) - Experimental memory devices. Memory hybrids and MCMs (2D) - Memory stacks and MCMs (3D) - Memory MCM testing and Reliability issues - Memory cards - High density memory packaging future directions.		
UNIT – IV	**SEMICONDUCTOR MEMORY RELIABILITY AND RADIATION EFFECTS**	**9 Periods**
General Reliability issues - RAM failure modes and mechanism - Nonvolatile Memory Reliability - Reliability modelling and Failure rate prediction - Design for reliability - Reliability test structures - Reliability screening and Qualification. Radiation effects - Single Event Phenomenon (SEP).		
UNIT – V	**MEMORY FAULT MODELING, TESTING AND MEMORY DESIGN FOR TESTABILITY AND FAULT TOLERANCE**	**9 Periods**
RAM fault modelling, Electrical testing, Pseudo random testing – Megabit DRAM – Nonvolatile memory modelling and testing - IDDQ fault modelling and testing - Application specific memory testing and the tools for fault modelling and testing.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Ashok K.Sharma,* ***"Semiconductor Memories Technology, Testing and Reliability",*** *Wiley-IEEE Press, 2002.*
2	*Betty Prince,* ***"Emerging Memories: Technologies and Trends****", Kluwer Academic publishers, 2002.*
3	*Ashok K.Sharma,* ***"Advanced Semiconductor Memories Architecture Design and Applications"****, Wiley, 2002.*
4	*Hai Li,* ***"Nonvolatile Memory Design: Magnetic, Resistive and Phase Change",*** *CRC Press, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the different types of memories and their architecture.	K2
CO2	Analyse Volatile and Non Volatile Memories.	K3
CO3	Reproduce the concepts of advanced memory packaging technologies.	K2
CO4	Explain the features of semiconductor memory reliability.	K2
CO5	Discuss the advanced VLSI Testing and the Fault Tolerant Detection procedures.	K2

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
23VLPE17	**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	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%

23VLPE18	VLSI FOR WIRELESS COMMUNICATION	SEMESTER IV

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

Course Objective	• To discuss and design various components of a typical communication system.	
UNIT – I	**COMMUNICATION SYSTEM DESIGN COMPONENTS**	**9 Periods**
Introduction to Communication Standards – Integrated Inductors, Resistors and MOSFET- Overview of Digital modulation schemes – Wireless channel description – Path loss – Multipath fading – Receiver front end architecture – Filter Design –Band Selection Filter – Image Rejection Filter – Channel Filter – Nonidealities and design parameters – Derivation of NF, IIP_3.		
UNIT – II	**LOW NOISE AMPLIFIER DESIGN**	**9 Periods**
Matching Networks – Wideband LNA Design – Impedance matching of Narrowband LNA -Narrowband LNA Design – Nose Figure – Trade-off between Noise Figure and Power.		
UNIT – III	**ACTIVE AND PASSIVE MIXERS**	**9 Periods**
Active Mixer: Unbalance Mixer – Single Balanced Mixer – Gilbert Mixer – Conversion gain – Distorion, low and high frequency analysis of Gilbert Mixer – Complete Active Mixer – Passive Mixer: Switching Mixer – Distortion, Conversion gain and Noise in unbalanced Switching Mixer – Practical Unbalanced Switching Mixer.		
UNIT – IV	**DATA CONVERTER SUB SYSTEMS**	**9 Periods**
Demodulators – ADC used in Receivers – Low pass Sigma Delta Modulators – Band pass Sigma Delta Modulators – Implementation of Low pass and Band pass Sigma Delta Modulators – Low Voltage Low Pass Modulator.		
UNIT – V	**FREQUENCY SYSTHESIZER SYSTEM DESIGN**	**9 Periods**
PLL based Frequency Synthesizer – Phase Detector – Divider – Voltage Controlled Oscillator – Ring Oscillator – Phase Noise – Loop Filter Design – Complete Synthesizer design- VLSI Architecture for Multiuser Wireless Systems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Bosco H Leung, "**VLSI for Wireless Communication", Pearson Education, 2012.***
2	*B.Razavi**, "RF Microelectronics",** Prentice-Hall of India Pvt Ltd , 2nd Edition, 2011.*
3	*Thomas H.Lee, "**The Design of CMOS Radio –Frequency Integrated Circuits"**, Cambridge University Press, 2013.*
4	*Emad N Farag and Mohamed I Elmasry, "**Mixed Signal VLSI Wireless Design - Circuits and Systems",** Kluwer Academic Publishers, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts and components required to design wireless communication systems.	K2
CO2	Perform design steps of low noise amplifiers and mention its importance in VLSI systems	K3
CO3	Explain the role and importance of Mixers in wireless systems	K2
CO4	Discuss the working of data converters as subsystem in wireless systems	K2
CO5	Design frequency synthesizer used wireless communication systems	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		1		2
CO2	3	2		1		2
CO3	3	2		1		2
CO4	3	2		1		2
CO5	3	2		1		2
23VLPE18	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 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%

23VLPE19	**ASIC DESIGN** *(Common to Applied Electronics and VLSI Design)*	**SEMESTER IV**

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

Course Objective	• To 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**", Pearson Education Reprint, 2006.*
2	*FarzadNekoogar and FaranakNekoogar, "**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	*NekoogarF.,"**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 ASICs	K2
CO3	Discuss 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	1	3	1	-	2
CO2	3	-	1	1	-	2
CO3	3	1	1	2	-	2
CO4	3	1	1	2	-	2
CO5	3	1	1	1	-	2
23VLPE19	3	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	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%

23VLPE20	VLSI FOR IOT SYSTEMS	SEMESTER IV

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

Course Objective	• To learn the fundamentals and recent trends of Internet of Things, various techniques that enable IoT solution, security aspects and cloud computing.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Concept of connected world – Need, Legacy systems for connected world - Features and limitations, IoT architecture – Characteristics – Physical design-Logical design - Enabling technologies- Merits and Demerits of IoT technology, IoT levels-Domain specific IoT.		
UNIT – II	**COMPONENTS OF IOT**	**9 Periods**
Basic building blocks of an IoT system –Sensors, Actuators, Computing nodes and Connectivity. Sensors used in IoT systems – Characteristics and requirements, Types of sensors for IoT systems, Connectivity technologies in IoT – 802.15.4, Zigbee, LoWPAN, Z wave, Wi-Fi, RFID.		
UNIT – III	**IC TECHNOLOGY FOR IOT**	**9 Periods**
SoC architecture for IoT Devices– Application Processors, Microcontrollers, Smart Analog; Memory architecture for IoT – Non Volatile Memories (NVM), Embedded Non-Volatile Memories, Anti-Fuse One Time Programmable (OTP) memories, Power Management - Low Drop Out Regulators, DC-to-DC Converters, Voltage References, Power Management Units (PMUs) in IC's and Systems, FPGA in IoT systems.		
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 and FOG Computing- Industrial IoT: Security.		
UNIT – V	**APPLICATION**	**9 Periods**
Various real time application of 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	*Alioto, **"Enabling the Internet of Things- From Integrated Circuits to Integrated Systems**", Springer Publications, First Edition, 2017.*
2	*Sudip Misra, Chandana Roy, Anandarup Mukherjee,**"Introduction to Industrial Internet of Tings and Industry 4.0**", CRC Press, 1st edition, 2021*
3	*Alasdair Gilchrist, **"Industry 4.0: The Industrial Internet of Things",** Apress, 2017.*
4	*ArshdeepBahga, Vijay Madisetti, "**Internet of Things-A hands-on approach**", Universities Press,2015.*
5	*Jim Lipman, Sidense Corp, **"NVM memory: A Critical Design Consideration for IoT Applications**"- https://www.designreuse.com/articles/32614/nvm-memory-iot-applications.html.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts of advanced IOT technology.	K2
CO2	Discuss various components of IOT technologies.	K2
CO3	Illustrate the different memory architectures employed in IOT.	K2
CO4	Describe various IOT Analytics platforms.	K3
CO5	Develop IOT system for real time application.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1		1	1	2
CO2	3	1		1	1	2
CO3	3	1		1	1	2
CO4	3	1		1	1	2
CO5	3	1		1	1	2
23VLPE20	3	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	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%

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

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

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

Course 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

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

REFERENCES

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

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

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

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

REFERENCES

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

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

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

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

REFERENCES

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

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

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

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

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

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

Course Objectives	• 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.		
Lecture: 45 Periods	**Tutorial: 0 Periods**	**Practical:0 Periods** **Total:45 Periods**

REFERENCES:

1	*Benjamin O.Alli,* ***Fundamental Principles of Occupational Health and Safety*** *ILO 2008.*
2	*Danuta Koradecka,* ***Handbook of Occupational Health and Safety****, CRC, 2010.*
3	*Dr. Siddhartha Ray,* ***Maintenance Engineering,*** *New Age International (P) Ltd., Publishers, 2017*
4	*Deshmukh. L.M.,* ***Industrial Safety Management****, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.*
5	*https://nptel.ac.in/courses/110105094*
6	*https://archive.nptel.ac.in/courses/110/105/110105094/*

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

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

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

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

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

Course Objectives	• 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.		
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods		

REFERENCES:

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

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

Course Articulation Matrix:

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

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

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

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

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

Course Objectives	• To summarize the characteristics of composite materials and effect of reinforcement in composite materials. • To identify the various reinforcements used in composite materials. • To compare the manufacturing process of metal matrix composites. • To understand the manufacturing processes of polymer matrix composites. • 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.		
Lecture: 45 Periods	**Tutorial: 0 Periods** **Practical: 0 Periods**	**Total: 45 Periods**

REFERENCES:

1	*Chawla K.K., **Composite Materials**, Springer, 2013.*
2	*Lubin.G, **Hand Book of Composite Materials**, Springer New York, 2013.*
3	*Deborah D.L. Chung, **Composite Materials Science and Applications**, Springer, 2011.*
4	*uLektz, **Composite Materials and Mechanics**, uLektz Learning Solutions Private Limited, Lektz, 2013.*
5	*https://nptel.ac.in/courses/112104168*

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

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

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

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

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

Course 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**		

TEXT BOOK:

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.*

REFERENCES:

1	*David Archer,* ***"Global warming: Understanding the Forecast"****, Wiley, 2nd Edition, 2011.*
2	*David S.K. Ting, Jacqueline A Stagner,* ***"Climate Change Science: Causes, Effects and Solutions for Global Warming"****, Elsevier, 1st Edition, 2021.*
3	*Frances Drake,* ***"Global Warming: The Science of Climate Change"****,Routledge, 1st edition, 2000.*
4	*Dickinson,* ***"Climate Engineering-A review of aerosol approaches to changing the global energybalance"****, Springer, 1996.*
5	*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**		

TEXT BOOK:

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.*

REFERENCES:

1	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
2	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*

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

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

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

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

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

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

Course 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**		

TEXT BOOK:

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.*

REFERENCES:

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

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

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

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

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

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

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

REFERENCES

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

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

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

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

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

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

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

REFERENCES

1	*Bhattacharyya, Subhes. C. (2011).* ***"Energy Economics: Concepts, Issues, Markets and Governance****". Springer.London, UK*
2	*Stevens, P. (2000).* ***"An Introduction to Energy Economics. In Stevens, P.(ed.) The Economics of Energy"****, Vol.1, Edward Elgar, Cheltenham, UK.*
3	*Nausir Bharucha,* ***"Guide to the Electricity Laws"****, LexisNexis, 2018*

4	*Mohammad Naseem,* ***"Energy Laws in India"****, Kluwer Law International, 3rd Edn, The Netherlands, 2017.*
5	*Alok Kumar & Sushanta K Chaterjee,* ***"Electricity Sector in India: Policy and Regulation"****, OUP, 2012.*
6	*Benjamin K Sovacool & Michael H Dowrkin,* ***"Global Energy Justice: Problems, Principles and Practices"****, Cambridge Univesity Press, 2014.*

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

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

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

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

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

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

REFERENCES

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

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

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

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

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

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

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

REFERENCES :

1	*Jeffrey Travis, Jim Kring, **"LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (3rd Edition),** Prentice Hall, 2006***.**
2	*Jovitha Jerome, **"Virtual Instrumentation using LabVIEW",** PHI, 2010*

3	*Gary W. Johnson, Richard Jennings,* ***"LabVIEW Graphical Programming"****, McGraw Hill Professional Publishing, 2019*
4	*Robert H. Bishop,* ***"Learning with LabVIEW"****, Prentice Hall, 2013.*
5	*Kevin James, "****PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control"****, Newness, 2000*

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

Course Articulation Matrix)					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	2	1
CO3	3	-	2	2	2
CO4	3	1	3	3	1
CO5	3	1	3	3	2
23PEOE22	**3**	**1**	**3**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

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

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

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

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

REFERENCES:

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

5	www.em-ea.org/gbook1.asp

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

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

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

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

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

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

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

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

Course Objective

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

UNIT – I MICROPROCESSOR ARCHITECTURE	**9 Periods**

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

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

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

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

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

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

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

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

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

Contact Periods:

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

REFERENCES:

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

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

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

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

23VLOE28	**HDL 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	-
23VL0E30	**2**	**2**	**-**	**2**	**2**	**-**

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

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

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

Course Objectives	Identify and apply AI techniques in the design of systems that act intelligently, making automatic decisions and learn from experience.	
UNIT – I	**SEARCH STRATEGIES**	**9 Periods**
Uninformed Strategies – BFS, DFS, Djisktra, Informed Strategies – A* search, Heuristic functions, Hill Climbing, Adversarial Search – Min-max algorithm, Alpha-beta Pruning		
UNIT – II	**PLANNING AND REASONING**	**9 Periods**
State Space search, Planning Graphs, Partial order planning, Uncertain Reasoning – Probabilistic Reasoning, Bayesian Networks, Dempster Shafer Theory, Fuzzy logic		
UNIT – III	**PROBABILISTIC REASONING**	**9 Periods**
Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks. Knowledge Representations – Ontological Engineering, Semantic Networks and description logics.		
UNIT – IV	**DECISION MAKING**	**9 Periods**
Utility Theory, Utility Functions, Decision Networks – Sequential Decision Problems – Partially Observable MDPs – Game Theory.		
UNIT – V	**REINFORCEMENT LEARNING**	**9 Periods**
Reinforcement Learning - Passive and active reinforcement learning - Generations in Reinforcement Learning - Policy Search – Deep Reinforcement Learning.		
Contact Periods: **Lecture: 3 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)*

PREREQUISITES	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

23VLACZ1	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	*Goldbort R* ***, "Writing for Science", Yale University Press*** *(available on GoogleBooks),2006*
2	*Day R ,* ***How to Write and Publish a Scientific Paper****, Cambridge University Press, 2006.*
3	*Highman N,* ***"Handbook of Writing for the Mathematical Sciences"****, SIAM. Highman's book, 1998.*
4	*Adrian Wallwork,"* ***English for Writing Research Papers"****, Springer New York Dordrecht Heidelberg London, 2011.*

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

COURSE ARTICULATION MATRIX :						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
23VLACZ1	**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

23VLACZ2	**DISASTER MANAGEMENT** *(Common to all branches)*

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.		
Lecture:30 Periods Tutorial: 0 Periods Practical: 0Periods Total: 30 Periods		

REFERENCES:

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

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

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23VLACZ2	**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

23VLACZ3	**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 and Cooperation. 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 behaviour 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	1	1
CO2	-	-	3	1	2	1
CO3	-	-	3	1	2	1
CO4	-	-	3	1	1	1
CO5	-	-	3	1	1	2
23VLACZ3	**-**	**-**	**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	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
23VLACZ4	**-**	**-**	**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	1. To Understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. 2. Application of knowledge in modification of curriculum, its assessment and introduction of innovation in teaching methodology.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.		
UNIT – II	**PEDAGOGICAL PRACTICES**	**6 Periods**
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies		
UNIT – III	**PEDAGOGICAL APPROACHES**	**6 Periods**
How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teacher's attitudes and beliefs and Pedagogic strategies.		
UNIT – IV	**PROFESSIONAL DEVELOPMENT**	**6 Periods**
Professional development: alignment with classroom practices and follow-up support. Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.		
UNIT – V	**CURRICULUM AND ASSESSMENT**	**6 Periods**
Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

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

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

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	2	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	2	1
23VLACZ5	**-**	**-**	**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%

23VLACZ6	**STRESS MANAGEMENT BY YOGA** *(Common to All Branches)*

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

Course Objectives	1. To create awareness on the benefits of yoga and meditation. 2. To understand the significance of Asana and Pranayama.	
UNIT – I	**PHYSICAL STRUCTURE AND ITS FUNCTIONS**	**6 Periods**
Yoga - Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation.		
UNIT – II	**YOGA TERMINOLOGIES**	**6 Periods**
Yamas - Ahimsa, satya, astheya, bramhacharya, aparigrahaNiyamas- Saucha, santosha, tapas, svadhyaya, Ishvarapranidhana.		
UNIT – III	**ASANA**	**6 Periods**
Asana - Rules & Reg		
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**", AdvaitaAshrama (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**	**PO6**
CO1	-	-	2	-	-	-
CO2	-	-	2	-	-	-
CO3	-	-	2	-	-	-
CO4	-	-	2	-	-	-
CO5	-	-	2	-	-	-
23VLACZ6	**-**	**-**	**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%	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%

23VLACZ7	**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	-	-	-
23VLACZ7	**-**	**-**	**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
23VLACZ8	**-**	**-**	**-**	**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%