KNOWLEDGE INSTITUTE OF TECHNOLOGY

(An Autonomous Institution)

Approved by AICTE, Affiliated to Anna University, Chennai.
Accredited by NBA (CSE, ECE, EEE & MECH), Accredited by NAAC with 'A' Grade
KIOT Campus, Kakapalayam (PO), Salem – 637504, Tamil Nadu, India.

M.E/M.Tech Regulations 2023

M.E. – VLSI Design

Curriculum and Syllabi

(For the Students Admitted from the Academic Year 2023 – 24 Onwards)

Version:1 .0 **Date:**09.09.2023

KNOWLEDGE INSTITUTE OF TECHNOLOGY(AUTONOMOUS), SALEM -637504

Approved by AICTE, Affiliated to Anna University,
Accredited by NAAC and NBA (B.E.: Mech., ECE, EEE & CSE)

Website: www.kiot.ac.in

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	Approved by AICTE, Affiliated to Anna University, Accredited by NAAC and NBA (B.E.: Mech., ECE, EEE & CSE)
	Website: www.kiot.ac.in

M.E. / M.Tech. REGULATIONS 2023 (R2023)

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

M.E. VLSI DESIGN

VISION OF THE INSTITUTE
To be a world class institution to impart value and need based professional education to the aspiring youth and carving them into disciplined world class professional who have the quest for excellence, achievement orientation and social responsibilities.

MISSION OF THE INSTITUTE	
A	To promote academic growth by offering state-of-art under graduate, post graduate, and doctoral programs and to generate new knowledge by engaging in cutting – edge
B	To nurture talent, innovation, entrepreneurship, all-round personality, and value system among the students and to foster competitiveness among students
C	To undertake collaborative projects which offer opportunities for long-term interaction with academia and industry
D	To pursue global standards of excellence in all our endeavors namely teaching, research, consultancy, continuing education and support functions

VISION OF THE DEPARTMENT
To produce competent Electronics and Communication Engineers by imparting quality education to meet the industry requirements and for serving the societal needs

MISSION OF THE DEPARTMENT	
M1	To develop appropriate facilities for promoting research activities
M2	To inculcate leadership qualities among students for self and societal growth
M3	To nurture students on emerging technologies for serving industry needs through industry institute interface
M4	To enrich teaching learning process by transforming young minds to be resourceful engineers

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)	
PEO1	To critically analyze and understand the principles involved in the designing and testing of electronic circuits relevant to industry and society.
PEO2	To appreciate the concepts in the working of electronic circuits
PEO3	To take up socially relevant and challenging projects and to provide Innovative solutions through research for the benefit of the society with latest hardware & software related to VLSI and also to develop the capacity to protect Intellectual Property.
PEO4	To Progress and Develop with Ethics and Communicate effectively.
PEO5	To become entrepreneurs to develop indigenous solutions

PROGRAM OUTCOMES (POs)	
PO1	An ability to independently carry out research/investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4	Understand the fundamentals involved in the Designing and Testing of electronic circuits in the VLSI domain.
PO5	Provide solutions through research to socially relevant issues for modern Electronic Design Automation (EDA) tools with knowledge, techniques, skills and for the benefit of the society
PO6	Interact effectively with the technical experts in industry

KNOWLEDGE INSTITUTE OF TECHNOLOGY (AUTONOMOUS), SALEM – 637504											
M.E. VLSI DESIGN											Version:1.0
Courses of Study and Scheme of Assessment (Regulations 2023)											Date:09.09.23
SEMESTER I											
Sl. No.	Course Code	Course Title	Periods/ Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
	THEORY										
1	ME23MA102	Graph Theory and Optimization Techniques	FC	4	3	1	0	4	40	60	100
2	ME23RM201	Research Methodology and IPR	RM	3	2	1	0	3	40	60	100
3	ME23VL301	Analog IC Design	PC	3	3	0	0	3	40	60	100
4	ME23VL302	Digital CMOS VLSI Design	PC	3	3	0	0	3	40	60	100
5	ME23VL303	Advanced Digital System Design	PC	3	3	0	0	3	40	60	100
6	ME23VL304	RFIC Design	PC	3	3	0	0	3	40	60	100
7	ME23AC7XX	Audit Course – I	AC	2	2	0	0	0	100	-	100
	PRACTICAL										
8	ME23VL305	FPGA Laboratory	PC	4	0	0	4	2	60	40	100
9	ME23VL306	Analog IC Design Laboratory	PC	4	0	0	4	2	60	40	100
EMPLOYABILITY ENHANCEMENT											
10	ME23PT801	Technical Seminar / Case study presentation	EEC	2	0	0	2	0	100	-	100
Total				31	19	2	10	23	560	440	1000

SEMESTER II											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1	ME23VL307	Design for Verification using UVM	PC	3	3	0	0	3	40	60	100
2	ME23VL308	Low Power VLSI Design	PC	3	3	0	0	3	40	60	100
3	ME23VL309	VLSI Testing	PC	3	3	0	0	3	40	60	100
4	ME23VL4XX	Professional Elective – I	PE	3	3	0	0	3	40	60	100
5	ME23VL4XX	Professional Elective – II	PE	3	3	0	0	3	40	60	100
6	ME23XX5XX	Open Elective - I	OE	3	3	0	0	3	40	60	100
7	ME23MC701	Universal Human Values and Ethics	MC	3	2	1	0	3	40	60	100
8	ME23AC7XX	Audit Course – II*	AC	2	2	0	0	0	100	-	100
PRACTICAL											
9	ME23VL310	Verification using UVM Laboratory	PC	4	0	0	4	2	60	40	100
EMPLOYABILITY ENHANCEMENT											
10	ME23PT802	Research Paper Review and presentation	EEC	2	0	0	2	1	100	-	100
		Total		29	22	1	6	24	540	460	1000

SEMESTER III											
Sl. No.	**Course Code**	**Course Title**	**Periods / Week**						**Maximum Marks**		
			CAT	**CP**	**L**	**T**	**P**	**C**	**IA**	**ESE**	**Total**
THEORY											
1	ME23VL311	VLSI Signal Processing	PC	3	3	0	0	3	40	60	100
2	ME23VL4XX	Professional Elective – III	PE	3	3	0	0	3	40	60	100
3	ME23VL4XX	Professional Elective – IV	PE	3	3	0	0	3	40	60	100
4	ME23XX5XX	Open Elective - II	OE	3	3	0	0	3	40	60	100
PRACTICAL											
5	ME23VL601	Project Work - I	PW	12	0	0	12	6	60	40	100
		Total		**24**	**12**	**0**	**12**	**18**	**220**	**280**	**500**

SEMESTER IV											
Sl. No.	**Course Code**	**Course Title**	**Periods / Week**						**Maximum Marks**		
			CAT	**CP**	**L**	**T**	**P**	**C**	**IA**	**ESE**	**Total**
PRACTICAL											
1	ME23VL602	Project Work - II	PW	24	0	0	24	12	60	40	100
		Total		**24**	**0**	**0**	**24**	**12**	**60**	**40**	**100**
									Total No. of Credits		**77**

PROFESSIONAL ELECTIVES											
SEMESTER – II (Professional Electives I & II)											
Sl. No.	**Course Code**	**Course Title**	**Periods / Week**						**Maximum Marks**		
			CAT	**CP**	**L**	**T**	**P**	**C**	**IA**	**ESE**	**Total**
THEORY											
1.	ME23VL401	ASIC Design	PE	3	3	0	0	3	40	60	100
2.	ME23VL402	Medical Imaging Systems	PE	3	3	0	0	3	40	60	100
3.	ME23VL403	Principles of Sensors and Signal Conditioning	PE	3	3	0	0	3	40	60	100
4.	ME23VL404	Hardware Software Co-Design for FPGA	PE	3	3	0	0	3	40	60	100
5.	ME23VL405	DSP Structures for VLSI	PE	3	3	0	0	3	40	60	100
6.	ME23VL406	Bio - Signal Processing	PE	3	3	0	0	3	40	60	100
7.	ME23VL407	Reconfigurable Architectures	PE	3	3	0	0	3	40	60	100
8.	ME23VL408	Advanced Wireless Sensor Networks	PE	3	3	0	0	3	40	60	100
9.	ME23VL409	Edge and Fog Computing	PE	3	3	0	0	3	40	60	100
10.	ME23VL410	System On Chip	PE	3	3	0	0	3	40	60	100

SEMESTER – III (Professional Electives III & IV)											
Sl. No.	**Course Code**	**Course Title**	**Periods / Week**						**Maximum Marks**		
			CAT	**CP**	**L**	**T**	**P**	**C**	**IA**	**ESE**	**Total**
THEORY											
1.	ME23VL411	MEMS and NEMS	PE	3	3	0	0	3	40	60	100
2.	ME23VL412	Network on Chip	PE	3	3	0	0	3	40	60	100
3.	ME23VL413	Evolvable Hardware	PE	3	3	0	0	3	40	60	100
4.	ME23VL414	Soft Computing and Optimization Techniques	PE	3	3	0	0	3	40	60	100
5.	ME23VL415	CAD for VLSI Design	PE	3	3	0	0	3	40	60	100
6.	ME23VL416	VLSI Architectures for Image Processing	PE	3	3	0	0	3	40	60	100
7.	ME23VL417	System Verilog	PE	3	3	0	0	3	40	60	100
8.	ME23VL418	Adaptive Signal Processing	PE	3	3	0	0	3	40	60	100
9.	ME23VL419	Machine Learning	PE	3	3	0	0	3	40	60	100
10.	ME23VL420	Advanced Digital Image Processing	PE	3	3	0	0	3	40	60	100

OPEN ELECTIVES											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
Except M.E. Computer Science and Engineering											
1	ME23CP501/ ME23CP310	Security Practices	OE	3	3	0	0	3	40	60	100
2	ME23CP502/ ME23CP401	Cloud Computing Technologies	OE	3	3	0	0	3	40	60	100
3	ME23CP503/ ME23CP415	Blockchain Technologies	OE	3	3	0	0	3	40	60	100
4	ME23CP504/ ME23CP414	Deep Learning	OE	3	3	0	0	3	40	60	100
5	ME23CP505	Design Thinking	OE	3	3	0	0	3	40	60	100
6	ME23CP506	Principles of Multimedia	OE	3	3	0	0	3	40	60	100
Except M.E. Industrial Safety Engineering											
7	ME23IS501/ ME23IS302	Environmental Safety	OE	3	3	0	0	3	40	60	100
8	ME23IS502/ ME23IS309	Electrical safety	OE	3	3	0	0	3	40	60	100
9	ME23IS503/ ME23IS413	Safety in Engineering Industry	OE	3	3	0	0	3	40	60	100
10	ME23IS504	Design of Experiments	OE	3	3	0	0	3	40	60	100
11	ME23IS505	Circular Economy	OE	3	3	0	0	3	40	60	100
Except M.E. Embedded System Technologies											
12	ME23ET501/ ME23ET310	IoT for Smart Systems	OE	3	3	0	0	3	40	60	100
13	ME23ET502/ ME23ET408	Machine Learning and Deep Learning	OE	3	3	0	0	3	40	60	100
14	ME23ET503	Renewable Energy Technology	OE	3	3	0	0	3	40	60	100
15	ME23ET504/ ME23ET423	Smart Grid	OE	3	3	0	0	3	40	60	100
Except M.E. VLSI Design											
16	ME23VL501	Big Data Analytics	OE	3	3	0	0	3	40	60	100
17	ME23VL502	Internet of Things and Cloud	OE	3	3	0	0	3	40	60	100
18	ME23VL503	Medical Robotics	OE	3	3	0	0	3	40	60	100
19	ME23VL504	Embedded Automation	OE	3	3	0	0	3	40	60	100

PROJECT WORK											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1.	ME23VL601	Project Work I	PW	12	0	0	12	6	60	40	100
2.	ME23VL602	Project Work II	PW	24	0	0	24	12	60	40	100

FOUNDATION COURSE											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1.	ME23MA102	Graph Theory and Optimization Techniques	FC	4	3	1	0	4	40	60	100

RESEARCH METHODOLOGY											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1.	ME23RM201	Research Methodology and IPR	RM	3	2	1	0	3	40	60	100

MANDATORY COURSES (MC)											
Registration for any of these courses is optional to students											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1	ME23MC701	Universal Human Values and Ethics	MC	3	2	1	0	3	40	60	100

EMPLOYABILITY ENHANCEMENT COURSES (EEC)											
Registration for any of these courses is optional to students											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1	ME23PT801	Technical Seminar / Case study presentation	EEC	2	0	0	2	0	100	-	100
2	ME23PT802	Research Paper Review and presentation	EEC	2	0	0	2	1	100	-	100

AUDIT COURSES (AC)											
Registration for any of these courses is optional to students											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1	ME23AC701	English for Research Paper Writing	AC	2	2	0	0	0	100	-	100
2	ME23AC702	Disaster Management	AC	2	2	0	0	0	100	-	100
3	ME23AC703	Constitution of India	AC	2	2	0	0	0	100	-	100
4	ME23AC704	நற்றமிழ் இலக்கியம்/ CLASSICAL TAMIL LITERATURE	AC	2	2	0	0	0	100	-	100

SUMMARY							
Sl. No.	**Course Category**	**Credits per Semester**				**Credits**	**Credit %**
		I	**II**	**III**	**IV**		
1	FC	4	-	-	-	04	5.19
2	RM	3	-	-	-	03	3.89
3	PC	16	11	3	-	30	38.96
4	PE	-	6	6	-	12	15.58
5	OE	-	3	3	-	06	7.79
6	PW	-	-	6	12	18	23.37
7	EEC	✓	1	-	-	01	1.3
8	MC	-	3	-	-	03	3.89
9	AC*	✓	✓	-	-	-	-
	Total	**23**	**24**	**18**	**12**	**77**	**100**

NOMENCLATURE					
CAT	Category of Course	FC	Foundation Courses	PW	Project Work Courses
CP	Contact Period	RM	Research Methodology and IPR Courses	EEC	Employability Enhancement Course
L	Lecture Period	PC	Professional Core Courses	AC	Audit Course
T	Tutorial Period	PE	Professional Elective Courses	IA	Internal Assessment
P	Laboratory Period	OE	Open Elective Courses	ESE	End Semester Examination
C	Credits	SE	Special Elective		

ME23MA102	GRAPH THEORY AND OPTIMIZATION TECHNIQUES	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		4	3	1	0	4

Use of Calculator -fx991ms are permitted

Course Objectives:

1	To apply graph theory and models to solve connectivity problems.
2	To apply various graph algorithms for optimization.
3	To construct mathematical models for solving linear programming problems
4	To construct mathematical models for solving non-linear programming problems
5	To apply simulation modeling techniques for solving engineering problems.

UNIT–I	GRAPHS	9+3

Graphs and graph models (L2) – Graph terminology and special types of graphs (L2) – Matrix representation of graphs and graph isomorphism (L3) – Connectivity – Euler and Hamilton paths (L3).

UNIT–II	GRAPH ALGORITHM	9+3

Graph Algorithms (L2) – Directed graphs – Some basic algorithms (L2) – Shortest path algorithms (L3) – Depth – First search on a graph (L3) – Theoretic algorithms – Performance of graph theoretic algorithms (L3) – Graph theoretic computer languages (L2).

UNIT– III	LINEAR PROGRAMMING	9+3

Formulation – Graphical solution (L3) – Simplex method (L3) – Two-phase method (L3) – Transportation and Assignment Models (L3).

UNIT – IV	NON-LINEAR PROGRAMMING	9+3

Constrained Problems (L3) – Equality constraints (L3) – Lagrangean Method (L3) – Inequality constraints – Karush – Kuhn-Tucker (KKT) conditions (L3) – Quadratic Programming (L3).

UNIT–V	SIMULATION MODELLING	9+3

Monte Carlo Simulation (L2) – Types of Simulation – Elements of Discrete Event Simulation (L3) – Generation of Random Numbers (L3) – Applications to Queuing systems (L2).

Total: 60 PERIODS

OPEN-ENDED PROBLEMS / QUESTIONS

Course specific Open Ended Problems will be solved during the class room teaching. Such problems can be given as Assignments and evaluated as Internal Assessment only and not for the End semester Examinations.

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Apply graph theory and models to solve connectivity problems.	L3 - APPLY
CO2	Apply various graph algorithms for optimization.	L3 - APPLY
CO3	Construct mathematical models for solving linear programming problems	L3 - APPLY
CO4	Construct mathematical models for solving non-linear programming problems	L3 - APPLY

CO5	Apply simulation modeling techniques for solving engineering problems.	L3 - APPLY

REFERENCE BOOKS:

1.	Taha H.A, "Operation Research: An Introduction", Ninth Edition, Pearson Education, New Delhi, 2010.
2.	Gupta P. K, and Hira D.S., "Operation Research", Revise Edition, S. Chand and Company Ltd., 2012.
3.	Sharma J.K., "Operation Research", 3rd Edition, Macmillan Publishers India Ltd., 2009.
4.	Douglas B. West, "Introduction to Graph Theory", Pearson Education, New Delhi, 2015.
5.	Balakrishna R., Ranganathan. K., "A text book of Graph Theory", Springer Science and Business Media, New Delhi, 2012.
6.	Narasingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall India,1997.

VIDEO REFERENCES:

1.	https://youtube.com/playlist?list=PLEAYkSg4uSQ2fXcfrTGZdPuTmv98bnFY5
2.	https://youtube.com/playlist?list=PLU6SqdYcYsfLV24T0XVb3z3mjl8QG0EBN

WEB REFERENCES:

1.	https://www.baeldung.com/cs/graph-theory-intro
2.	https://sitn.hms.harvard.edu/flash/2021/graph-theory-101/

ONLINE COURSES:

1.	https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ma10/
2.	https://www.udemy.com/course/graph-theory/

Mapping of COs with POs

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		
Average	2		1	1		

1–Low, 2 –Medium, 3–High.

ME23RM201	RESEARCH METHODOLOGY AND IPR	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	2	1	0	3

Course Objectives:

1	Analyze the significance of research and formulate well-defined research questions.
2	Apply appropriate research methods and critically evaluate research articles.
3	Create well-structured research papers and utilize research tools proficiently.
4	Produce effective technical reports and deliver impactful presentations.
5	Understand forms of intellectual property and analyze their implications on technological research and international cooperation.

UNIT–I	CONCEPT OF RESEARCH	6+3

Meaning and Significance of Research (L2)-Skills, Habits and Attitudes for Research (L1)-Time Management (L3) -Status of Research in India (L2)-Why, How, and What a Research is? (L2)-Types and Process of Research (L2)-Outcome of Research (L2)-Sources of Research Problem (L2)-Characteristics of a Good Research Problem (L2)-Errors in Selecting a Research Problem (L2)-Importance of Keywords (L1)-Literature Collection - Analysis (L2)-Citation Study - Gap Analysis (L2)-Problem Formulation Techniques (L2).

UNIT–II	RESEARCH METHODS AND JOURNALS	6+3

Interdisciplinary Research (L2)-Need for Experimental Investigations (L2)-Data Collection Methods (L3)-Appropriate Choice of Algorithms / Methodologies / Methods (L2)-Measurement and Result Analysis (L3)-Investigation of Solutions for Research Problem (L2)-Interpretation (L2)-Research Limitations (L2)-Journals in Science/Engineering (L2)-Indexing and Impact factor of Journals (L3)-Citations(L2)- h Index (L2)- i10 Index (L2)-Journal Policies (L4)How to Read a Published Paper (L2)-Ethical Issues Related to Publishing(L3)- Plagiarism and Self-Plagiarism (L2).

UNIT–III	PAPER WRITING AND RESEARCH TOOLS	6+3

Types of Research Papers (L2)- Original Article/Review Paper/Short Communication/Case Study(L2)-When and Where to Publish? (L2) - Journal Selection Methods (L2)-Layout of a Research Paper (L2)-Guidelines for Submitting the Research Paper (L2)-Review Process - Addressing Reviewer Comments (L3)-Use of tools / Techniques for Research (L3)-Hands-on Training related to Reference Management Software - EndNote (L3)- Introduction to Origin, SPSS(L2)-Software for Detection of Plagiarism (L2)

UNIT–IV	EFFECTIVE TECHNICAL THESIS WRITING/PRESENTATION	6+3

How to Write a Report(L1)- - Language and Style (L1)-Format of Project Report (L1) - Use of Quotations (L2)-Method of Transcription Special Elements (L3)-Title Page - Abstract - Table of Contents - Headings and Sub-Headings (L2)-Footnotes - Tables and Figures - Appendix - Bibliography etc. (L3)-Different Reference Formats (L2)-Presentation using PPTs (L2).

UNIT–V	NATURE OF INTELLECTUAL PROPERTY	6+3

Patents(L1) - Designs(L2) - Trade and Copyright (L2)- Process of Patenting and Development (L2)-Technological research(L2)- innovation(L2)- - patenting(L2)-Development International Scenario (L2)-International Cooperation on Intellectual Property (L2)-Procedure for Grants of Patents (L2).

Total : 30+15=45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination.

COURSE OUTCOMES: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Illustrate the importance and objectives of research in contributing to knowledge and solving real-world problems.	L2 - Understand
CO2	Experiment with data collection techniques, choosing fitting approaches to ensure sound research framework and methodology.	L3 - Apply
CO3	Utilize research & analytic tools for enhancing the research publication	L2 - Understand
CO4	Apply knowledge to produce presentations and technical reports that effectively communicate research findings.	L3 - Apply
CO5	Explain types of intellectual property and comprehend patenting as essential for safeguarding innovation and creativity.	L2 - Understand

REFERENCE BOOKS:	
1.	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2.	DePoy, Elizabeth, and Laura N. Gitlin, "Introduction to Research-E-Book: Understanding and Applying Multiple Strategies", Elsevier Health Sciences, 2015.
3.	Walliman, Nicholas, "Research Methods: The basics", Routledge, 2017
4.	Bettig Ronald V., "Copyrighting culture: The political economy of intellectual property", Routledge, 2018.
5.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=1vf8ZvADxfY&list=PLLhSIFfDZcUWRlgiXMkd1rNeLSz1You4O
2.	https://www.youtube.com/watch?v=eIUaS51U05M&list=PLIEVEMAFhG4_JmLtWGr6G0PRGB13xapyC
WEB REFERENCES:	
1.	https://www.researchgate.net/
2.	https://www.wipo.int/about-ip/en/
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc23_ge36/preview
2.	https://onlinecourses.nptel.ac.in/noc22_hs59/preview

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1			1
CO2	3	3		2		
CO3	3			3	1	
CO4	3	3				
CO5	2	2		2		1
Average	2.8	2.5	1	2.33	1	1

ME23VL301	ANALOG IC DESIGN	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To design and analyze single stage amplifiers.
2	To characterize the high frequency and noise in amplifiers.
3	To characterize the parameters of single stage and multi stage op-amps.
4	To analyze stability and frequency compensation techniques in op-amps.
5	To design current sources and current sink circuits for band gap references.

UNIT–I	SINGLE STAGE AMPLIFIERS	9

Basic MOS physics and equivalent circuits and models (L2), CS, CG and Source Follower (L2), differential amplifier with active load (L2), Cascode and Folded Cascode configurations with active load (L3), design of Differential and Cascode Amplifiers – to meet specified SR (L3), noise, gain, BW, ICMR and power dissipation (L2), voltage swing (L2), high gain amplifier structures (L2).

UNIT–II	HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS	9

Miller effect (L2), association of poles with nodes (L3), frequency response of CS, CG and Source Follower (L3), Cascode and Differential Amplifier stages (L2), statistical characteristics of noise (L3), noise in Single Stage amplifiers (L3), noise in Differential Amplifiers (L3).

UNIT– III	FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS	9

Properties and types of negative feedback circuits (L2), effect of loading in feedback networks (L3), operational amplifier performance parameters (L3), single stage Op Amps (L2), two-stage Op Amps (L2), input range limitations, gain boosting (L2), slew rate, power supply rejection, noise in Op Amps (L2)

UNIT – IV	STABILITY AND FREQUENCY COMPENSATION OF TWO STAGE AMPLIFIER	9

Analysis Of Two Stage Op Amp – Two Stage Op Amp Single Stage CMOS CS as Second Stage And Using Cascode Second Stage (L3), Multiple Systems, Phase Margin (L2), Frequency Compensation, And Compensation Of Two Stage Op Amps (L3), Slewing In Two Stage Op Amps (L3), Other Compensation Techniques (L2).

UNIT–V	BANDGAP REFERENCES	9

Current sinks and sources, current mirrors (L2), Wilson current source (L3), Widlar current source (L3), cascode current source, design of high swing cascode sink (L3), current amplifiers, supply independent biasing, temperature independent references (L3), PTAT and CTAT current generation (L2), constant-gm biasing (L3).

Total: 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination.

Course Outcomes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Design and analyze single stage amplifiers.	L3 - Apply
CO2	Characterize the high frequency and noise in amplifiers.	L3 - Apply
CO3	Characterize the parameters of single stage and multi stage op-amps.	L3 - Apply
CO4	Analyze stability and frequency compensation techniques in op-amps.	L3 - Apply

CO5	Design current sources and current sink circuits for band gap references.	L3 - Apply

REFERENCE BOOKS:	
1.	Behzad Razavi, "Design Of Analog Cmos Integrated Circuits", Tata Mcgraw Hill, 2001.
2.	Willey M.C. Sansen, "Analog Design Essentials", Springer, 2006.
3.	Grebene, "Bipolar And Mos Analog Integrated Circuit Design", John Wiley & Sons,Inc.,2003.
4.	Phillip E.Allen, Douglas R .Holberg, "Cmos Analog Circuit Design", Oxford University Press, 2nd Edition, 2002.
5.	Recorded Lecture Available at http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
6.	Jacob Baker "CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.
VIDEO REFERENCES:	
1.	NPTEL :: Electronics & Communication Engineering - NOC:Analog IC Design
2.	https://youtube.com/playlist?list=PLbMVogVj5nJQB44z6h0XO2644Vbv7OM8_
WEB REFERENCES:	
1.	What is Analog Design? – Analog vs. Digital Design | Synopsys
2.	Education | Analog Devices
ONLINE COURSES:	
1.	Analog Ic Design - Course (nptel.ac.in)
2.	CMOS Analog Circuit Design | Udemy

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2	1		
CO2	1		2	1		
CO3	1		2	1	2	
CO4	1		2	1	2	
CO5	1		2	1	2	
Average	1	1	2	1	2	
1–Low, 2 –Medium, 3–High.						

ME23VL302	DIGITAL CMOS VLSI DESIGN	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To analyze various characteristics of MOS transistors and CMOS inverter.
2	To design combinational circuits using different CMOS logic styles.
3	To characterize clocking strategies and clocking issues of sequential logic circuits.
4	To implement data path circuits such as adders, accumulators and multipliers.
5	To design memory units including ROM and SRAM.

UNIT–I	MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER	9

MOSFET characteristic under static and dynamic conditions (L2), MOSFET secondary effects (L3), Elmore constant (L3), CMOS inverter-static characteristic, dynamic characteristic (L2), power, energy, and energy delay parameters (L2), stick diagram and layout diagrams (L3).

UNIT–II	COMBINATIONAL LOGIC CIRCUITS	9

Static CMOS design (L2), different styles of logic circuits (L2), logical effort of complex gates (L3), static and dynamic properties of complex gates (L3) interconnect delay, dynamic logic gates (L2).

UNIT– III	SEQUENTIAL LOGIC CIRCUITS	9

Static latches and registers (L4), dynamic latches and registers (L4), timing issues (L3), pipelines, clocking strategies (L3), non bi-stable sequential circuits (L2)

UNIT – IV	ARITHMETIC BUILDING BLOCKS	9

Data path circuits (L2), architectures for adders, accumulators (L2), multipliers, barrel shifters (L2), speed, power and area tradeoffs (L2).

UNIT–V	MEMORY ARCHITECTURES	9

Memory architectures and Memory control circuits: Read-Only Memories (L2), ROM cells, Read Write Memories (RAM) (L3), dynamic memory design (L3), 6 Transistor SRAM cell (L3), sense amplifiers (L2).

Total: 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination.

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Analyze the characteristics of MOS transistors and CMOS inverter.	L3 – Apply
CO2	Design combinational circuits using different CMOS logic styles.	L3 – Apply
CO3	Characterize clocking strategies and clocking issues of sequential logic circuits.	L4 – Analyze
CO4	Implement data path circuits such as adders, accumulators and multipliers.	L2 – Understand
CO5	Design memory units including ROM and SRAM.	L3 - Apply

REFERENCE BOOKS:

1.	N.Weste, K. Eshraghian, " Principles Of Cmos VLSI Design", Addision Wesley, 2nd Edition, 1993

2.	M J Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997
3.	Sung-Mo Kang & Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis And Design", Mcgraw-Hill, 1998
4.	Jan Rabaey, Anantha Chandrakasan, B Nikolic, " Digital Integrated Circuits: A Design Perspective", Prentice Hall Of India, 2nd Edition, Feb 2003
VIDEO REFERENCES:	
1.	CMOS Digital VLSI Design - YouTube
2.	EE141 - Spring 2012 - Digital Integrated Circuits - UC Berkeley - Jan M. Rabaey - YouTube
WEB REFERENCES:	
1.	CMOS VLSI Design and Circuit Simulation Tasks (cadence.com)
2.	Index of /~mcdermot/vlsi1/main/lectures (utexas.edu)
ONLINE COURSES:	
1.	CMOS Digital VLSI Design - Course (nptel.ac.in)
2.	Index of /classes/ece410/salem/files/s16/lectures (msu.edu)

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1	1		
CO2	1		2	1		
CO3	1		1	1		
CO4	1		2	1		
CO5	1		1	1		
Average	1		1.4	1		

1–Low, 2 –Medium, 3–High.

ME23VL303	ADVANCED DIGITAL SYSTEM DESIGN	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To design clocked synchronous sequential circuits.
2	To analyze the asynchronous sequential circuits.
3	To apply the fault testing procedure for digital circuits.
4	To design the synchronous circuits using programmable devices.
5	To design and implement digital circuits using HDL programming.

UNIT–I	SEQUENTIAL CIRCUIT DESIGN	9

Analysis of Clocked Synchronous Sequential Circuits and Modeling- State Diagram (L4), State Table, State Table Assignment (L3) and Reduction-Design of Synchronous Sequential Circuits (L3), Design of Iterative Circuits-ASM Chart and Realization using ASM (L3).

UNIT–II	ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN	9

Analysis of Asynchronous Sequential Circuit – Flow Table Reduction (L4) -Races-State Assignment Transition Table and Problems in Transition Table (L4)- Design of Asynchronous Sequential Circuit - Static, Dynamic and Essential hazards (L3) – Mixed Operating Mode Asynchronous Circuits (L2) – Designing Vending Machine Controller (L2).

UNIT– III	FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS	9

Fault Table Method-Path Sensitization Method (L3) – Boolean Difference Method - D Algorithm (L3) – Tolerance Techniques – The Compact Algorithm (L3)– Fault in PLA – Test Generation (L3) - DFT Schemes – Built in Self Test (L3).

UNIT – IV	SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES	9

Programming Logic Device Families (L2)– Designing a Synchronous Sequential Circuit using PLA/PAL (L2) – Designing ROM with PLA (L2) – Realization of Finite State Machine using PLD (L2) – FPGA – Xilinx FPGA - Xilinx 4000 (L2).

UNIT–V	SYSTEM DESIGN USING VERILOG	9

Hardware Modeling with Verilog HDL (L2)– Logic System, Data Types And Operators For Modeling In Verilog HDL (L2) - Behavioral Descriptions In Verilog HDL (L2) – HDL Based Synthesis (L3)– Synthesis Of Finite State Machines– Structural Modeling (L3) – Compilation And Simulation Of Verilog Code (L3) – Test Bench - Realization Of Combinational And Sequential Circuits Using Verilog (L3) – Registers – Counters – Sequential Machine – Serial Adder – Multiplier- Divider – Design Of Simple Microprocessor (L3), Introduction To System Verilog (L2).

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination.

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Design clocked synchronous sequential circuits.	L3 - Apply
CO2	Analyze the asynchronous sequential circuits.	L4 - Analyze
CO3	Apply the fault testing procedure for digital circuits.	L3 – Apply
CO4	Design the synchronous circuits using programmable devices.	L2–Understand

CO5	Design and implement digital circuits using HDL programming.	L4 - Apply

REFERENCE BOOKS:	
1.	Charles H.Roth jr., "Fundamentals of Logic Design" Thomson Learning,2013.
2.	M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999
3.	M.G.Arnold, Verilog Digital – Computer Design, Prentice Hall (PTR), 1999.
4.	Nripendra N Biswas "Logic Design Theory" Prentice Hall of India,2001.
5.	Paragk.Lala "Fault Tolerant and Fault Testable Hardware Design" B S Publications,2002
6.	Paragk.Lala "Digital System Design Using PLD" B S Publications,2003
7.	Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003
VIDEO REFERENCES:	
1.	ECE 4305 – Advanced Digital Design Using System Verilog HDL – YouTube
2.	Digital System Design – YouTube
WEB REFERENCES:	
1.	Resources – Advanced Circuit Techniques Electrical Engineering and Computer Science – MIT Open Course Ware
2.	Advanced Circuit Techniques – Electrical Engineering and Computer Science – MIT Open Course Ware
ONLINE COURSES:	
1.	Digital System Design – Course (nptel.ac.in)
2.	Advanced Digital Design Course – VLSI Guru

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1	1	1	
CO2	1		1	1	1	
CO3	1		1	1	1	
CO4	1		1	1	2	
CO5	1		1	1	1	
Average	1		1	1	1.2	

1–Low, 2 –Medium, 3–High.

ME23VL304	RFIC DESIGN	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To design impedance matching circuits for RF amplifiers.
2	To design low noise amplifiers and RF power amplifiers.
3	To analyze the various parameters involved in RF mixers.
4	To design and analyze RF oscillators.
5	To design PLL and analyze frequency synthesizer

UNIT–I	IMPEDANCE MATCHING IN AMPLIFIERS	9

Definition of 'Q' (L2), Series Parallel Transformations of Lossy Circuits (L2) , Impedance Matching Using 'L', 'Pi' and T Networks (L2) , Integrated Inductors, Resistors, Capacitors, Tunable Inductors, Transformers (L2).

UNIT–II	AMPLIFIER DESIGN	9

Noise Characteristics of MOS Devices (L2), Design of CG LNA and Inductor Degenerated LNAs (L3). Principles of RF Power Amplifiers Design (L3)

UNIT– III	ACTIVE AND PASSIVE MIXERS	9

Qualitative Description of the Gilbert Mixer (L3) - Conversion Gain, and Distortion and Noise (L2), Analysis of Gilbert Mixer – Switching Mixer (L4) - Distortion in Unbalanced Switching Mixer (L3)- Conversion Gain in Unbalanced Switching Mixer (L3) - Noise in Unbalanced Switching Mixer (L3) - a Practical Unbalanced Switching Mixer (L4). Sampling Mixer - Conversion Gain in Single-Ended Sampling Mixer (L3) - Distortion in Single-Ended Sampling Mixer (L4) - Intrinsic Noise in Single-Ended Sampling Mixer (L3) - Extrinsic Noise in Single-Ended Sampling Mixer (L3)

UNIT – IV	OSCILLATORS	9

LC Oscillators, Voltage Controlled Oscillators (L3) , Ring Oscillators, Delay Cells (L3) , Tuning Range in Ring Oscillators (L3) , Tuning in LC Oscillators, Tuning Sensitivity (L2) , Phase Noise in Oscillators (L3) , Sources of Phase Noise (L2)

UNIT–V	PLL AND FREQUENCY SYNTHESIZERS	9

Phase Detector/Charge Pump (L2), Analog Phase Detectors, Digital Phase Detectors (L2) , Frequency Dividers, Loop Filter Design (L3) , Phase Locked Loops, Phase Noise in PLL, Loop Bandwidth (L3), Basic Integer-N Frequency Synthesizer (L3), Basic Fractional-N Frequency Synthesizer (L3)

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination.

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Design impedance matching circuits for RF amplifiers.	L2 - Understand
CO2	Design low noise amplifiers and RF power amplifiers.	L3 – Apply
CO3	Analyze the various parameters involved in RF mixers.	L4 – Analyse
CO4	Design and analyze RF oscillators.	L3 - Apply
CO5	Design PLL and analyze frequency synthesizer	L3 - Apply

REFERENCE BOOKS:	
1.	B.Razavi ,"RF Microelectronics" , Prentice-Hall ,1998
2.	Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002
3.	Behzad Razavi, "Design of Analog CMOS Integrated Circuits" Mcgraw-Hill, 1999
4.	Jia-Sheng Hong, "Microstrip Filters for RF/Microwave Applications", Wiley, 2001
5.	Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits', Cambridge University Press ,2003
VIDEO REFERENCES:	
1.	https://youtube.com/playlist?list=PLD60B441FD4FBF559&si=XJ7xRVOJSyRX4k8E
2.	https://youtu.be/2fVt_555TmI?si=30Y6UEG_lUQv0FSg
WEB REFERENCES:	
1.	https://www.ee.iitm.ac.in/~ani/2011/ee6240/lectures.html
2.	NPTEL :: Electronics & Communication Engineering - RF Integrated Circuits
ONLINE COURSES:	
1.	https://nptel.ac.in/courses/117102012

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		2	2	2	
CO2	2		2	2	2	
CO3	1		2	2	2	
CO4	1		2	3	2	
CO5	2		2	2	2	
Average	1.6		2	2.2	2	
1–Low, 2 –Medium, 3–High.						

ME23PT801	TECHNICAL SEMINAR / CASE STUDY PRESENTATION	Version : 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		2	0	0	2	0

Course Objectives:

1	To encourage the students to study advanced engineering developments
2	To prepare and present the technical and case study reports

Method of Evaluation:

The students need to identify an area of interest or topic in their programme of study or case study and prepare a 5-10 page report and a presentation. Based on the report and presentation, the course is evaluated for 100 marks. Minimum 50 marks is essential to pass. In case a student fails, he has to make such presentation in the subsequent semesters. The evaluation guidelines will be issued by the Head of the Department before the commencements of the course. The objectives are improving literature searching capabilities, comprehension and ability to write reports and to make presentations. It is assessed in Internal Assessment mode only and no End Semester Examination.

Total : 30 PERIODS

Course Outcomes: At the end of this course, the students will demonstrate the ability to		**BLOOM'S Taxonomy**
CO1	Perform the review and present technological developments in their field	L3 - Apply
CO2	Interpret the case study report and make a decision	L3 - Apply

Mapping of COs with POs						
CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
1		3				
2		3				
Avg		3				
1–Low, 2 –Medium, 3–High.						

ME23VL305	FPGA LABORATORY	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		4	0	0	4	2

Course Objectives:

1.	To study the basics of HDL programming and simulator tools.
2.	To design and verify ALU and Instruction stack.
3.	To generate test program for combinational and sequential circuit.
4.	To develop a test bench using object oriented structure.
5.	To develop and verify test environments with various constraints.

LIST OF EXPERIMENTS

1.	Introduction to Verilog and System Verilog
2.	Running simulator and debug tools
3.	Experiment with 2 state and 4 state data types
4.	Experiment with blocking and non-blocking assignments
5.	Model and verify simple ALU
6.	Model and verify an Instruction stack
7.	Use an interface between testbench and DUT
8.	Developing a test program
9.	Create a simple and advanced OO testbench
10.	Create a scoreboard using dynamic array
11.	Use mailboxes for verification
12.	Generate constrained random test values
13.	Using coverage with constrained random tests

TOTAL: 60PERIODS

COURSE OUTCOMES		BLOOM'S
CO 1	Comprehend the basics of HDL programming and simulator tools.	L2 – Understand
CO 2	Design and verify ALU and Instruction stack.	L3 – Apply
CO 3	Generate test program for combinational and sequential circuit.	L3 – Apply
CO 4	Develop a test bench using object oriented structure.	L3 – Apply
CO 5	Develop and verify test environments with various constraints.	L3 – Apply

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1			3	2	
CO2	1			3	2	
CO3	1			3	2	
CO4	1			3	2	
CO5	1			3	2	
Average	1			3	2	

1–Low, 2 –Medium, 3–High.

ME23VL306	ANALOG IC DESIGN LABORATORY	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		4	0	0	4	2

Course Objectives:

1	To design and analyse the various parameters of digital CMOS circuits for a given specification.
2	To build and verify the SPICE models of oscillator circuits.
3	To design and characterize single stage amplifier circuits for a given specification.
4	To design and characterize instrumentation amplifier circuit.
5	To design and extract circuit parameters using layout editor tool.

LIST OF EXPERIMENTS

1	Extraction of process parameters of CMOS process transistors a. Plot ID vs. VGS at different drain voltages for NMOS, PMOS. b. Plot ID vs. VGS at particular drain voltage for NMOS, PMOS and determine Vt. c. Plot log ID vs. VGS at particular gate voltage for NMOS, PMOS and determine IOFF and sub threshold slope. d. Plot ID vs. VDS at different gate voltages for NMOS, PMOS and determine Channel length modulation factor. e. Extract Vth of NMOS/PMOS transistors (short channel and long channel). Use VDS of appropriate voltage To extract Vth use the following procedure. i. Plot gm vs VGS using SPICE and obtain peak gm point. ii. Plot y=ID/(gm) as a function of VGS using SPICE. iii. Use SPICE to plot tangent line passing through peak gm point in y (VGS) plane and determine Vth. f. Plot ID vs. VDS at different drain voltages for NMOS, PMOS, plot DC load line and calculate gm, gds, gm/gds, and unity gain frequency. Tabulate result according to technologies and comment on it.
2	CMOS inverter design and performance analysis a. i. Plot VTC curve for CMOS inverter and thereon plot dVout vs. dVin and determine transition voltage and gain g. Calculate VIL, VIH, NMH, NML for the inverter. ii. Plot VTC for CMOS inverter with varying VDD. iii. Plot VTC for CMOS inverter with varying device ratio. b. Perform transient analysis of CMOS inverter with no load and with load and determine propagation delay tpHL, tpLH, 20%-to-80% rise time tr and 80%-to-20% fall time tf. c. Perform AC analysis of CMOS inverter with fanout 0 and fanout 1.
3	Use spice to build a three stage and five stage ring oscillator circuit and compare its frequencies. Use FFT and verify the amplitude and frequency components in the spectrum
4	Single stage amplifier design and performance analysis a. Plot small signal voltage gain of the minimum-size inverter in the technology chosen as a function of input DC voltage. Determine the small signal voltage gain at the switching point using spice and compare the values for two different process transistors. b. Consider a simple CS amplifier with active load, with NMOS transistor as driver and PMOS transistor as load.

	i. Establish a test bench to achieve VDSQ=VDD/2. ii. Calculate input bias voltage for a given bias current. iii. Use spice and obtain the bias current. Compare with the theoretical value iv. Determine small signal voltage gain, -3dB BW and GBW of the amplifier v. Using small signal analysis in spice, considering load capacitance. vi. Plot step response of the amplifier with a specific input pulse amplitude. vii. Derive time constant of the output and compare it with the time constant viii. Resulted from -3dB Band Width. ix. Use spice to determine input voltage range of the amplifier
5	Three OPAMP Instrumentation Amplifier (INA). a. Use proper values of resistors to get a three OPAMP INA with differential-mode voltage gain=10. Consider voltage gain=2 for the first stage and voltage gain=5 for the second stage. i. Draw the schematic of op-amp macro model. ii. Draw the schematic of INA. iii. Obtain parameters of the op-amp macro model such that meets a given specification for: i. low-frequency voltage gain, ii. unity gain BW (fu) iii. input capacitance iv. output resistance v. CMRR b. Draw schematic diagram of CMRR simulation setup. c. Simulate CMRR of INA using AC analysis (it's expected to be around 6dB below CMRR of OPAMP). d. Plot CMRR of the INA versus resistor mismatches (for resistors of second stage only) changing from -5% to +5% (use AC analysis). Generate a separate plot for mismatch in each resistor pair. e. Explain how CMRR of OPAMP changes with resistor mismatches. f. Repeat (iii) to (vi) by considering CMRR of all OPAMPs with low frequency gain setting.
6	Use Layout editor. a. Draw layout of a minimum size inverter using transistors from CMOS process library. Use Metal 1 as interconnect line between inverters. b. Run DRC, LVS and RC extraction. Make sure there is no DRC error. c. Extract the netlist. Use extracted netlist and obtain tPHLtPLH for the inverter using Spice. d. Use a specific interconnect length and connect and connect three inverters in a chain. e. Extract the new netlist and obtain tPHL and tPLH of the middle inverter. f. Compare new values of delay times with corresponding values obtained in part 'c'.
7	Design a differential amplifier with resistive load using transistors from CMOS process library that meets a given specification for the following parameter a. low-frequency voltage gain, b. unity gain BW (fu), c. Power dissipation i. Perform DC analysis and determine input common mode range and compare with the theoretical values. ii. Perform time domain simulation and verify low frequency gain. iii. Perform AC analysis and verify.
	TOTAL: 60PERIODS

COURSE OUTCOMES		BLOOM'S Taxonomy
CO 1	Design and analyse the various parameters of digital CMOS circuits for a given specification.	L3 – Apply
CO 2	Build and verify the SPICE models of oscillator circuits.	L3 – Apply
CO 3	Design and characterize single stage amplifier circuits for a given specification.	L3 – Apply
CO 4	Design and characterize instrumentation amplifier circuit.	L3 – Apply
CO 5	Design and extract circuit parameters using layout editor tool.	L3 – Apply

Mapping of COs with POs						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1			3	2	
CO2	1			3	2	
CO3	1			3	2	
CO4	1			3	2	
CO5	1			3	2	
Average	1			3	2	
1–Low, 2 –Medium, 3–High.						

ME23VL307	DESIGN FOR VERIFICATION USING UVM	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To provide the students an understanding on UVM concepts
2	To understand the function of verification components
3	To become proficient at UVM verification,
4	To provide an understanding of register classes and models
5	To provide an experience on self-checking UVM test benches

UNIT–I	INTRODUCTION	9

Overview- The Typical UVM Testbench Architecture (L2)- The UVM Class Library (L2) -Transaction-Level Modeling (TLM) (L2) - Overview- TLM, TLM-1, and TLM-2.0 (L2) -TLM-1 Implementation (L2) - TLM-2.0 Implementation (L2)

UNIT–II	DEVELOPING REUSABLE VERIFICATION COMPONENTS	9

Modeling Data Items for Generation (L3)- Transaction-Level Components - Creating the Driver - Creating the Sequencer (L3) - Connecting the Driver and Sequencer -Creating the Monitor (L3) - Instantiating Components- Creating the Agent (L3) - Creating the Environment -Enabling Scenario Creation (L3) -Managing of Test-Implementing Checks and Coverage (L3)

UNIT– III	UVM USING VERIFICATION COMPONENTS	9

Creating a Top-Level Environment- Instantiating Verification Components (L3) - Creating Test Classes - Verification Component Configuration (L3) - Creating and Selecting a User-Defined Test (L3) - Creating Meaningful Tests- Virtual Sequences (L3) - Checking for DUT Correctness- Scoreboards (L3) - Implementing a Coverage Model (L3)

UNIT – IV	UVM USING THE REGISTER LAYER CLASSES	9

Using The Register Layer Classes - Back-Door Access -Special Registers -Integrating a Register- Model in a Verification Environment- Integrating a Register Model- Randomizing Field Values- Pre-Defined Sequences

UNIT–V	ASSIGNMENT IN TESTBENCHES	9

Assignment, APB: Protocol (L2), Test bench Architecture (L2) , Driver and Sequencer V , Monitor, Agent and Environment (L2); Creating Sequences, Building Test (L2) , Design and Testing of Top Module (L2)

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Understand the basic concepts of two methodologies UVM	L2 – Understand
CO2	Build actual verification components	L3 – Apply
CO3	Generate the register layer classes.	L3 – Apply
CO4	Code test benches using UVM.	L3 – Apply

CO5	Understand advanced peripheral bus testbenches	L2 – Understand

REFERENCE BOOKS:

1.	The UVM Primer, An Introduction to the Universal Verification Methodology, Ray Salemi, 2013.
2.	System Verilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear, Greg Tumbush, 3rd edition, 2012.
3.	https://www.udemy.com/learn-ovm-UVM/ 2.
4.	http://www.testbench.in/ut_00_index.html 3.
5.	http://www.testbench.in/ot_00_index.html
6.	https://www.accellera.org/images/downloads/standards/UVM/UVM_users_guide_1.2.pdf

VIDEO REFERENCES:

1.	https://youtu.be/2026Ei1wGTU
2.	https://youtu.be/8F5nLB5zL-0

WEB REFERENCES:

1.	Guide - Developing Reusable Verification Components (chipverify.com)
2.	RTL Design - APB Protocol | QuickSilicon - YouTube

ONLINE COURSES:

1.	UVM for Verification Part 1 : Fundamentals | Udemy
2.	UVM for Verification Part 2 : Projects | Udemy

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	1	2	
CO2	1		1	1	2	
CO3	1		1	1	2	
CO4	1		1	1	2	1
CO5	1		1	1	2	1
Average	1		1	1	2	1

1–Low, 2 –Medium, 3–High.

ME23VL308	LOW POWER VLSI DESIGN	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	Identify sources of power in an IC.
2	Identify the power reduction techniques based on technology independent and technology dependent methods
3	Identify suitable techniques to reduce the power dissipation
4	Estimate power dissipation of various MOS logic circuits
5	Develop algorithms for low power dissipation

UNIT–I	POWER DISSIPATION IN CMOS	9

Hierarchy of Limits of Power (L2)– Sources of Power Consumption (L2) – Physics of Power Dissipation in CMOS FET Devices (L2) – Basic Principle of Low Power Design (L2).

UNIT–II	POWER OPTIMIZATION	9

Logic Level Power Optimization (L2) – Circuit Level Low Power Design (L2) – Gate Level Low Power Design (L2) –Architecture Level Low Power Design (L2) – VLSI Subsystem Design of Adders, Multipliers (L3), PLL, Low Power Design (L2).

UNIT– III	DESIGN OF LOW POWER CMOS CIRCUITS	9

Computer Arithmetic Techniques for Low Power System (L2) – Reducing Power Consumption in Combinational Logic, Sequential Logic, Memories (L3) – Low Power Clock – Advanced Techniques (L3) – Special Techniques (L3), Adiabatic Techniques – Physical Design, Floor Planning, Placement and Routing (L3).

UNIT – IV	POWER ESTIMATION	9

Power Estimation Techniques (L3), Circuit Level, Gate Level, Architecture Level, Behavioral Level, – Logic Power Estimation (L4) – Simulation Power Analysis (L3) –Probabilistic Power Analysis (L4)

UNIT–V	SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER CMOS CIRCUITS	9

Synthesis for Low Power – Behavioral Level Transform (L3) –Algorithms for Low Power (L3) – Software Design for Low Power (L3).

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Able to find the power dissipation of MOS circuits	L2 – Understand
CO2	Design and analyze various MOS logic circuits	L3 – Apply
CO3	Apply low power techniques for low power dissipation	L3 – Apply
CO4	Able to estimate the power dissipation of ICs	L4 – Analyze

CO5	Able to develop algorithms to reduce power dissipation by software tools.	L3 - Apply

REFERENCE BOOKS:	
1.	Kaushik Roy and S.C.Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2000
2.	J.B.Kulo and J.H Lou, "Low Voltage CMOS VLSI Circuits", Wiley 1999.
3.	James B.Kulo, Shih-Chia Lin, "Low Voltage SOI CMOS VLSI Devices and Circuits", John Wiley and Sons, Inc. 2001
4.	J.Rabaey, "Low Power Design Essentials (Integrated Circuits and Systems)", Springer, 2009
VIDEO REFERENCES:	
1.	https://youtube.com/playlist?list=PLbMVogVj5nJTDr6KqQXNcxCvooSMnBuXj
2.	https://youtube.com/playlist?list=PLB3F0FC99B5D89571
WEB REFERENCES:	
1.	NPTEL :: Computer Science and Engineering - Low Power VLSI Circuits & Systems
2.	Low Power Design Methodology | IntechOpen
ONLINE COURSES:	
1.	VLSI System Design & SubSystems of Digital Circuits Course | Udemy

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		2	3	2	
CO2	2		2	2	2	
CO3	1		2	2	2	
CO4	1		2	3	2	
CO5	2		2	2	3	
Average	1.6		2	2.4	2.2	

1–Low, 2 –Medium, 3–High.

ME23VL309	VLSI TESTING	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To introduce the VLSI testing.
2	To introduce logic and fault simulation and testability measures
3	To study the test generation for combinational and sequential circuits
4	To study the design for testability.
5	To study the fault diagnosis

UNIT–I	INTRODUCTION TO TESTING	9

Introduction – VLSI Testing Process and Test Equipment (L2)– Challenges in VLSI Testing - Test Economics and Product Quality (L2)– Fault Modeling – Relationship Among Fault Models (L2).

UNIT–II	LOGIC & FAULT SIMULATION & TESTABILITY MEASURES	9

Simulation for Design Verification and Test Evaluation (L3) – Modeling Circuits for Simulation (L3) – Algorithms for True Value and Fault Simulation (L3) – Scoap Controllability and Observability (L3)

UNIT– III	TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS	9

Algorithms and Representations (L3) – Redundancy Identification – Combinational ATPG Algorithms (L3) – Sequential ATPG Algorithms (L3) – Simulation Based ATPG (L3) – Genetic Algorithm Based ATPG (L3)

UNIT – IV	DESIGN FOR TESTABILITY	9

Design for Testability Basics (L2) – Testability Analysis - Scan Cell Designs (L2) – Scan Architecture (L2) – Built-in Self-Test (L2) – Random Logic Bist (L2) – DFT for Other Test Objectives (L2).

UNIT–V	FAULT DIAGNOSIS	9

Introduction and Basic Definitions – Fault Models for Diagnosis (L3) – Generation of Vectors for Diagnosis (L3) – Combinational Logic Diagnosis (L3) - Scan Chain Diagnosis – Logic BIST Diagnosis (L3).

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Understand VLSI Testing Process	L2 – Understand
CO2	Develop Logic Simulation and Fault Simulation	L3 – Apply
CO3	Develop Test for Combinational and Sequential Circuits	L3 – Apply
CO4	Understand the Design for Testability	L2 – Understand

CO5	Perform Fault Diagnosis.	L3 – Apply

REFERENCE BOOKS:	
1.	Laung-Terng Wang, Cheng-Wen Wu and Xiaoqing Wen, "VLSI Test Principles and Architectures", Elsevier, 2017
2.	Michael L. Bushnell and Vishwani D. Agrawal, "Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits" , Kluwer Academic Publishers, 2017.
3.	Niraj K. Jha and Sandeep Gupta, "Testing of Digital Systems", Cambridge University Press, 2017.
VIDEO REFERENCES:	
1.	https://youtube.com/playlist?list=PLbMVogVj5nJTClnafWQ9FK2nt3cGG8kCF&si=KsCdiDSXxro72ARc
2.	https://youtube.com/playlist?list=PLx98Qgh5zPjh6oWI73QfQHZAmAiyt8Wkf&si=W7cJqNXn8EuHtDPo
WEB REFERENCES:	
1.	https://archive.nptel.ac.in/content/storage2/courses/106103116/handout/mod7.pdf
2.	https://archive.nptel.ac.in/courses/117/105/117105137/
ONLINE COURSES:	
1.	https://nptel.ac.in/courses/117105137
2.	https://onlinecourses.nptel.ac.in/noc20_ee76/preview

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		2	3	3	1
CO2	2		2	2	3	1
CO3	1		2	2	3	1
CO4	1		2	3	2	1
CO5	2		2	2	1	1
Average	1.6		2	2.4	2.4	1
1–Low, 2 –Medium, 3–High.						

ME23MC701	UNIVERSAL HUMAN VALUES AND ETHICS	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	2	1	0	3

Instructions if any

Course Objectives:

1	To understand the concept of Universal Human Values
2	To explain theoretical and practical implications of UHV
3	To discuss the use of harmony in the family and society
4	To classify the harmony in the nature methods.
5	To describe effective human values in personal and professional in life

UNIT–I	INTRODUCTION TO VALUE EDUCATION	9

Right Understanding (L2), Relationship and Physical Facility (L2) (Holistic Development and the Role of Education) (L2) - Understanding Value Education (L2) - Sharing about Oneself (L2) - Self-exploration as the Process for Value Education (L2) - Continuous Happiness and Prosperity (L2) – the Basic Human Aspirations (L1) - Exploring Human Consciousness (L2) - Happiness and Prosperity (L2) – Current Scenario (L2) - Method to Fulfil the Basic Human Aspirations (L2) - Exploring Natural Acceptance (L2).

UNIT–II	HARMONY IN THE HUMAN BEING	9

Understanding Human being as the Co-existence of the Self and the Body (L2) - Distinguishing between the Needs of the Self and the Body (L2)- Exploring the difference of Needs of Self and Body (L2) - The Body as an Instrument of the Self (L2)- Understanding Harmony in the Self (L2)- Exploring Sources of Imagination in the Self(L2) - Harmony of the Self with the Body (L2)- Programme to ensure self-regulation and Health (L2)- Exploring Harmony of Self with the Body (L2).

UNIT– III	HARMONY IN THE FAMILY AND SOCIETY	9

Harmony in the Family (L2) – the Basic Unit of Human Interaction (L2) - 'Trust' – the Foundational Value in Relationship (L2) - Exploring the Feeling of Trust (L2) - 'Respect' – as the Right Evaluation (L3) - Exploring the Feeling of Respect (L2) - Other Feelings (L2), Justice in Human-to-Human Relationship (L2) - Understanding Harmony in the Society (L2)- Vision for the Universal Human Order (L3) – Exploring Systems to fulfil Human Goal (L2).

UNIT – IV	HARMONY IN THE NATURE/EXISTENCE	9

Understanding Harmony in the Nature (L2) – Interconnectedness (L2), self-regulation and Mutual Fulfilment among the Four Orders of Nature (L3) - Exploring the Four Orders of Nature (L2) - Realizing Existence as Co-existence at All Levels (L2) - The Holistic Perception of Harmony in Existence (L2) - Exploring Co-existence in Existence (L2).

UNIT–V	IMPLICATIONS OF THE HOLISTIC UNDERSTANDING - A LOOK AT PROFESSIONAL ETHICS	9

Natural Acceptance of Human Values (L2) - Definitiveness of (Ethical) Human Conduct (L2) - Exploring Ethical Human Conduct (L2) - A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order (L2) - Competence in Professional Ethics (L2) - Exploring Humanistic Models in Education (L2) - Holistic Technologies, Production Systems and Management Models (L2) -Typical Case Studies (L2)- Strategies for Transition towards Value-based Life and Profession (L2) - Exploring Steps of Transition towards Universal Human Order (L2).

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	
Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination		
Course Out comes: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Recognize the concepts of Universal Human Values.	L2 - Understand
CO2	Describe both theoretical and practical implications of Universal Human Values.	L2 - Understand
CO3	Use the harmony in family and society.	L3 - Apply
CO4	Incorporate harmony in all human existence.	L3 - Apply
CO5	Use human values in both personal and professional life.	L2 - Understand

REFERENCE BOOKS:

1.	R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics – Teachers Manual, Excel books, New Delhi, 2010.
2.	B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow, Reprinted 2008.
3.	Frankl, Viktor E. Yes to Life In spite of Everything, Penguin Random House, London, 2019.
4.	Van Zomeren, M., & Dovidio, J. F. The Oxford Handbook of the Human Essence (Eds.), New York Oxford University Press, 2018.
5.	B P Banerjee, Foundations of Ethics and Management, Excel Books, 2005.

VIDEO REFERENCES:

1.	https://www.youtube.com/c/UniversalHumanValues
2.	https://www.youtube.com/watch?v=OgdNx0X923I

WEB REFERENCES:

1.	Story of Stuff, http://www.storyofstuff.com
2.	https://fdp-si.aicte-india.org/UHVII.php

ONLINE COURSES:

1.	https://nptel.ac.in/courses/109104068
2.	https://uhv.org.in/course

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		2	3	3	1
CO2	2		2	2	3	1
CO3	1		2	2	3	1
CO4	1		2	3	2	1
CO5	2		2	2	1	1
Average	1.6		2	2.4	2.4	1
1–Low, 2 –Medium, 3–High.						

ME23VL310	VERIFICATION USING UVM LABORATORY	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		4	0	0	4	2

Course Objectives:

1.	To help the engineers to design the system with verilog and system Verilog
2.	Complete understanding of Verilog Hardware Description Language
3.	To practice for writing synthesizable RTL models that work correctly in both simulation and synthesis.

LIST OF EXPERIMENTS

1.	Simulate a simple UVM testbench and DUT
2.	Examining the UVM testbench
3.	Design and simulate sequence items and sequence
4.	Design and simulate a UVM driver and sequencer
5.	Design and simulating UVM monitor and agent
6.	Design, simulate and examine coverage
7.	Design and simulate a UVM scoreboard and environment, and verifying the outputs of a (faulty) DUT
8.	Design and simulate a test that runs multiple sequence
9.	Design and simulate a configurable UVM test environment

TOTAL: 60PERIODS

COURSE OUTCOMES		BLOOM'S Taxonomy
CO 1	Understand the features and capabilities of the UVM class library for system Verilog	L3 – Apply
CO 2	Combine multiple UVCs into a complete verification environment	L3 – Apply
CO 3	Create and configure reusable, scalable, and robust UVM verification components (UVCs).	L3 – Apply
CO 4	Create a UVM test bench structure using the UVM library base classes and the UVM factory	L3 – Apply
CO 5	Develop a register model for your DUT and use the model for initialization and accessing DUT registers	L3 – Apply

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1			3	2	
CO2	1			3	2	
CO3	1			3	2	
CO4	1			3	2	
CO5	1			3	2	
Average	1			3	2	

1–Low, 2 –Medium, 3–High.

ME23PT802	RESEARCH PAPER REVIEW AND PRESENTATION	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		2	0	0	2	1

Instructions if any

Course Objectives:

1	To Learn scientific paper reading and wiring skills
2	To Learn the literature review and report wiring skills
3	To understand the research gap and formulation of the research problem

The work involves the following steps:

1 Assigning the faculty supervisor
2 Selecting a subject, narrowing the subject into a topic
3 Stating an objective.
4 Collecting the relevant bibliography (atleast 20 research papers)
5 Studying the papers understanding the authors contributions and critically analysing each paper.
6 Preparing a 20-25 page literature review report
7 Preparing conclusions based on the literature review report.
8 Writing the Final Review Paper
9 Final Presentation to the review committee

Evaluation method:

A faculty supervisor will be assigned to each student. The supervisor will assign a topic to the student. The student has to review the literature pertaining to the topic, prepare a 20-25 page report and make a presentation. Minimum 20 research papers have to be reviewed out of which 60% have to be in the recent 05 years. The format for the research paper report and guidelines for assessment will be issued by the Head of the Department before the commencement of the course. The evaluation will be carried out based on the research paper report and presentation, and is evaluated for 100 marks. Minimum 50 marks is essential to pass. In case a student fails, he or she has to redo the course in the forthcoming semesters. Assessment is by Internal Assessment mode only no End Semester Examination.

Total : 30 PERIODS

Course Outcomes: At the end of this course, the students will demonstrate the ability to		BLOOM'S Taxonomy
CO1	Write a scientific review paper in their field	L3 - Apply
CO2	Identify the research gap and formulate the research problem	L3 - Apply

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		3				
CO2		3				
Average		3				
1–Low, 2 –Medium, 3–High.						

ME23VL401	ASIC DESIGN	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To introduce the concepts of CMOS Logic Cells, I/O Cells and ASIC library design
2	To design programmable ASIC using interconnects
3	To analyse the hardware resources of various FPGA boards
4	To apply floor planning, placement and routing algorithms for optimization
5	To analyse Communication Architectures available for system on chip design

UNIT–I	INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN	9

Types of Asics (L1) - Design Flow (L2) - CMOS Transistors (L2) - Combinational Logic Cell (L2) – Sequential Logic Cell (L2) - Data Path Logic Cell (L2) - Transistors as Resistors (L2) - Transistor Parasitic Capacitance- Logical Effort (L2).

UNIT–II	PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS	9

Anti Fuse - Static Ram (L2) - EPROM and EEPROM Technology (L3) - ACTEL ACT (L2)- Xilinx LCA (L2) – ALTERA FLEX (L2) - ALTERA MAX DC & AC Inputs and Outputs (L2) - Clock & Power Inputs (L2) - Xilinx I/O Blocks (L2).

UNIT– III	PROGRAMMABLE ASIC ARCHITECTURE	9

Architecture and Configuration of ARTIX (L3) / Cyclone and KINTEX Ultra Scale (L3) / STRATIX FPGA – Micro-Blaze (L3) / NIOS Based Embedded Systems (L3) – Signal Probing Techniques (L3).

UNIT – IV	LOGIC SYNTHESIS, PLACEMENT AND ROUTING	9

Logic Synthesis - Floor Planning Goals and Objectives (L3), Measurement of Delay in Floor Planning (L3), Floor Planning Tools (L3), I/O and Power Planning (L3), Clock Planning (L3), Placement Algorithms (L3). Routing: Global Routing (L2), Detailed Routing (L3), and Special Routing (L3).

UNIT–V	SYSTEM-ON-CHIP DESIGN	9

SoC Design Flow (L3), Platform-Based and IP Based SoC Designs (L3), Basic Concepts of Bus-Based Communication Architectures (L2), High Performance Filters using Delta-Sigma Modulators (L3). Case Studies: Digital Camera (L3), SDRAM (L2), High Speed Data standards (L3).

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Apply Logical Effort Technique for predicting Delay, Delay Minimization and FPGA Architectures	L2 – Understand
CO2	Design Logic Cells and I/O Cells in ASIC	L3 – Apply
CO3	Analyse the various hardware resources of recent FPGAs	L3 – Apply
CO4	Apply Algorithms for Floor Planning, Placement and Routing for optimization of area and Speed	L3 – Apply

CO5	Analyse Communication Architectures available for ASICs	L3 – Apply

REFERENCE BOOKS:	
1.	M.J.S.Smith, "Application Specific Integrated Circuits", Pearson, 2003
2.	Steve Kilts, "Advanced FPGA Design," Wiley Inter-Science,2006
3.	Roger Woods, John Mcallister, Dr. Ying Yi, Gaye Lightbod, "FPGA-Based Implementation of Signal Processing Systems", Wiley, 2008
VIDEO REFERENCES:	
1.	https://youtu.be/oZSv68esbgI?si=5ucBX12p-Uc3gfnv
2.	https://onlinecourses.nptel.ac.in/noc20_ee44/preview
WEB REFERENCES:	
1.	https://parts.jpl.nasa.gov/asic/Sect.3.2.html
2.	ASIC Design: What Is ASIC Design? | System To ASIC (system-to-asic.com)
ONLINE COURSES:	
1.	VLSI Design Flow – Udemy
2.	https://dl.acm.org/doi/abs/10.1145/3453688.3461502

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1	3	3	2
CO2	1		1	2	3	2
CO3	1		1	2	3	1
CO4	1		2	3	2	1
CO5	1		2	2	1	1
Average	1		1.4	2.4	2.4	1.4
1–Low, 2 –Medium, 3–High.						

ME23VL402	MEDICAL IMAGING SYSTEMS	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To understand the production of x-rays and its application to different medical Imaging
2	To explore the different types of Radio diagnostic techniques
3	To understand the special imaging techniques for visualizing the cross sections of the body
4	To understand the production of Magnetic resonance images for various pulse sequences
5	To realize the importance of image quality assessments for medical imaging systems

UNIT–I	X – RAYS	9

Principle and production of soft X – Rays (L2), X- ray machine and digital radiography (L2), principles of Angiography and Fluoroscopic Techniques (L2), digital subtraction angiography (L2), mammography(L2).

UNIT–II	CT AND ULTRASOUND IMAGING	9

CT principle (L2)- Multi section Radiography(L2), Computerised Axial Tomography(L3), Type of Detection (L2), image reconstruction(L2), Spiral CT, Transverse Tomography,3D Imaging(L3). Ultrasonic frequency for medical application (L3), different modes of Display A, B and M, ultrasonic probes (L2), Real time echo and 2D scanner (L2).

UNIT– III	COMPUTER AIDED TOMOGRAPHY	9

Need for sectional images (L2), Principles of sectional scanning (L2), Method of convolution and Back Propagation (L2), Methods of reconstruction (L2), Multislice CT (L2), artifacts (L2).

UNIT – IV	MAGNETIC RESONANCE IMAGING AND EMISSION COMPUTED TOMOGRAPHY IMAGING	9

Principle of MRI (L2), MRI instrumentation (L2), Imaging Different Sections of the Body (L3), Tissue Characterization, MR Spectroscopy (L2), Functional MRI. Alpha, Beta, Gamma Emission (L3), different types of Radiation Detectors (L2), Functions of Gamma Camera (L3), PET (L2), SPECT, PET/CT (L2), PET/MRI (L2).

UNIT–V	QUALITY METRICS FOR IMAGING SYSTEMS	9

Global parameter assessment (L2), spatial – frequency assessment (L2), Image – processing assessment (L2), Observer assessment (L2), Image discrimination models (L2), figure of merit (L2), Comparing model to human Performance (L2).

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Explain the functionalities and applications of X ray in medicine	L2 – Understand
CO2	Demonstrate the images acquisition procedures using CT	L3 – Apply
CO3	Explain the suitable projection methods for anatomy and biology specific	L2 – Understand
CO4	Demonstrate the applications of magnetic field in the field of medicine	L3 – Apply

CO5	Explain the assessment method to quantify the presence of noise in the image	L2 – Understand

REFERENCE BOOKS:	
1.	Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging, Volume 1. Physics and Psychophysics, SPIE, 2000
2.	Chesney D. N., Chesney M. O. Radio graphic imaging, CBS Publications, New Delhi, 1989
3.	Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI from Picture to proton, Cambridge University press, second edition, New York 2007
4.	Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders Elsevier, 2005
5.	Jerry L. Prince, Jnathan M. Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2014
6.	Peggy, W., Roger D. Ferimarch, MRI for Technologists, McGraw Hill, New York, second edition, 2000
VIDEO REFERENCES:	
1.	https://www.youtube.com/@HealthInformatics/playlists
2.	https://youtu.be/A4wz-7EL9E0?si=jNPduoa72Y-6q_6p
WEB REFERENCES:	
1.	https://link.springer.com/book/10.1007/978-3-319-96520-8
2.	https://www.ncbi.nlm.nih.gov/books/NBK546151/
ONLINE COURSES:	
1.	Introduction to medical imaging – Udemy
2.	NPTEL – Introduction to Bio Medical Imaging Systems

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1	1	3	2
CO2	1		1	2	3	1
CO3	2		1	2	3	1
CO4	2		1	2	2	2
CO5	1		1	2	1	1
Average	1.4		1	2.2	2.4	1.4
1–Low, 2 –Medium, 3–High.						

ME23VL403	PRINCIPLES OF SENSORS AND SIGNAL CONDITIONING	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To provide in-depth understanding of physical principles applied in sensing, measurement and characterisation of sensors
2	To introduce concepts of various Optical sensing mechanisms and theory of instruments and sensors for measuring velocity and acceleration
3	To give a knowledge on the basic laws and operation of transformation of energy in sensors
4	To apply sensors for the design, construction, and execution of mechanical measurements such as strain, force, torque and pressure
5	To apply sensors for the measurement of fluid flow, temperature and acoustics

UNIT–I	SENSOR FUNDAMENTALS AND OPTICAL SOURCES &DETECTORS	9

Sensor Classification (L2), Performance and Types (L2), Error Analysis characteristics (L2), Electronic and Optical properties of semiconductors as sensors (L2), LED (L2), Semiconductor lasers (L2), Fiber optic sensors (L2), Thermal detectors, Photomultipliers (L2), photoconductive detectors (L2), Photodiodes, Avalanche photodiodes (L2), CCDs (L2).

UNIT–II	INTENSITY POLARIZATION AND INTERFEROMETRIC SENSORS	9

Intensity sensor (L2), Micro bending concept (L2), Interferometers, Mach Zehnder (L3), Michelson, FabryPerot and Sagnac (L2), Phase sensor: Phase detection (L3), Polarization maintaining fibers
Strain (L3), Force, Torque and Pressure sensors:
Strain gages, strain gage beam force sensor (L3), piezoelectric force sensor, load cell (L3), torque sensor, Piezo-resistive and capacitive pressure sensor(L3), optoelectronic pressure sensors(L3), vacuum sensors. Design of signal conditioning circuits for strain gauges (L3), piezo, capacitance(L3) and optoelectronics sensors(L3)

UNIT– III	POSITION, DIRECTION, DISPLACEMENT AND LEVEL SENSORS	9

Potentiometric and capacitive sensors (L2), Inductive and magnetic sensor (L2), LVDT, RVDT (L2), eddy current (L2), transverse inductive (L2), Hall effect, magneto resistive (L2), magneto strictive sensors (L2). Fiber optic liquid level sensing (L2), Fabry Perot sensor, ultrasonic sensor (L2), capacitive liquid level sensor(L2)

UNIT – IV	VELOCITY AND ACCELERATION SENSORS	9

Electromagnetic velocity sensor (L3), Doppler with sound (L3), light, Accelerometer characteristics (L3), capacitive (L3), piezo-resistive (L3), piezoelectric accelerometer (L3), thermal accelerometer (L3), rotor, monolithic and optical gyroscopes(L3)

UNIT–V	FLOW, TEMPERATURE AND ACOUSTIC SENSORS	9

Flow sensors: pressure gradient technique (L2), thermal transport, ultrasonic (L2), electromagnetic and Laser anemometer (L2). microflow sensor, Coriolis mass flow and drag flow sensor (L2). Temperature sensors- thermosensitive (L2), thermoelectric, semiconductor and optical (L2). Piezoelectric temperature sensor (L2). Acoustic sensors- microphones (L2)-resistive, capacitive (L2), piezoelectric (L2), fiber optic (L2), solid-state - electric microphone (L2).

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination		
Course Out comes: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Explain the physical principles applied in sensing, measurement and characterisation of sensors	L2 – Understand
CO2	Apply concepts of various Optical sensing mechanisms for sensor design for measuring velocity and acceleration	L3 – Apply
CO3	Describe the basic laws and operation of transformation of energy in sensors	L2 – Understand
CO4	Design sensors for mechanical applications such as strain, force, torque and pressure	L3 – Apply
CO5	Differentiate the various sensors for the measurement of fluid flow, temperature and acoustics	L2 – Understand
REFERENCE BOOKS:		
1.	Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science,Delhi.	
2.	John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2ndedition,CRC Press, Florida.	
3.	Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers andscientists", 2013, 2nd edition, Wiley, New Jersey.	
4.	Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1stedition,John Wiley, New York.	
VIDEO REFERENCES:		
1.	https://onlinecourses.nptel.ac.in/noc21_ee32/preview	
2.	https://onlinecourses.swayam2.ac.in/arp20_ap41/preview	
WEB REFERENCES:		
1.	https://onlinecourses.nptel.ac.in/noc23_ee95/preview	
2.	https://archive.nptel.ac.in/courses/108/108/108108147/	
ONLINE COURSES:		
1.	https://onlinecourses.swayam2.ac.in/arp20_ap41/preview	
2.	https://alison.com/course/signal-conditioning-in-mechatronics	

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1		3	3	
CO2	2	1		2	3	
CO3	2	1		2	3	
CO4	1	3		1	2	
CO5	1	2		1	1	
Average	1.6	1.6		1.8	2.4	
1–Low, 2 –Medium, 3–High.						

ME23VL404	HARDWARE SOFTWARE CO-DESIGN FOR FPGA	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To acquire the knowledge about system specification and modelling
2	To learn the formulation of hardware and software partitioning
3	To apply various algorithms for hardware and software co synthesis
4	To study the different technical aspects about prototyping and emulation
5	To apply various verification concepts for hardware and software co synthesis

UNIT–I	SYSTEM SPECIFICATION AND MODELLING	9

Embedded Systems (L2), Hardware/Software Co-Design (L2), Co-Design for System Specification and Modeling, Co-Design for Heterogeneous Implementation(L2) - Processor Synthesis, Single-Processor Architectures with One ASIC (L2), Single-Processor Architectures with Many ASICs (L2), Multi-Processor Architectures (L2), Comparison of Co-Design Approaches (L2), Models of Computation (L2), Requirements for Embedded System Specification(L2)

UNIT–II	HARDWARE/SOFTWARE PARTITIONING	9

The Hardware/Software Partitioning Problem (L3), Hardware-Software Cost Estimation (L3), Generation of The Partitioning Graph (L3), Formulation of The HW/SW Partitioning Problem (L3), Optimization, HW/SW Partitioning Based On Heuristic Scheduling (L3), HW/SW Partitioning Based On Genetic Algorithms (L3).

UNIT– III	HARDWARE/SOFTWARE CO-SYNTHESIS	9

The Co-Synthesis Problem (L3), State-Transition Graph (L3), Refinement and Controller Generation (L3), Distributed System Co-Synthesis (L3)

UNIT – IV	PROTOTYPING AND EMULATION	9

Introduction, Prototyping and Emulation Techniques (L3), Prototyping and Emulation Environments (L3), Future Developments in Emulation and Prototyping (L3), Target Architecture, Architecture Specialization Techniques (L3), System Communication Infrastructure (L3), Target Architectures and Application System (L3) Classes, Architectures for Control-Dominated Systems (L3), Architectures for Data- Dominated Systems (L3), Mixed Systems and Less Specialized Systems(L3).

UNIT–V	DESIGN SPECIFICATION AND VERIFICATION	9

Concurrency, Coordinating Concurrent Computations(L3), Interfacing Components (L3), Verification (L3), Languages for System-Level Specification and Design System-Level Specification (L3), Design Representation for System Level Synthesis(L3), System Level Specification Languages(L3), Heterogeneous Specification and Multi-Language Co-Simulation

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Describe the system architectures and design methodologies of fundamental attributes	L2 – Understand
CO2	Solve Co-Design Problems using data flow models and to optimize system	L3 – Apply
CO3	Apply Co-Design Methodologies for translating between Software and Hardware.	L3 – Apply

CO4	Develop Co-Design Solutions to problems using modern Hardware/Software Tools for building prototypes	L3 – Apply
CO5	Design and analyse Software (C Code) and Hardware (HDL) Components	L3 – Apply

REFERENCE BOOKS:	
1.	Patrick Schaumont, "A Practical Introduction to Hardware/Software Co-design", Springer,2010
2.	Ralf Niemann, "Hardware/Software Co-Design for Data Flow Dominated Embedded Systems", Kluwer Academic Publisher, 1998.
3.	Jorgen Staunstrup, Wayne Wolf, "Hardware/Software Co-Design: Principles and Practice", Kluwer Academic Publisher,1997.
4.	Giovanni De Micheli, Rolf Ernst Morgon, "Reading in Hardware/Software Co-Design", Kaufmann Publisher,2001.
VIDEO REFERENCES:	
1.	https://youtu.be/f0ydpnir8Bg?si=N9S3_V7Gm5qKjQSe
2.	https://youtu.be/pEilWi6PMHY?si=q8vnWjfnIZLwgXqY
WEB REFERENCES:	
1.	Hardware-Software Codesign and Prototyping on SoC FPGAs (mathworks.com)
2.	https://cordis.europa.eu/project/id/286770
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc20_ee44/preview
2.	https://onlinecourses.nptel.ac.in/noc23_ee137/preview

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	0	3	3	
CO2	2	1	0	2	3	
CO3	2	1	0	2	3	
CO4	1	3	2	1	2	
CO5	1	2	2	1	1	
Average	1.6	1.6	0.8	1.8	2.4	

1–Low, 2 –Medium, 3–High.

ME23VL405	DSP STRUCTURES FOR VLSI	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To understand the fundamentals concepts of DSP
2	To learn various DSP structures and their implementation
3	To know designing constraints of various filters
4	To design and optimize VLSI architectures for basic DSP algorithms
5	To enable students to design VLSI system with high speed and low power

UNIT–I	INTRODUCTION TO DIGITAL SIGNAL PROCESSING	9

Linear system theory (L2)- convolution- correlation (L2) - DFT- FFT- basic concepts in FIR filters (L2) and IIR filters (L2)- filter realizations (L2). Representations of DSP algorithms-(L2) block diagram-SFG-DFG (L2)

UNIT–II	ITERATION BOUND, PIPELINING AND PARALLEL PROCESSING OF FIR FILTER	9

Data-flow graph representations (L3) - Loop bound and Iteration bound algorithms for computing iteration bound-LPM algorithm (L3). Pipelining and parallel processing: pipelining of FIR digital filters (L3)- parallel processing (L3), pipelining and parallel processing for low power (L3)

UNIT– III	RETIMING, UNFOLDING AND FOLDING	9

Retiming: definitions, properties and problems (L3)- solving systems of inequalities (L3). Properties of Unfolding, critical path, Unfolding and Retiming (L3), applications of Unfolding (L3), Folding transformation (L3)- register minimization techniques (L3), register minimization in folded architecture-folding of multirate system

UNIT – IV	FAST CONVOLUTION	9

Cook-toom algorithm (L3)- modified cook-Toom algorithm (L3). Design of fast convolution algorithm by inspection (L3) - Winograd algorithm (L3)- modified Winograd algorithm (L3)

UNIT–V	ARITHMETIC STRENGTH REDUCTION IN FILTERS	9

Parallel FIR filters-fast FIR algorithms-two parallel and three parallel (L3). Parallel architectures for rank order filters (L3) -odd-even, merge-sort architecture-rank order filter (L3) architecture-parallel rank order filters-running order merge order sorter (L3), low power rank order filter (L3)

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Expalin the fundamentals concepts of DSP	L2 – Understand
CO2	Implement various DSP structures such as filters and pipelines	L3 – Apply
CO3	Design advanced filters using retiming and folding techniques	L3 – Apply
CO4	Design and optimize VLSI architectures using basic DSP algorithms	L3 – Apply
CO5	Design high speed and low power VLSI systems	L3 – Apply

REFERENCE BOOKS:

1.	K.K Parhi: "VLSI Digital Signal Processing", John-Wiley, 2nd Edition Reprint, 2008.
2.	John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing", Prentice Hall of India, 1st Edition, 2009
VIDEO REFERENCES:	
1.	https://onlinecourses.nptel.ac.in/noc20_ee44/preview
2.	https://youtu.be/2fVt_555TmI?si=30Y6UEG_lUQv0FSg
WEB REFERENCES:	
1.	https://www.oreilly.com/library/view/vlsi-digital-signal/9780471241867/sec-1.1.html
2.	https://mtlsites.mit.edu/researchgroups/icsystems/pubs/conferences/1996/chandrakasan_vlsid_paper.pdf
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc20_ee44/preview
2.	https://onlinecourses.nptel.ac.in/noc23_ee137/preview

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	1		
CO2	1		1	1		
CO3	1		1	1		
CO4	1		1	1		
CO5	1		1	1		
Average	1		1	1		

1–Low, 2 –Medium, 3–High.

ME23VL406	BIO-SIGNAL PROCESSING	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To introduce the characteristics of different bio-signals
2	To discuss linear and non-linear filtering techniques to extract desired information
3	To demonstrate the significance of wavelet detection applied in bio-signal processing.
4	To extract the features from the bio-signal
5	To introduce techniques for automated classification and decision making to aid diagnosis

UNIT–I	SIGNAL, SYSTEM AND SPECTRUM	9

Characteristics of some dynamic biomedical signals (L2), Noises- random, structured and physiological noises (L3). Filters- IIR and FIR filters (L3). Spectrum – power spectral density function (L3), cross-spectral density and coherence function (L3), cepstrum and homomorphic filtering (L3). Estimation of mean of finite time signals (L3)

UNIT–II	TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION	9

Time series analysis (L2) – linear prediction models (L3), process order estimation (L3), non-stationary process, fixed segmentation, adaptive segmentation (L3), application in EEG (L3), PCG and HRV signals (L3), model based ECG simulator. Spectral estimation – Blackman Tukey method (L3), periodogram and model based estimation (L3). Application in Heart rate variability, PCG signals. (L3)

UNIT– III	ADAPTIVE FILTERING AND WAVELET DETECTION	9

Filtering – LMS adaptive filter (L3), adaptive noise cancelling in ECG (L3), improved adaptive filtering in FECG (L2), EEG and other applications in Bio signals (L3), Wavelet detection in ECG – structural features (L2), matched filtering (L3), adaptive wavelet detection (L3), detection of overlapping wavelets (L3).

UNIT – IV	ANALYSIS OF BIOSIGNAL	9

Removal of artifact – ECG (L3), Event detection –ECG(L3), P Wave, QRS complex (L3), T wave (L3), Correlation analysis of ECG signals (L3), Average of Signals-PCG (L3), ECG and EMG (L3)

UNIT–V	BIOSIGNAL CLASSIFICATION AND RECOGNITION	9

Statistical signal classification (L2), linear discriminate function (L2), direct feature selection and ordering, Back propagation neural network based classification (L2). Case study: 1. various methods used to extract features from EEG signal (L2), Case Study 2: Diagnosis and monitoring of sleep apnea (L2)

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Analyse the different types of signals & systems	L3 – Apply
CO2	Analyse signals in time series domain & estimate the spectrum	L3 – Apply
CO3	Understand the significance of wavelet detection applied in bio signal processing	L3 – Apply
CO4	Extract the features from biosignal	L3 – Apply

CO5	Describe the performance of the classification of biosignals	L2 – Understand

REFERENCE BOOKS:	
1.	P.Ramesh Babu, "Digital Signal Processing, Sixth Edition, Scitech publications, Chennai, 2014
2.	Raghuveer M. Rao and AjithS.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000
3.	Rangaraj M. Rangayyan, 2nd edition "Biomedical Signal Analysis-A case study approach", Wiley-Interscience /IEEE Press, 2015
4.	Emmanuel C. Ifeachor, Barrie W.Jervis, second edition, "Digital Signal processing- A Practical Approach" Pearson education Ltd., 2002
5.	Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006
VIDEO REFERENCES:	
1.	https://nptel.ac.in/courses/108105101
2.	https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/pages/lecture-notes/
WEB REFERENCES:	
1.	https://www.nitsri.ac.in/Department/Electronics%20&%20Communication%20Engineering/Course_Contents_for_Biomedical_and_Image_Processing.pdf
2.	https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/pages/lecture-notes/
ONLINE COURSES:	
1.	https://nptel.ac.in/courses/108105101
2.	https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/c8dc8096a9d75f8f30b4b97354b48437_ch1_adc.pdf

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1	3	3	1
CO2	1		1	2	3	1
CO3	1		1	2	3	1
CO4	1		1	3	2	1
CO5	1		1	2	1	1
Average	1		1	2.4	2.4	1
1–Low, 2 –Medium, 3–High.						

ME23VL407	RECONFIGURABLE ARCHITECTURES	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	The student shall develop an overview and deeper insight into the research and development that is underway to meet future needs of flexible processors
2	To learn the concepts of implementation, synthesis and placement of modules in reconfigurable architectures
3	To understand the communication techniques and System on Programmable Chip for reconfigurable architectures
4	To learn the process of reconfiguration management
5	To familiarize the applications of reconfigurable architectures

UNIT–I	INTRODUCTION	9

General purpose computing (L3) – domain specific processors – Application Specific Processors (L3)– reconfigurable computing – fields of application (L3) – evolution of reconfigurable systems (L3) – simple Programmable Logic Devices(L3) – Complex Programmable Logic Devices (L3) – Field Programmable Gate Arrays – coarse grained reconfigurable devices (L3)

UNIT–II	IMPLEMENTATION, SYNTHESIS AND PLACEMENT	9

Integration – FPGA design flow (L2) – logic synthesis (L2) – LUT based technology mapping (L3) – modeling – temporal partitioning algorithms (L3) – offline and online temporal placement (L3) – managing device's free and occupied spaces(L2).

UNIT– III	COMMUNICATION AND SOPC	9

Direct communication (L3) – communication over third party (L3) – bus based communication – circuit switching (L3) – Network on Chip – dynamic Network on Chip (L3) – System on a Programmable Chip (L3) – adaptive multi - processing on chip (L3).

UNIT – IV	RECONFIGURATION MANAGEMENT	9

Reconfiguration (L2) – configuration architectures (L3) – managing the reconfiguration process (L3) – reducing configuration transfer time (L3) – configuration securit(L3)y.

UNIT–V	APPLICATIONS	9

FPGA based parallel pattern matching (L2)- low power FPGA based architecture for microphone arrays in Wireless Sensor Networks L2)- - exploiting partial reconfiguration on a dynamic coarse grained reconfigurable architecture L2)- – parallel pipelined OFDM baseband modulator with dynamic frequency scaling for 5G systems L2)-.

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Analyze the different architecture principles relevant to reconfigurable computing systems	L3 – Apply
CO2	Compare the tradeoffs that are necessary to meet the area, power and timing criteria of reconfigurable systems	L3 – Apply
CO3	Analyze the algorithms related to placement and partitioning	L3 – Apply
CO4	Analyze the communication techniques and system on programmable chip	L3 – Apply

	for reconfigurable architectures	
CO5	Analyze the principles of Network and System on a Programmable Chip	L2 – Understand

REFERENCE BOOKS:	
1.	Christophe Bobda, "Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications", Springer 2007.
2.	Scott Hauck and Andre Dehon, "Reconfigurable Computing: The Theory and Practice of FPGA Based Computation", Elsevier 2008
3.	M. Gokhale and P. Graham, "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays", Springer, 2005.
4.	Nikoloas Voros Et Al. "Applied Reconfigurable Computing: Architectures, Tools and Applications" Springer, 2018.
5.	Koen Bertels, João M.P. Cardoso, Stamatis Vassiliadis, "Reconfigurable Computing: Architectures and Applications", Springer 2006.
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=5_H_j72Ftq8
2.	https://www.youtube.com/watch?v=o5hhEJrHH4c
WEB REFERENCES:	
1.	https://www.sciencedirect.com/topics/computer-science/reconfigurable-architecture
2.	https://link.springer.com/referenceworkentry/10.1007/978-94-017-7358-4_12-1
ONLINE COURSES:	
1.	https://www.coursera.org/learn/copy-of-fpga-intro
2.	https://nptel.ac.in/courses/117108040

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		2	1		
CO2	2		2	2		
CO3	1		2	1		
CO4	1		2	1		
CO5	1		2	1		
Average	1.2		2	1.2		

1–Low, 2 –Medium, 3–High.

ME23VL408	ADVANCED WIRELESS SENSOR NETWORKS	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To enable the student to understand the role of sensors and the networking of sensed data for different applications.
2	To expose the students to the sensor node essentials and the architectural details, the medium access and routing issues and the energy constrained operational scenario
3	To enable the student to understand the challenges in synchronization and localization of sensor nodes, topology management for effective and sustained communication, data management and security aspects
4	To understand the sensor tasking and control
5	To familiarize the data management security systems

UNIT–I	OVERVIEW OF WIRELESS SENSOR NETWORKS	9

Challenges for wireless sensor networks (L2) - -characteristics requirements (L2) -required mechanisms, difference between mobile ad-hoc and sensor networks (L3), applications of sensor networks (L3) - case study, enabling technologies for wireless sensor networks (L3).

UNIT–II	ARCHITECTURES	9

Single-node architecture (L3) - hardware components, energy consumption of sensor nodes (L3), operating systems and execution environments (L3), network architecture - sensor network scenarios, optimization goals and figures of merit (L3), gateway concepts. Physical layer and transceiver design consideration

UNIT– III	MAC AND ROUTING	9

MAC protocols for wireless sensor networks (L3), IEEE 802.15.4 (L3), Zigbee, low duty cycle protocols and wakeup concepts - s-MAC (L3) , the mediation device protocol, wakeup radio concepts (L3), address and name anagement, assignment of MAC addresses (L3), routing protocols- energy- efficient routing, geographic routing.

UNIT – IV	NFRASTRUCTURE ESTABLISHMENT	9

Topology control (L3), clustering, time synchronization (L3), localization and positioning (L3), sensor tasking and control (L3)

UNIT–V	DATA MANAGEMENT AND SECURITY	9

Data management in WSN (L2), storage and indexing in sensor networks, query processing in sensor (L2), data aggregation, directed diffusion (L2), tiny aggregation, greedy aggregation(L2), security in WSN, security protocols for sensor networks(L2),, secure charging and rewarding scheme (L2), secure event and event boundary detection(L2)

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Design and implement simple wireless network concepts	L3 – Apply
CO2	Design, analyze and implement different network architectures	L3 – Apply
CO3	Implement MAC layer and routing protocols	L3 – Apply

CO4	Deal with timing and control issues in wireless sensor networks	L3 – Apply
CO5	Analyze and design secured wireless sensor networks	L2 – Understand

REFERENCE BOOKS:	
1.	Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" , John Wiley, 2005.
2.	Erdal Çayirci , Chunming Rong, "Security in Wireless Ad Hoc and Sensor Networks", John Wiley and Sons, 2009
3.	Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks-S Technology, Protocols, and Applications", John Wiley, 2007.
4.	Yingshu Li, My T. Thai,Weili Wu, "Wireless Sensor Networks and Applications", Springer, 2008.
VIDEO REFERENCES:	
1.	https://archive.nptel.ac.in/courses/106/105/106105160/
2.	https://www.youtube.com/@wirelessadhocandsensornetw3342
WEB REFERENCES:	
1.	https://ocw.mit.edu/courses/mas-836-sensor-technologies-for-interactive-environments-spring-2011/
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3231431/
ONLINE COURSES:	
1.	https://ocw.mit.edu/courses/mas-836-sensor-technologies-for-interactive-environments-spring-2011/
2.	https://archive.nptel.ac.in/courses/106/105/106105160/

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0		3	1	3	
CO2	0		2	1	3	
CO3	3		1	1	3	
CO4	3		2	1	0	
CO5	3		2	1	3	
Average	3		2	1	3	

1–Low, 2 –Medium, 3–High.

ME23VL409	EDGE AND FOG COMPUTING	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To give understanding on the basic concepts of fog and edge computing
2	To give insight on key architectures and protocols in fog and edge computing
3	To design and integrate fog and edge computing services with IoT
4	To implement fog and edge computing using standard open-source software tools
5	To appreciate the applications of fog and edge computing in various fields

UNIT–I	INTRODUCTION TO EDGE AND FOG COMPUTING	9

Edge Computing-Concept (L2), Basic characteristics and attributes, Edge –Real-time (L2), Benefits of Edge Computing (L2), Cross Value of Edge Computing (L2), Collaboration of Edge Computing and Cloud Computing Introduction to Fog Computing (L2), Cloud and Fog Computing (L2), Need for Fog Computing, Characteristics of FOG Computing, History of FOG Computing, Application of FOG Computing (L2)

UNIT–II	EDGE AND FOG COMPUTING ARCHITECTURE	9

Overview of edge and fog computing architecture and components (L2), Edge devices (L2), gateways, fog nodes (L2), cloud data centers (L2), Hierarchical and mesh-based networking models (L2), Communication protocols in edge and fog computing (L2)

UNIT– III	INTERNET OF THINGS (IOT) INTEGRATION	9

Understanding IoT devices and their role in edge and fog computing (L3), Challenges and solutions in integrating diverse IoT devices (L3), Data aggregation (L3), filtering (L3), and preprocessing at the network edge (L3)

UNIT – IV	EDGE COMPUTING PLATFORMS AND TOOLS	9

Overview of popular edge computing platforms and frameworks (L3), Hands-on exercises with edge computing tools for real-time data analytics(L3) ,Python advance libraries (L3) (Pandas, Scikit Learn), Tensor flow and Yolo (L3)

UNIT–V	EDGE AND FOG COMPUTING USE CASES	9

Applications of edge and fog computing in various industries (L2) (e.g., healthcare, transportation, smart cities), Real-time data processing and decision-making at the edge (L2), Integration with cloud-based services for comprehensive solutions (L2)

45 PERIODS

	OPEN ENDED PROBLEMS / QUESTIONS	

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Explain thebasic concepts of fog and edge computing	L2 – Understand
CO2	Describe various architectures and protocols in fog and edge computing	L2 – Understand
CO3	Design and fog and edge computing services with IoT	L3 – Apply
CO4	Develop fog and edge computing applications using standard open-source software tools	L3 – Apply

CO5	Summarise the applications of fog and edge computing in various fields	L2 – Understand
REFERENCE BOOKS:		
1.	Assad Abbas, "Fog computing: Theory and Practice", John wiley, 2015	
2.	Rajkumar Buyya, Sathish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", John wiley,2019	
3.	Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" , John Wiley, 2005.	
VIDEO REFERENCES:		
1.	https://onlinecourses.nptel.ac.in/noc23_cs65/preview	
2.	https://www.youtube.com/watch?v=x13NRw4uMuI	
WEB REFERENCES:		
1.	https://xailient.com/blog/edge-computing-vs-fog-computing-a-comprehensive-guide/	
2.	https://www.knowledgenile.com/blogs/edge-cloud-fog-computing-what-is-the-difference-between-them	
ONLINE COURSES:		
1.	https://www.my-mooc.com/en/mooc/fog/	
2.	https://www.open.edu/openlearn/mod/oucontent/view.php?id=48820&section=1.11	

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0		3	1	3	
CO2	0		2	1	3	
CO3	3		1	1	3	
CO4	3		2	1	0	
CO5	3		2	1	3	
Average	3		2	1	3	

1–Low, 2 –Medium, 3–High.

ME23VL410	SYSTEM ON CHIP	Version: 1.0				
Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To introduce architecture and design concepts underlying system on chips
2	To introduce concepts of instruction set and handling of pipeline delays.
3	To impart knowledge SOC memory organization
4	To apply FPGA optimization techniques for customisation of SOCs
5	To design and interface SOC embedded processor with memory and peripherals

UNIT–I	SYSTEM ARCHITECTURE: OVERVIEW	9

Components of the system (L2) – Processor architectures (L2) – Memory and addressing (L2) – system level interconnection – SoC design requirements and specifications (L2) – design integration (L2) – design complexity – cycle time (L2), die area and cost (L2), ideal and practical scaling (L2), area-time-power tradeoff in processor design (L2), Configurability.

UNIT–II	PROCESSOR SELECTION FOR SOC	9

Overview – soft processors (L2), processor core selection (L2). Basic concepts – instruction set (L2), branches, interrupts and exceptions (L2). Basic elements in instruction handling (L2) – Minimizing pipeline delays (L2) – reducing the cost of branches (L2) – Robust processors (L2)– Vector processors, VLIW processors (L2), Superscalar processors (L2)

UNIT– III	MEMORY DESIGN	9

SoC external memory (L3), SoC internal memory (L3), Scratch pads and cache memory (L3) – cache organization and write policies (L2)– strategies for line replacement at miss time (L2) – split I- and Dcaches – multilevel caches (L3) – SoC memory systems (L3) – board based memory systems (L3) – simple processor/memory interaction (L3).

UNIT – IV	INTERCONNECT ARCHITECTURES AND SOC CUSTOMISATION	9

Bus architectures (L3) – SoC standard buses (L3) – AMBA, CoreConnect – Processor customization (L3) approaches – Reconfigurable technologies (L2) – mapping designs onto reconfigurable devices (L3) - FPGA based design – Architecture of FPGA (L2), FPGA interconnect technology (L2), FPGA memory (L2), Floor plan and routing (L2)

UNIT–V	FPGA BASED EMBEDDED PROCESSOR	9

Hardware software task partitioning – FPGA fabric Immersed Processors (L2) – Soft Processors and Hard Processors (L2) – Tool flow for Hardware/Software Co-design –Interfacing Processor with memory and peripherals (L2) – Types of On-chip interfaces – Wishbone interface (L2), Avalon Switch Matrix (L3), OPB Bus Interface, Creating a Customized Microcontroller (L3) - FPGA-based Signal Interfacing and Conditioning (L3)

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Explain architecture and concepts underlying system on chips	L2 – Understand
CO2	Describe the instruction set and handling of pipeline delays in SOCs	L2 – Understand

CO3	Analyse various memory organization techniques in SOC	L3 – Apply
CO4	Apply FPGA optimization techniques for customisation of SOCs	L3 – Apply
CO5	Design and interface SOC embedded processor with various peripherals	L3 – Apply

REFERENCE BOOKS:

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, 2008

VIDEO REFERENCES:

1.	https://nptel.ac.in/courses/108102045
2.	https://www.cl.cam.ac.uk/teaching/1617/SysOnChip/materials.html

WEB REFERENCES:

1.	https://users.ece.utexas.edu/~gerstl/ee382m_f18/syllabus.html
2.	https://cse.usf.edu/~haozheng/teach/soc/

ONLINE COURSES:

1.	https://www.arm.com/resources/education/online-courses/introduction-to-soc
2.	https://users.ece.utexas.edu/~gerstl/ee382m_f18/syllabus.html

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		3	1	3	
CO2	1		2	1	3	
CO3	3		1	1	3	
CO4	3		2	1	0	
CO5	3		2	1	3	
Average	2.2		2	1	3	

1–Low, 2 –Medium, 3–High.

ME23CP501 / ME23CP310	SECURITY PRACTICES	Version: 1.0

EXCEPT FOR M.E. - COMPUTER SCIENCE AND ENGINEERING

Programme & Branch	M.E. - COMPUTER SCIENCE AND ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1.	To learn the core fundamentals of system and web security concepts
2.	To have through understanding in the security concepts related to networks
3.	To deploy the security essentials in IT Sector
4.	To be exposed to the concepts of Cyber Security and cloud security
5.	To perform a detailed study of Privacy and Storage security and related Issues

UNIT -I	SYSTEM SECURITY	9

Model of network security (L1)– Security attacks, services and mechanisms(L1) – OSI security architecture A Cryptography primer- Intrusion detection system(L1)- Intrusion Prevention system (L1)- Security web applications- Case study: OWASP(L3) - Top 10 Web Application Security Risks(L2)

UNIT -II	NETWORK SECURITY	9

Internet Security - Intranet security(L2)- Local Area Network Security - Wireless Network Security(L2) - Wireless Sensor Network Security(L1)- Cellular Network Security - Mobile security(L2) - IOT security - Case Study - Kali Linux(L3).

UNIT –III	SECURITY MANAGEMENT	9

Information security essentials for IT Managers- Security Management System (L2)- Policy Driven System Management- IT Security(L3) - Online Identity and User Management System. Case study: Metasploit(L3)

UNIT –IV	CYBER SECURITY AND CLOUD SECURITY	9

Cyber Forensics- Disk Forensics – Network Forensics (L2)– Wireless Forensics – Database Forensics(L2) – Malware Forensics – Mobile Forensics (L2)– Email Forensics(L3)- Best security practices for automate Cloud infrastructure management (L2)– Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA(L2)

UNIT –V	PRIVACY AND STORAGE SECURITY	9

Privacy on the Internet(L2) - Privacy Enhancing Technologies (L3)- Personal privacy Policies - Detection of Conflicts in security policies(L2)- privacy and security in environment monitoring systems(L2). Storage Area Network Security(L3) - Storage Area Network Security Devices (L2)- Risk management - Physical Security Essentials(L3)

Total:- 45 PERIODS

OPEN ENDED PROBLEMS /QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Outcomes: Upon completion of this course the students will be able to:		BLOOMS Taxonomy
CO1	Understand the core fundamentals of system security	L3 – Apply
CO2	Apply the security concepts to wired and wireless networks	L3 – Apply
CO3	Implement and Manage the security essentials in IT Sector	L2 – Understand
CO4	Explain the concepts of Cyber Security and Cyber forensics	L3 – Apply
CO5	Be aware of Privacy and Storage security Issues	L3 – Apply

REFERENCEBOOKS:	
1.	John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2.	Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3.	Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4.	Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing,Exploit Development and Vulnerability Research,Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5.	John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6.	Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	1	2	1
CO2	2	1	3	1	1	2
CO3	-		2	3	3	3
CO4	2	2	1	2	1	3
CO5	1	-	1	1	2	3
Average	1.5	1.67	1.6	8	1.4	2.4
1–Low, 2 –Medium, 3–High.						

ME23CP502 / ME23CP401	CLOUD COMPUTING TECHNOLOGIES	Version: 1.0

EXCEPT FOR M.E. - COMPUTER SCIENCE AND ENGINEERING

Programme & Branch	M.E- COMPUTER SCIENCE AND ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1.	To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
2.	To understand the architecture, infrastructure and delivery models of cloud computing
3.	To explore the roster of AWS services and illustrate the way to make applications in AWS
4.	To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
5.	To develop the cloud application using various programming model of Hadoop and Aneka

UNIT -I	VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE	9

Basics of Virtual Machines(L1) - Process Virtual Machines (L1)– System Virtual Machines (L1)– Emulation (L1)– Interpretation(L1) – Binary Translation - Taxonomy of Virtual Machines. Virtualization (L1)– Management Virtualization – Hardware Maximization – Architectures (L1)– Virtualization Management – Storage Virtualization (L1)– Network Virtualization- Implementation levels of virtualization(L1) – virtualization structure(L1) – virtualization of CPU, Memory and I/O devices (L1)– virtual clusters and Resource Management (L1)– Virtualization for data center automation(L1).

UNIT -II	CLOUD PLATFORM ARCHITECTURE	9

Cloud Computing: Definition, Characteristics (L1)- Cloud deployment models: public, private, hybrid, community(L1) – Categories of cloud computing(L1): Everything as a service: Infrastructure(L1), platform, software- A Generic Cloud Architecture Design(L1) – Layered cloud Architectural Development(L1) – Architectural Design Challenges(L1).

UNIT –III	AWS CLOUD PLATFORM - IAAS	9

Amazon Web Services: AWS Infrastructure(L1)- AWS API- AWS Management Console - Setting up AWS Storage (L1)- Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes(L1)- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy(L1), AWS Code Pipeline(L1), AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling(L1), AWS control Tower, Cloud Formation(L1), Cloud Trail, AWS License Manager(L1).

UNIT –IV	PAAS CLOUD PLATFORM	9

Windows Azure: Origin of Windows Azure(L1), Features, The Fabric Controller – First Cloud APP in Windows Azure(L1)- Service Model and Managing Services: Definition and Configuration(L1), Service runtime API(L1)- Windows Azure Developer Portal(L1)- Service Management API(L1)- Windows Azure Storage Characteristics-Storage Services(L1)- REST API(L1)- Blops(L1).

UNIT –V	PROGRAMMING MODEL	9

Introduction to Hadoop Framework - Map reduce, Input splitting, map and reduce functions, specifying input and output parameters(L1), configuring and running a job(L1) –Developing Map Reduce Applications(L1)- Design of Hadoop file system(L1) –Setting up Hadoop Cluster(L1)- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map(L1)-Reduce Programming in Aneka(L1).

Total:- 45 PERIODS

OPEN ENDED PROBLEMS /QUESTIONS		
Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination		
Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOMS Taxonomy**
CO1	Employ the concepts of virtualization in the cloud computing	L3 – Apply
CO2	Identify the architecture, infrastructure and delivery models of cloud computing	L3 – Apply
CO3	Develop the Cloud Application in AWS platform	L2 – Understand
CO4	Apply the concepts of Windows Azure to design Cloud Application	L3 – Apply
CO5	Develop services using various Cloud computing programming models	L3 – Apply
REFERENCEBOOKS:		
1.	Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.	
2.	Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.	
3.	Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.	
4.	Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013	
5.	Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guide‖, McGraw-Hill Osborne Media, 2009.	
6.	Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005	

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	2	2	1
CO2	2	3	1	-	-	1
CO3	3	-	3	-	1	3
CO4	-	-	-	2	-	3
CO5	3	2	-	-	-	-
Average	2.67	2.5	2	2	1.5	2
1–Low, 2 –Medium, 3–High.						

ME23CP503 / ME23CP415	BLOCKCHAIN TECHNOLOGIES	Version: 1.0

EXCEPT FOR M.E. - COMPUTER SCIENCE AND ENGINEERING

Programme & Branch	M.E- COMPUTER SCIENCE AND ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1.	This course is intended to study the basics of Blockchain technology.
2.	During this course the learner will explore various aspects of Blockchain technology like application in various domains
3.	By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT -I	INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN	9

Introduction to Blockchain(L1), Blockchain Technology Mechanisms & Networks (L1), Blockchain Origins, Objective of Blockchain, Blockchain Challenges(L1), Transactions and Blocks, P2P Systems(L1), Keys as Identity, Digital Signatures(L1), Hashing, and public key cryptosystems(L1), private vs. public Blockchain(L1).

UNIT -II	BITCOIN AND CRYPTOCURRENCY	9

Introduction to Bitcoin(L1), The Bitcoin Network, The Bitcoin Mining Process(L1), Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks(L1), Ethereum Virtual Machine (EVM), Merkle Tree(L2), Double-Spend Problem(L1), Blockchain and Digital Currency, Transactional Blocks(L1), Impact of Block chain Technology on Cryptocurrency(L1)

UNIT –III	INTRODUCTION TO ETHEREUM	9

Introduction to Ethereum(L1), Consensus Mechanisms(L1), Metamask Setup(L1), Ethereum Accounts(L1) , Transactions, Receiving Ethers, Smart Contracts(L1).

UNIT –IV	INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING	9

Introduction to Hyperledger(L1), Distributed Ledger Technology & its Challenges(L1), Hyperledger & Distributed Ledger Technology(L2), Hyperledger Fabric(L2), Hyperledger Composer(L2). Solidity (L2)- Language of Smart Contracts(L1), Installing Solidity & Ethereum Wallet(L1), Basics of Solidity(L1), Layout of a Solidity Source File & Structure of Smart Contracts(L2), General Value Types(L2).

UNIT –V	BLOCKCHAIN APPLICATIONS	9

Internet of Things(L2), Medical Record Management System(L3), Domain Name Service and Future of Blockchain(L3), Alt Coins(L2)

Total:- 45 PERIODS

OPEN ENDED PROBLEMS /QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Outcomes: Upon completion of this course the students will be able to:		BLOOMS Taxonomy
CO1	Understand and explore the working of Block chain technology	L3 – Apply
CO2	Analyze the working of Smart Contracts	L3 – Apply
CO3	Understand and analyze the working of Hyper ledger	L2 – Understand

CO4	Apply the learning of solidity to build de-centralized apps on Ethereum	L3 – Apply
CO5	Develop applications on Block chain	L3 – Apply
REFERENCEBOOKS:		
1.	Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018	
2.	Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016	
3.	Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .	
4.	Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.	
5.	D. Drescher, Blockchain Basics. Apress, 2017.	

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	2	2	3
CO2	2	1	2	3	2	2
CO3	2	1	3	1	2	1
CO4	2	1	2	3	2	2
CO5		1		2		
Average	2	1	2.5	2.2	2	2
1–Low, 2 –Medium, 3–High.						

ME23CP504 / ME23CP414	DEEP LEARNING	Version: 1.0

EXCEPT FOR M.E. - COMPUTER SCIENCE AND ENGINEERING

Programme & Branch	M.E. – COMPUTER SCIENCE AND ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	Develop and Train Deep Neural Networks
2	Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
3	Build and train RNNs, work with NLP and Word Embeddings
4	The internal structure of LSTM and GRU and the differences between them
5	The Auto Encoders for Image Processing

UNIT–I	DEEP LEARNING CONCEPTS	6

Fundamentals about Deep Learning (L2) Perception Learning Algorithms (L2) Probabilistic modelling (L2) Early Neural Networks (L2) How Deep Learning different from Machine Learning (L2) Scalars (L2) Vectors (L2) Matrixes(L2) Higher Dimensional Tensor (L2). Manipulating Tensors (L2) Vector Data (L2) Time Series Data (L2) Image Data (L2) Video Data (L2)

UNIT–II	NEURAL NETWORKS	9

About Neural Networ (l2) Building Blocks of Neural Network (L2) Optimizers (L2) Activation Functions (L3) Loss Functions (L3) Data Pre-processing for neural networks()L3 Feature Engineering (L2) Overfitting and Underfitting(L2) Hyperparameters(L2)

UNIT– III	CONVOLUTIONAL NEURAL NETWORK	10

About CNN (L2) Linear Time Invariant (L2) Image Processing Filtering (L2) Building a convolutional neural network (L2) Input Layers (L2) Convolution Layers (L2) Pooling Layers (L2) Dense Layers(L2) Backpropagation Through the Convolutional Layer(L2) Filters and Feature Map (L2). Backpropagation Through the Pooling Layers(L3) Dropout Layers and Regularization(L3) Batch Normalization (L3) Various Activation Functions (L2) Various Optimizers(L2) LeNet (L2), AlexNet(L2), VGG16 (L2), ResNet (L2) Transfer Learning with Image Data(L3) Transfer Learning using Inception Oxford VGG Model(L3), Google Inception Model(L3), Microsoft ResNet Model(L2). R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO(L2)

UNIT – IV	NATURAL LANGUAGE PROCESSING USING RNN	10

About NLP & its Toolkits(L2) Language Modeling(L2) Vector Space Model (VSM)(L2) Continuous Bag of Words (CBOW) (L2) Skip-Gram Model for Word Embedding(L3) Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors (L3). Transfer Learning (L2) Word2Vec(L2) Global Vectors for Word Representation GloVe (L3) Backpropagation Through Time (L2) Bidirectional RNNs (BRNN)(L2) . Long Short Term Memory (LSTM)(L2) Bi-directional LSTM(L2) Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU(L2)

UNIT–V	DEEP REINFORCEMENT & UNSUPERVISED LEARNING	10

About Deep Reinforcement Learning(L2) Q-Learning(L2) Deep Q-Network (DQN)(L2). Policy Gradient Methods(L2). Actor-Critic Algorithm(L3) About Autoencoding(L2) Convolutional Auto Encoding(L2) Variational Auto Encoding(L3) Generative Adversarial Networks (L2) Autoencoders for Feature Extraction(L2) Auto Encoders for Classification (L3). Denoising Autoencoders(L2) Sparse Autoencoders(L2)

TOTAL : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS		
Course specific Open Ended Problems will be solved during the classroom teaching. Such problems can be given as Assignments and evaluated as Internal Assessment (IA) only and not for the End semester Examinations.		
Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Feature Extraction from Image and Video Data	L2 - Understand
CO2	Implement Image Segmentation and Instance Segmentation in Images	L3 - Apply
CO3	Implement image recognition and image classification using a pretrained network (Transfer Learning)	L3 - Apply
CO4	Traffic Information analysis using Twitter Data.	L3 - Apply
CO5	Autoencoder for Classification & Feature Extraction.	L3 - Apply
REFERENCE BOOKS:		
1.	Josh Patterson and Adam Gibson," Deep Learning A Practitioner's Approach", O'Reilly Media, Inc.2017	
2.	Jojo Moolayil," Learn Keras for Deep Neural Networks", Apress,2018	
3.	Vinita Silaparasetty," Deep Learning Projects Using TensorFlow 2", Apress, 2020	
4.	François Chollet," Deep Learning with Python", Manning Shelter Island,2017	
5.	Santanu Pattanayak," Pro Deep Learning with TensorFlow", Apress,2017	
VIDEO REFERENCES:		
1.	https://onlinecourses.nptel.ac.in/noc20_cs62/preview	
2.	https://onlinecourses.nptel.ac.in/noc20_cs50/preview	
WEB REFERENCES:		
1.	https://www.kaggle.com/learn/intro-to-deep-learning	
2.	https://www.datacamp.com/tutorial/tutorial-deep-learning-tutorial	
ONLINE COURSES:		
1.	https://www.udemy.com/course/deeplearning	
2.	https://in.mathworks.com/solutions/deep-learning	

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2		3	3	3
CO2	2	2	2	3	3	2
CO3	2	2	2	3	2	3
CO4	2	2	1	3	3	3
CO5	2	2		3	2	2
Average	2	2	1.67	3	2.6	2.6
1–Low, 2 –Medium, 3–High.						

ME23CP505	DESIGN THINKING	Version: 1.0
EXCEPT FOR M.E. - COMPUTER SCIENCE AND ENGINEERING		

Programme & Branch	M.E. – COMPUTER SCIENCE AND ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To provide a sound knowledge in UI & UX
2	To understand the need for UI and UX
3	Research Methods used in Design
4	Tools used in UI & UX
5	Creating a wireframe and prototype

UNIT–I	UX LIFECYCLE TEMPLATE	8

Introduction (L1) A UX process lifecycle template (L2) Choosing a process instance for your project (L2). The system complexity space (L2) Meet the user interface team (L2) Scope of UX presence within the team (L2) More about UX lifecycles(L2) Business Strategy (L2) Value Innovation (L2) Validated User Research (L2) Killer UX Design (L2) The Blockbuster Value Proposition(L2) What Is a Value Proposition? (L2)

UNIT–II	CONTEXTUAL INQUIRY	10

The system concept statement (L2) User work activity data gathering (L3) Look for emotional aspects of work practice (L3) Abridged contextual inquiry process (L3) Data-driven vs. model-driven inquiry(L2) Organizing concepts: work roles and flow model(L2) Creating and managing work activity notes (L3) Constructing your work activity affinity diagram (WAAD) (L3). Abridged contextual analysis process (L3) History of affinity diagrams(L2)

UNIT– III	DESIGN THINKING, IDEATION, AND SKETCHING	9

Design-informing models: second span of the bridge(L2) Some general "how to" suggestions(L2) A New example domain: slideshow presentations (L3) User models (L2) Usage models(L2) Work environment models(L2) Barrier summaries(L2) Model consolidation(L3) Protecting your sources(L2) Abridged methods for design-informing models extraction(L3) Design paradigms(L2) Design thinking(L2) Design perspectives(L2) User personas(L3) Ideation(L3) Sketching(L3)

UNIT – IV	UX GOALS, METRICS, AND TARGETS	8

Introduction (L1) UX goals (L2) UX target tables(L2) Work roles (L2) user classes(L2) and UX goals(L2) UX measures (L2) Measuring instruments. UX metric(L3) Baseline level(L3) Target level(L3) Setting levels(L3) Observed results(L2) Practical tips and cautions for creating UX targets(L3) How UX targets help manage the user experience engineering process(L2).

UNIT–V	ANALYSING USER EXPERIENCE	10

Sharpening Your Thinking Tools (L2) UX Research and Strength of Evidence (L2) Agile Personas(L2) How to Prioritize Usability Problems(L2). Creating Insights(L2), Hypotheses and Testable Design Ideas(L2). How to Manage Design Projects with User Experience Metrics(L2) Two Measures that Will Justify Any Design Change(L2). Evangelizing UX Research(L2). How to Create a User Journey Map(L3). Generating Solutions to Usability Problems(L3). Building UX Research into the Design Studio Methodology(L3). Dealing with Common objections to UX Research(L3). The User Experience Debrief Meeting(L3). Creating a User Experience Dashboard(L3).

TOTAL : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS		
Course specific Open Ended Problems will be solved during the classroom teaching. Such problems can be given as Assignments and evaluated as Internal Assessment (IA) only and not for the End semester Examinations.		
Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Build UI for user Applications.	L2 - Understand
CO2	Use the UI Interaction behaviors and principles	L3 - Apply
CO3	Evaluate UX design of any product or application.	L3 - Apply
CO4	Demonstrate UX Skills in product development.	L3 - Apply
CO5	Implement Sketching principles.	L3 - Apply
REFERENCE BOOKS:		
1.	Westley Knight," UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-toDay Development Work", Apress, 2018	
2.	Rex Hartson, Pardha Pyla. Morgan Kaufmann," The UX Book: Process and Guidelines for Ensuring a Quality User Experience", 2012	
3.	Edward Stull," UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers". Apress, 2018	
4.	Gothelf, Jeff, Seiden, and Josh," Lean UX: Designing Great Products with Agile Team", O'Reilly Media, 2016	
5.	Ben Coleman, and Dan Goodwin," Designing UX: Prototyping: Because Modern Design is Never Static", SitePoint, 2017	
VIDEO REFERENCES:		
1.	https://onlinecourses.nptel.ac.in/noc22_mg32/preview	
2.	https://elearn.nptel.ac.in/shop/iit-workshops/completed/introduction-to-design-thinking-its-creative-tools/	
WEB REFERENCES:		
1.	https://www.ibm.com/design/thinking/	
2.	https://designthinking.ideo.com/	
ONLINE COURSES:		
1.	https://www.edx.org/learn/design-thinking	
2.	https://www.udemy.com/topic/design-thinking/	

Mapping of COs with POs						
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		
Average	2	2	1	1		
1–Low, 2 –Medium, 3–High.						

ME23CP506	PRINCIPLES OF MULTIMEDIA	Version: 1.0
EXCEPT FOR M.E. - COMPUTER SCIENCE AND ENGINEERING		

Programme & Branch	M.E. – COMPUTER SCIENCE AND ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To get familiarity with gamut of multimedia and its significance
2	To acquire knowledge in multimedia components
3	To acquire knowledge about multimedia tools and authoring
4	To acquire knowledge in the development of multimedia applications
5	To explore the latest trends and technologies in multimedia

UNIT–I	INTRODUCTION	9

Introduction to Multimedia (L2) – Characteristics of Multimedia Presentation (L2) – Multimedia Components (L2) – Promotion of Multimedia Based Components (L2) – Digital Representation (L2) – Media and Data Streams (L2) – Multimedia Architecture (L2) – Multimedia Documents (L2) , Multimedia Tasks and Concerns (L2), Production (L2), sharing and distribution (L2), Hypermedia (L2), WWW and Internet (L2), Authoring (L2), Multimedia over wireless and mobile networks(L2)

Suggested Activities:

1. Flipped classroom on media Components (L3).
2. External learning – Interactive presentation (L3).

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT–II	ELEMENTS OF MULTIMEDIA	9

Text-Types (L2), Font, Unicode Standard, File Formats (L2), Graphics and Image data representations (L2) – data types, file formats, color models(L2); video – color models in video (L2), analog video (L2), digital video, file formats, video display interfaces (L2), 3D video and TV: Audio – Digitization (L2), SNR, SQNR, quantization, audio quality, file formats, MIDI (L2); Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation (L2)

Suggested Activities:

1. Flipped classroom on different file formats of various media elements (L3).
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition(L3).

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models

UNIT– III	MULTIMEDIA TOOLS	9

Authoring Tools (L2) – Features and Types (L2) – Card and Page Based Tools(L2) – Icon and Object Based Tools (L2) – Time Based Tools (L2) – Cross Platform Authoring To(L2)ols – Editing Tools (L2)– Painting and Drawing Tools (L2) – 3D Modeling and Animation Tools (L2) – Image Editing Tools (L2)– Sound Editing Tools (L2)– Digital Movie Tools (L2).

Suggested Activities:

1. Flipped classroom on multimedia tools (L3).
2. External learning – Comparison of various authoring tools (L3).

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT – IV	**MULTIMEDIA SYSTEMS**	**9**

Compression Types and Techniques: CODEC (L2), Text Compression: GIF Coding Standards, JPEG standard (L2) – JPEG 2000 (L2), basic audio compression (L2) – ADPCM, MPEG Psychoacoustics (L2), basic Video compression techniques (L2) – MPEG, H.26X – Multimedia Database System (L2) – User Interfaces – OS Multimedia Support (L2) – Hardware Support (L2)– Real Time Protocols (L2) – Play Back Architectures (L2) – Synchronization (L2) – Document Architecture (L2) – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis(L2).

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures(L3).
2. External learning – Digital repositories and hypermedia design (L3).

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT–V	**MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS**	**9**

ADDIE Model (L2)– Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors (L2) – Testing – Report Writing – Documentation (L2). Multimedia for the web and mobile platforms(L2) Virtual Reality, Internet multimedia content distribution (L2), Multimedia Information sharing (L2) – social media sharing, cloud computing for multimedia services, interactive cloud gaming(L2). Multimedia information retrieval (L2).

Suggested Activities:

1. External learning – Game consoles (L3).
2. External learning – VRML scripting languages (L3).

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific Open Ended Problems will be solved during the classroom teaching. Such problems can be given as Assignments and evaluated as Internal Assessment (IA) only and not for the End semester Examinations.

Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Handle the multimedia elements effectively.	L3 - Apply
CO2	Articulate the concepts and techniques used in multimedia applications	L3 - Apply
CO3	Develop effective strategies to deliver Quality of Experience in multimedia applications	L3 - Apply
CO4	Design and implement algorithms and techniques applied to multimedia objects.	L3 - Apply
CO5	Design and develop multimedia applications following software engineering models.	L3 - Apply

REFERENCE BOOKS:	
1.	Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, "Fundamentals of Multimedia", Springer, Third Edition, 2021
2.	Prabhat K.Andleigh, Kiran Thakrar, "MULTIMEDIA SYSTEMS DESIGN", Pearson Education, 2015
3.	Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018. (digital book)
4.	Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017
5.	Santanu Pattanayak," Pro Deep Learning with TensorFlow", Apress,2017
VIDEO REFERENCES:	
1.	https://nptel.ac.in/courses/117105083
2.	https://www.classcentral.com/course/swayam-cit-003-web-based-technologies-and-multimedia-applications-20229
WEB REFERENCES:	
1.	https://ctl.wiley.com/principles-of-multimedia-learning/
2.	https://pressbooks.pub/elearning2020/chapter/a-quick-overview-of-the-multimedia-principle/
ONLINE COURSES:	
1.	https://www.skillshare.com/browse/multimedia
2.	https://leverageedu.com/blog/multimedia-courses/

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				1	3	2
CO2				1	3	2
CO3				1	3	2
CO4				1	3	2
CO5				1	3	2
Average				1	3	2
1–Low, 2 –Medium, 3–High.						

ME23IS501 / ME23IS302	ENVIRONMENTAL SAFETY	Version: 1.0
(EXCEPT FOR M.E. INDUSTRIAL SAFETY ENGINEERING)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
2	To give understanding of air and water pollution and their control.
3	To expose the students to the basis in hazardous waste management.
4	To provide knowledge on pollution monitoring and control devices.
5	To design emission measurement devices.

UNIT–I	AIR POLLUTION	9

Classification and properties of air pollutants (L1)-Pollution sources (L1)-Effects of air pollutants on human beings(L2), Animals, Plants, and Materials (L2)-Automobile pollution (L1)-Hazards of air pollution (L2)-Concept of clean coal combustion technology (L2)-Ultra violet radiation (L1), infrared radiation(L1), radiation from the sun (L1)-Hazards due to depletion of ozone (L2)-Deforestation (L2), ozone holes (L2), automobile exhausts, chemical factory stack emissions, CFC (L2).

UNIT–II	WATER POLLUTION	9

Classification of water pollutants (L1)-Health hazards (L2)-Sampling and analysis of water (L2)-Water treatment (L3)-Different industrial effluents and their treatment and disposal (L2)-Advanced wastewater treatment (L3)-Effluent quality standards and laws (L3)-Chemical industries, tannery, textile effluents (L2)-Common treatment (L2).

UNIT– III	HAZARDOUS WASTE MANAGEMENT	9

Hazardous waste management in India (L1)-Waste identification, characterization, and classification (L2)-Technological options for collection, treatment, and disposal of hazardous waste (L2)Selection charts for the treatment of different hazardous wastes (L2)-Methods of collection and disposal of solid wastes (L2)-Health hazards - (L2)-Toxic and radioactive wastes (L2)-Incineration and vitrification (L1)-Hazards due to bio-process(L1)-, dilution, standards, and restrictions (L1)-Recycling and reuse (L2).

UNIT – IV	ENVIRONMENTAL MEASUREMENT AND CONTROL	9

Sampling and analysis (L2)-Dust monitor (L2)-Gas analyzer(L1)-, particle size analyzer (L2)-Lux meter(L1)-, pH meter (L1)-Gas chromatograph (L1)-Atomic absorption spectrometer (L1)-Gravitational settling chambers(L1), cyclone separators(L1), scrubbers (L1)-Electrostatic precipitator(L1), bag filter(L1), maintenance (L2)-Control of gaseous emission by adsorption(L2), absorption(L2), and combustion methods (L2)-Pollution Control Board, laws (L1).

UNIT–V	POLLUTION CONTROL IN PROCESS INDUSTRIES	9

Pollution control in process industries (L2)-Cement, paper, petroleum, petroleum products, textile (L2)-Tanneries, thermal power plants (L2)-Dyeing and pigment industries (L2)-Eco-friendly energy (L2).

Total : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Illustrate and familiarize the basic concepts scope of environmental safety.	L2 - Understand

CO2	Interpret the standards of professional conduct that are published by professional safety organizations and/or certification bodies.	L2 - Understand
CO3	Explain the ways in which environmental health problems have arisen due to air and water pollution.	L2 - Understand
CO4	Examine the role of hazardous waste management and use of critical thinking to identify and assess environmental health risks.	L4 - Analyze
CO5	Apply concepts of emission measurement and design emission measurement devices.	L3 - Apply

REFERENCE BOOKS:

1.	E. C Wolfe, Race to Save to Save Planet, Wadsworth Publishing Co., Belmont, CA 2006.
2.	G. T Miller, Environmental Science: Working with the Earth, 11th Edition, Wadsworth Publishing Co., Belmont, CA, 2006
3.	M.J Hammer,., and M.J Hammer,., Jr., Water and Wastewater Technology, Pearson Prentice Hall, 2006
4.	Rao, CS, "Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1 st January 2018.
5.	S. P. Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 2006.
6.	Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=DAQapF-F4Vw&list=PL9108F6C4E154885A
2.	https://www.youtube.com/watch?v=5dukz1UOtkA&list=PLLy_2iUCG87BwOQUbS7WSdMVWHDXByk-w

WEB REFERENCES:

1.	https://tifac.org.in/index.php/programmes/activities/8-publication/145-industrial-air-pollution-control-technologies?showall=1
2.	https://www.unep.org/beatpollution/global-response-pollution

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc23_ce14/preview
2.	https://onlinecourses.nptel.ac.in/noc23_ch72/preview

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		1	2			1
CO2		1	3	1		1
CO3		2	2		1	2
CO4	1	3	3	1	3	
CO5	1	1	3	3		
Average	1	1.6	2.75	1.66	2	1.33
1–Low, 2 –Medium, 3–High.						

ME23IS502 / ME23IS309	ELECTRICAL SAFETY	Version: 1.0
(EXCEPT FOR M.E. INDUSTRIAL SAFETY ENGINEERING)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To impart knowledge on fundamental electrical concepts, equipment principles, and comply with safety regulations, including basic first aid.
2	To familiarize students with primary electrical hazards, insulation, and lightning protection measures.
3	To provide an in depth knowledge on functioning of fuses, circuit breakers, and safety measures against electrical faults.
4	To provide knowledge on equipment selection, safety features, and maintenance for electrical tools.
5	To familiarize students with hazardous zone classification, safe equipment, and safety measures in different environments.

UNIT–I	CONCEPTS AND STATUTORY REQUIREMENTS	9

Introduction – electrostatics (L1), electro magnetism(L1), stored energy(L1), energy radiation and electromagnetic interference(L1) – Working principles of electrical equipment(L2)-Indian electricity act and rules(L1)-statutory requirements from electrical inspectorate(L1)-international standards on electrical safety (L1)– first aid-cardio pulmonary resuscitation(CPR) (L1).

UNIT–II	ELECTRICAL HAZARDS	9

Primary and secondary hazards (L2)-shocks(L1), burns(L1), scalds(L1), falls-human safety in the use of electricity(L1).

Energy leakage(L2)-clearances and insulation(L2)-classes of insulation(L2)-voltage classifications(L2)-excess energycurrent surges(L2)-Safety in handling of war equipments(L2)-over current and short circuit current(L2)-heating effects of current(L2)-electromagnetic forces(L1)-corona effect(L2)-static electricity(L1) –definition, sources, hazardous conditions(L2), control(L2), electrical causes of fire and explosion(L2)-ionization, spark and arcignition energy(L2)-national electrical safety code ANSI(L2). Lightning (L2), hazards (L2), lightning arrestor (L2), installation – earthing(L2), specifications(L2), earth resistance(L2), earth pit maintenance(L2).

UNIT– III	PROTECTION SYSTEMS	9

Fuse(L1), circuit breakers and overload relays(L1) – protection against over voltage and under voltage (L2)– safe limits of amperage – voltage –safe distance from lines(L2)-capacity and protection of conductor-joints-and connections(L2), overload and short circuit protection(L2)-no load protection(L2)-earth fault protection(L2).

FRLS insulation(L2)-insulation and continuity test(L2)-system grounding(L2)-equipment grounding(L2)-earth leakage circuit breaker (ELCB) (L2)-cable wires(L2)-maintenance of ground-ground fault circuit interrupter(L2)-use of low voltage(L2)-electrical guards(L2)-Personal protective equipment(L2) – safety

in handling hand held electrical appliances tools and medical equipment's(L2).		
UNIT – IV	**SELECTION, INSTALLATION, OPERATION AND MAINTENANCE**	**9**
Role of environment in selection(L2)-safety aspects in application(L2) - protection and interlock(L2)-self diagnostic features and fail safe concepts(L2)-lock out and work permit system(L2)-discharge rod and earthing devices safety in the use of portable tools(L2)-cabling and cable joints(L2)-preventive maintenance(L2).		
UNIT–V	**HAZARDOUS ZONES**	**9**
Classification of hazardous zones(L2)-intrinsically safe and explosion proof electrical apparatus(L2)-increase safe equipment(L2)-their selection for different zones(L2)-temperature classification(L2)-grouping of gases(L2)-use of barriers and isolators(L2)-equipment certifying agencies(L2).		
Total : 45 PERIODS		

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

COURSE OUTCOMES: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Demonstrate understanding of electrical concepts and legal compliance for safe operation, within regulatory constraints.	L2 - Understand
CO2	Identify and mitigate electrical hazards, ensuring safety adherence to protocols and guidelines.	L3 - Apply
CO3	Utilize protection systems effectively, ensuring electrical safety within specified standards.	L3 - Apply
CO4	Apply a safe and efficient process for selecting, installing, operating, and maintaining electrical equipment, adhering to industry regulations.	L3 - Apply
CO5	Develop expertise in managing hazardous zones safely, within the constraints of applicable safety standards.	L3 - Apply

REFERENCE BOOKS:

1.	"Accident prevention manual for industrial operations", N.S.C., Chicago, 1982.
2.	Indian Electricity Act and Rules, Government of India.
3.	Power Engineers – Handbook of TNEB, Chennai, 1989.
4.	Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt. Ltd., England, 1988.
5.	Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1986.

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=zRHtJLFJf78
2.	https://www.youtube.com/watch?v=7N9chOXO8TU

WEB REFERENCES:

1.	https://www.osha.gov/sites/default/files/2019-03/electrical_safety_manual.pdf

2.	https://www.ilo.org/global/topics/labour-administration-inspection/resources-library/publications/guide-for-labour-inspectors/electrical-safety/lang--en/index.htm
ONLINE COURSES:	
1.	https://onlinecourses.swayam2.ac.in/nou20_cs08/preview
2.	https://learning.tcsionhub.in/courses/ve/safety/siemens/electrical-safety-online-course-and-training/

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	3		1	1
CO2		1	3	1	2	2
CO3		2	3	2	2	2
CO4	1	1	3	1	1	1
CO5		2	3		2	
Average	1	1.4	3	1.33	1.6	1.5
1–Low, 2 –Medium, 3–High.						

ME23IS503/ ME23IS413	SAFETY IN ENGINEERING INDUSTRY	Version: 1.0
(EXCEPT FOR M.E. INDUSTRIAL SAFETY ENGINEERING)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To know the safety rules and regulations, standards and codes
2	To study various mechanical machines and their safety importance
3	To understand the principles of machine guarding and operation of protective devices.
4	To know the working principle of mechanical engineering processes such as metal forming and joining process and their safety risks.
5	To impart knowledge on finishing, inspection and testing operations in engineering industry

UNIT–I	SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES	9

General safety rules(L1), principles(L1), maintenance(L1), Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines (L3), CNC machines(L1), Wood working machinery(L1), types(L1),, safety principles(L1),, electrical guards(L2),, work area(L1), material handling(L1), inspection(L3),, standards and codes(L1),- saws(L1), types(L1),hazards(L2).

UNIT–II	PRINCIPLES OF MACHINE GUARDING	9

Guarding during maintenance(L2),, Zero Mechanical State (ZMS) (L2),, Definition(L1),, Policy for ZMS(L1), – guarding of hazards(L2), - point of operation protective devices(L2), machine guarding(L2), types, fixed guard(L2), interlock guard(L2), automatic guard(L2), trip guard(L2), electron eye(L2), positional control guard(L2), fixed guard fencing(L2), - guard construction(L2), - guard opening(L1).

Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses-forge hammer(L1) -flywheels(L1) -shafts(L1)-couplings(L1)-gears(L1)-sprockets wheels and chains(L1)-pulleys and belts(L1)-authorized entry to hazardous installations(L3)-benefits of good guarding systems(L1).

UNIT– III	SAFETY IN WELDING AND GAS CUTTING	9

Gas welding and oxygen cutting(L2), resistances welding(L2), arc welding and cutting(L2), common hazards(L1), personal protective equipment(L1), training(L1), safety precautions in brazing, soldering and metalizing(L2) – explosive welding(L1), selection, care and maintenance of the associated equipment and instruments(L2) – safety in generation, distribution and handling of industrial gases(L2) -colour coding(L2) – flashback arrestor (L2)– leak detection(L1)-pipe line safety(L1)-storage and handling of gas cylinders(L2).

UNIT – IV	SAFETY IN COLD FARMING AND HOT WORKING OF METALS	9

Cold working(L1), power presses(L1), point of operation safe guarding(L2), auxiliary mechanisms(L1),

feeding and cutting mechanism(L1),, hand or foot-operated presses(L1),, power press electric controls(L1),, power press set up and die removal(L2), inspection and maintenance(L3), -metal sheers-press brakes(L2).

Hot working safety in forging (L2), hot rolling mill operation(L2), safe guards in hot rolling mills(L2), – hot bending of pipes(L2), hazards and control measures(L1).

Safety in gas furnace operation, cupola, crucibles, ovens (L2)- foundry health hazards(L2), work environment(L1), material handling in foundries(L1), foundry production cleaning and finishing foundry processes(L2).

UNIT–V	SAFETY IN FINISHING, INSPECTION AND TESTING	9

Heat treatment operations(L2), electro plating(L2), paint shops(L1), sand and shot blasting(L1), safety in inspection and testing(L3), dynamic balancing(L2), hydro testing(L2), valves(L1), boiler drums and headers(L1), pressure vessels(L1), air leak test(L2), steam testing(L2), safety in radiography(L2), personal monitoring devices(L2), radiation hazards(L2), engineering and administrative controls(L2), Indian Boilers Regulation(L1).

Health and welfare measures in engineering industry(L2),-pollution control in engineering industry(L2) - industrial waste disposal(L2) .

Total : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

COURSE OUTCOMES: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Apply safety rules for maintaining and inspecting metal and wood working machines, ensuring industry standards.	L3 - Apply
CO2	Apply effective design strategies for machine guarding systems, emphasizing zero mechanical state (ZMS) during maintenance.	L3 - Apply
CO3	Demonstrate proficiency in safe welding and cutting, ensuring proper equipment selection, care, and maintenance.	L2 - Understand
CO4	Make use of safety measures in cold and hot metalworking, ensuring proper equipment setup, inspection, and maintenance.	L3 - Apply
CO5	Apply safety protocols in finishing, inspection, and testing, adhering to regulations and considering health and pollution control in engineering.	L3 - Apply

REFERENCE BOOKS:

1.	"Accident Prevention Manual" – NSC, Chicago, 1982.
2.	"Occupational safety Manual" BHEL, Trichy, 1988.
3.	"Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4.	"Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
5.	Indian Boiler acts and Regulations, Government of India.
6.	Safety in the use of wood working machines, HMSO, UK 1992.

7.	Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=7ZjDk92zE1Y
2.	https://www.youtube.com/watch?v=3VReVbsmjKI
WEB REFERENCES:	
1.	https://www.nsc.org/getmedia/238460ca-6df0-411d-914a-54d36282fc36/apm_et_answers_q_cs_ch25.pdf
2.	https://www.osha.gov/sites/default/files/2019-03/sheetmetal.pdf
ONLINE COURSES:	
1.	https://www.nfpa.org/for-professionals/training-for-me/industrial-hazards-training/hot-work-safety-certificate-online-training
2.	https://www.nsc.org/safety-training/workplace/advanced-safety-certificate/safety-inspections

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		1	3		2	
CO2		1	3		3	1
CO3	1	1	3		3	
CO4	1	1	3		3	1
CO5	2	1	3	1	3	
Average	1.33	1	3	1	2.8	1
1–Low, 2 –Medium, 3–High.						

ME23IS504	DESIGN OF EXPERIMENTS	Version: 1.0
(EXCEPT FOR M.E. INDUSTRIAL SAFETY ENGINEERING)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To impart knowledge on principles and steps in designing a statistically designed experiment.
2	To build foundation in analysing the data in single factor experiments and to perform post hoc tests.
3	To provide knowledge on analysing the data in factorial experiments.
4	To educate on analysing the data analysis in special experimental designs and Response Surface Methods.
5	To impart knowledge in designing and analysing the data in Taguchi's Design of Experiments to improve Process/Product quality.

UNIT–I	EXPERIMENTAL DESIGN FUNDAMENTALS	9

Importance of experiments(L2), experimental strategies(L2), basic principles of design(L2), terminology, ANOVA(L3), steps in experimentation(L2), sample size(L3), normal probability plot(L3), linear regression models(L3).

UNIT–II	SINGLE FACTOR EXPERIMENTS	9

Completely randomized design(L2), Randomized block design(L2), Latin square design(L2). Statistical analysis(L3), estimation of model parameters(L3), model adequacy checking(L3), pair wise comparison tests(L4).

UNIT– III	MULTIFACTOR EXPERIMENTS	9

Two and three factor full factorial experiments(L2), Randomized block factorial design(L3), Experiments with random factors(L3), rules for expected mean squares(L3), approximate F-tests(L4). 2^K factorial Experiments(L4).

UNIT – IV	SPECIAL EXPERIMENTAL DESIGNS	9

Blocking and confounding in 2^K designs(L2). Two level Fractional factorial design(L3), nested designs(L3), Split plot design(L3), Introduction to Response Surface Methods(L3).

UNIT–V	TAGUCHI METHODS	9

Steps in experimentation(L2), design using Orthogonal Arrays(L3), data analysis(L3), Robust design(L2),- control and noise factors(L3), S/N ratios(L3), parameter design(L3), Multi-level experiments(L2), Multi-response optimization(L2), Introduction to Shainin DOE(L2).

Total : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

COURSE OUTCOMES: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Interpret the Design of Experiments principles, strategizing experiment design within practical resource considerations and goals.	L2 - Understand
CO2	Analyze single-factor experiment data, focusing on randomization and pair-wise comparison tests.	L4 - Analyze

CO3	Analyze multifactor experiment data, applying rules for expected mean squares and approximate F-tests.	L4 - Analyze
CO4	Apply special experimental designs, minimize confounding effects, optimize data collection, and introduce Response Surface Methods with practical considerations.	L3 - Apply
CO5	Apply Taguchi-based approaches for quality evaluation, emphasizing practical experimentation with orthogonal arrays and multi-response optimization.	L3 - Apply

REFERENCE BOOKS:	
1.	Krishnaiah, K. and Shahabudeen, P. Applied Design of Experiments and Taguchi Methods, PHI learning private Ltd., 2012.
2.	Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, Eighth edition, 2012.
3.	NicoloBelavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.
4.	Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
5.	Montgomery, D.C., Design and Analysis of Experiment, Minitab Manual, John Wiley and Sons, Seventh edition, 2010.
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=k3lUo0XYG3E
2.	https://www.youtube.com/watch?v=IEUTRhyoHNc&list=PLPjSqITyvDeWS9Lxp4jreGJ7eNsxHxJA8
WEB REFERENCES:	
1.	https://www.itl.nist.gov/div898/handbook/pmd/section3/pmd31.htm
2.	https://www.sartorius.com/en/knowledge/science-snippets/what-is-doe-design-of-experiments-basics-for-beginners-507170
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc21_mg48/preview
2.	https://www.coursera.org/specializations/design-experiments

Mapping of COs with POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1			
CO2	2	2	1		1	
CO3	2	2	1		1	
CO4	3	2	1		1	
CO5	3	2	1	3	1	
Average	2.2	2	1	3	1	

1–Low, 2 –Medium, 3–High.

ME23IS505	CIRCULAR ECONOMY	Version: 1.0
(EXCEPT FOR M.E. INDUSTRIAL SAFETY ENGINEERING)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To equip graduates with circularity expertise for diverse national and international job opportunities.
2	To develop skilled manpower and foster entrepreneurship in Circular Economy.
3	To facilitate student-professional interactions for real-world exposure in technology, research, innovation, and circular business models.
4	To inspire students to address circularity business needs and pursue Research and Development (R&D) and entrepreneurship.
5	To cultivate environmentally conscious entrepreneurs through core competencies in environmental education and collaborative university-industry partnerships.

UNIT–I	INTRODUCTION TO CIRCULAR ECONOMY	9

Linear Economy and its emergence(L2), Economic and Ecological disadvantages of linear economy(L3), Replacing Linear economy by Circular Economy(L3), Development of Concept of Circular Economy(L2), A differential - Linear Vs Circular Economy(L2).

UNIT–II	CHARACTERISTICS OF CIRCULAR ECONOMY	9

Material recovery(L2), Waste Reduction(L2), reducing negative externalities(L3), Explaining Butterfly diagram(L2), Concept of Loops(L2).

UNIT– III	CIRCULAR DESIGN, INNOVATION AND ASSESSMENT	9

Zero waste: Waste Management in context of Circular Economy(L3), Circular design(L3), Research and innovation(L4), LCA(L2), Circular Business(L2)

UNIT – IV	CASE STUDIES	9

Business models(L2), Solid Waste Management / Wastewater, Plastics: A case study(L4), EPR: polluters pay principle(L3), Industrial symbiosis/ Eco-parks(L2)

UNIT–V	LEGAL AND POLICY FRAMEWORK	9

Role of governments and networks(L2), Sharing best practices(L2), Universal circular economy policy goals(L2), India and CE strategy(L2), ESG(L2).

Total : 45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

COURSE OUTCOMES: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Differentiate Circular Economy from Linear Economy and showcase its practical application.	L2 - Understand
CO2	Apply Circular Economy principles, incorporating material recovery and waste reduction to illustrate the Butterfly diagram and emphasize the loops within the circular system.	L3 - Apply
CO3	Apply circular design and innovation principles, assess sustainability in Circular Economy, and examine circular business models	L3 - Apply
CO4	Analyze case studies on circular economy from different fields and connect these cases to Circular Economy concepts professionally.	L4 - Analyze
CO5	Infer government roles, share best practices, and articulate Circular Economy policy goals, demonstrating expertise in legal frameworks with an ESG focus, especially in India.	L2 - Understand

REFERENCE BOOKS:	
1.	Towards Zero Waste: Circular Economy Boost, Waste to Resources María-Laura Franco-García, Jorge Carlos Carpio-Aguilar, Hans Bressers. Springer International Publishing 2019
2.	Strategic Management and the Circular Economy Marcello Tonelli, Nicolo Cristoni, Routledge 2018.
3.	Circular Economy: Global Perspective Sadhan Kumar Ghosh, Springer, 2020
4.	The Circular Economy: A User's Guide Stahel, Walter R. Routledge 2019
5.	An Introduction to Circular Economy Lerwen Liu, Seeram Ramakrishna, Springer Singapore 2021
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=ETxYCzS7xIg
2.	https://www.youtube.com/watch?v=2KdTYaCSBCs
WEB REFERENCES:	
1.	https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf
2.	https://ic-ce.com/product/principles-of-circular-economy/
ONLINE COURSES:	
1.	https://online-learning.harvard.edu/course/introduction-circular-economy?delta=0
2.	https://www.coursera.org/learn/circular-economy

Mapping of COs with POs						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2	1					
CO3	1	2			1	
CO4	2					
CO5						
Average	1.33	2			1	
1–Low, 2 –Medium, 3–High.						

ME23ET501 / ME23ET310	IOT FOR SMART SYSTEMS	Version : 1.0

EXCEPT FOR M.E. EMBEDDED SYSTEM TECHNOLOGIES

Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To study about Internet of Things technologies and its role in real time applications.
2	To introduce the infrastructure required for IoT
3	To familiarize the accessories and communication techniques for IoT.
4	To provide insight about the embedded processor and sensors required for IoT
5	To familiarize the different platforms and Attributes for IoT

UNIT–I	INTRODUCTION TO INTERNET OF THINGS	9

Overview(L2), Hardware and software requirements for IOT(L2), Sensor and actuators, Technology driver(L2)s, Business drivers(L2), Typical IoT applications(L3), Trends and implications(L3).

UNIT–II	IOT ARCHITECTURE	9

IoT reference model and architecture (L2)-Node Structure(L2) - Sensing, Processing, Communication, Powering, Networking(L2) - Topologies(L2), Layer/Stack architecture(L2), IoT standards(L2), Cloud computing for IoT(L2), Bluetooth(L2), Bluetooth Low Energy beacons(L2).

UNIT– III	PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT PROTOCOLS	9

NFC, SCADA and RFID, Zigbee, MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe, GSM, CDMA, LTE, GPRS, small cell(L2). **Wireless technologies for IoT:** WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends. (L2).

UNIT – IV	IOT PROCESSORS	9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability (L2).

Embedded processors for IOT :Introduction to Python programming(L2) -Building IOT with RASPERRY PI and Arduino (L3).

UNIT–V	CASE STUDIES	9
Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense(L3).		
		Total : 45 PERIODS

Course Outcomes: At the end of this course, the students will have the ability to		**BLOOM'S Taxonomy**
CO1	Analyze the concepts of IoT and its present developments.	L3 - Apply
CO2	Compare and contrast different platforms and infrastructures available for IoT	L2 - Understand
CO3	Explain different protocols and communication technologies used in IoT	L2 - Understand
CO4	Analyze the big data analytic and programming of IoT	L3 - Apply
CO5	Implement IoT solutions for smart applications	L3 - Apply

REFERENCE BOOKS:

1.	ArshdeepBahga and VijaiMadisetti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2.	Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3.	Samuel Greengard, " The Internet of Things", The MIT press, 2015.
4.	Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.
5.	Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6.	Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7.	Lingyang Song/DusitNiyato/ Zhu Han/Ekram Hossain,"Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8.	OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and I ntegrated Ecosystems", River Publishers Series in Communication, 2013.
9.	Vijay Madisetti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10.	Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
11.	JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
12.	UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

WEB REFERENCES:

1.	https://archive.nptel.ac.in/courses/106/105/106105166/
2.	https://www.geeksforgeeks.org/architecture-of-internet-of-things-iot/

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc22_cs53/
2.	https://www.udemy.com/course/internet-of-things-iot-fundamentals

VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE
2.	https://www.youtube.com/watch?v=urUBLmXFKI0&list=PLgMDNELGJ1CaBrefq-0eYatfOnoncW0y-
3.	https://www.youtube.com/watch?v=hdZzNOQV5vU

Mapping of COs with POs						
COs	**POs**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2	1			
CO2		2				
CO3	1	2		1	3	
CO4	2		3	3	3	
CO5	3	2	3	3	3	
Average	1.75	2	2.33	2.33	3	
1–Low, 2 –Medium, 3–High.						

ME23ET502 / ME23ET408	MACHINE LEARNING AND DEEP LEARNING	Version : 1.0

EXCEPT FOR M.E. EMBEDDED SYSTEM TECHNOLOGIES

Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	Understanding about the learning problem and algorithms
2	Providing insight about neural networks
3	Introducing the machine learning fundamentals and significance
4	Enabling the students to acquire knowledge about pattern recognition
5	Motivating the students to apply deep learning algorithms for solving real life problems. metering infrastructure.

UNIT–I	LEARNING PROBLEMS AND ALGORITHMS	9

Various paradigms of learning problems(L2), Supervised, Semi-supervised and Unsupervised algorithms(L2).

UNIT–II	NEURAL NETWORKS	9

Differences between Biological and Artificial Neural Networks(L2) - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association (L2)- Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning (L2).

UNIT– III	MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1(L2)- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering (L2).

UNIT – IV	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	9

Feed forward networks(L2), Activation functions(L2), back propagation in CNN(L2), optimizers(L2), batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs(L2).

UNIT–V	DEEP LEARNING: RNNS, AUTOENCODERS AND GANS	9
State, Structure of RNN Cell, LSTM and GRU(L2), Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders(L2), GANs: The discriminator, generator, DCGANs(L2).		
		Total : 45 PERIODS

Course Outcomes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Illustrate the categorization of machine learning algorithms.	L2 – Understand
CO2	Compare and contrast the types of neural network architectures, activation functions	L2 – Understand
CO3	Acquaint with the pattern association using neural networks	L2 – Understand
CO4	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks	L2 – Understand
CO5	Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs	L2 – Understand

REFERENCE BOOKS:	
1.	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2015, PHI learning.
2.	Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3.	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2019.
4.	Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2016
5.	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

WEB REFERENCES:	
1.	https://archive.nptel.ac.in/courses/106/106/106106139/
2.	https://archive.nptel.ac.in/courses/106/106/106106202/

ONLINE COURSES:	
1.	https://nptel.ac.in/courses/117105084
2.	https://onlinecourses.nptel.ac.in/noc23_ee87/

VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=KshIEHQn5ZM
2.	https://www.youtube.com/watch?v=TIFFfLejkcA
3.	https://www.youtube.com/watch?v=4TC5s_xNKSs&list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT&index=2

Mapping of COs with POs						
COs	**POs**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	3	1			
CO2	2	3	2			
CO3	3		3		3	
CO4	2	3	3			
CO5	3	3	3		3	
Average	2.42	3	2.57		3	
1–Low, 2 –Medium, 3–High.						

ME23ET503	RENEWABLE ENERGY TECHNOLOGY	Version : 1.0
EXCEPT FOR M.E. EMBEDDED SYSTEM TECHNOLOGIES		

Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To provide knowledge about the different types of renewable energy technologies
2	To provide knowledge on standalone operation of solar energy systems
3	To provide knowledge on grid connected operation of solar energy systems
4	To analyze the various operating modes of wind energy generating systems
5	To provide knowledge about other renewable energy systems.

UNIT–I	INTRODUCTION	9

Classification of energy sources(L2) – Co2 Emission (L2)- Features of Renewable energy(L2) - Renewable energy scenario in India(L2) -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO2 Emission(L2) - importance of renewable energy sources, Potentials – Achievements– Applications(L2)

UNIT–II	SOLAR PHOTOVOLTAICS	9

Solar Energy: Sun and Earth(L1)-Basic Characteristics of solar radiation(L2)- angle of sunrays on solar collector(L2)-Estimating Solar Radiation Empirically (L2)- Equivalent circuit of PV Cell(L2)-Photovoltaic cell characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics(L2), Shading Impacts on I-V characteristics(L2)-Bypass diode -Blocking diode(L2).

UNIT– III	PHOTOVOLTAIC SYSTEM DESIGN	9

Block diagram of solar photo voltaic system: Line commutated converters (inversion mode) - Boost and buck-boost converters(L2) - selection of inverter, battery sizing, array sizing (L2)- PV systems classification(L2)- standalone PV systems(L2) - Grid tied and grid interactive inverters(L2)- grid connection issues(L2).

UNIT – IV	WIND ENERGY CONVERSION SYSTEMS	9

Origin of Winds: Global and Local Winds(L2)- Aerodynamics of Wind turbine(L3)-Derivation of Betz's limit Power available in wind(L2)-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine(L2)- Aerodynamic Efficiency(L3)-Tip Speed(L2)-Tip Speed Ratio(L3)-Solidity-Blade Count-Power curve of wind turbine (L2)- Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations(L2)- Grid connection

Issues(L2) - Grid integrated SCIG and PMSG based WECS(L3).

UNIT–V	OTHER RENEWABLE ENERGY SOURCES	9

Qualitative study of different renewable energy resources: ocean(L2), Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC)(L2), Tidal and wave energy, Geothermal Energy Resources(L2).

Total : 45 PERIODS

Course Outcomes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Demonstrate the need for renewable energy sources.	L2 – Understand
CO2	Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system	L2 – Understand
CO3	Design a stand-alone and Grid connected PV system	L2 – Understand
CO4	Analyze the different configurations of the wind energy conversion systems.	L3 - Apply
CO5	Realize the basic of various available renewable energy sources	L2 – Understand

REFERENCE BOOKS:

1.	S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2019.
3.	Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
4.	Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
5.	Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012
6.	John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2016.

WEB REFERENCES:

1.	https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA-ETSAP_Tech_Brief_Power_Grid_Integration_2015.pdf
2.	https://www.nrel.gov/docs/fy15osti/63033.pdf

ONLINE COURSES:

1.	https://www.coursera.org/learn/renewable-power-electricity-systems
2.	https://nptel.ac.in/courses/103103206

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=mh51mAUexK4&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk
2.	https://www.youtube.com/watch?v=cGHlV0EavaQ

Mapping of COs with POs						
COs	POs					
	1	2	3	4	5	6
CO1	3		2			
CO2	3		2			
CO3	3		2			
CO4	3		2			
CO5	3		2			
Average	3		2			
1-Low, 2 -Medium, 3-High.						

ME23ET504 / ME23ET423	SMART GRID	Version : 1.0

EXCEPT FOR M.E. EMBEDDED SYSTEM TECHNOLOGIES

Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
2	To know about the function of smart grid
3	To familiarize the power quality management issues in Smart Grid
4	To familiarize the high performance computing for Smart Grid applications
5	To get familiarized with the communication networks for Smart Grid applications

UNIT–I	INTRODUCTION TO SMART GRID	9

Evolution of Electric Grid(l2), Concept, Definitions and Need for Smart Grid(l2), Smart grid drivers, functions, opportunities, challenges and benefits(l2), Difference between conventional & Smart Grid(L2), Comparison of Micro grid and Smart grid(l2), Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India(l2) – Case Study(L2).

UNIT–II	SMART GRID TECHNOLOGIES	9

Technology Drivers, Smart Integration of energy resources(L2), Smart substations(L2), Substation Automation(L2), Feeder Automation(L2), Transmission systems: EMS, FACTS and HVDC(L2), Wide area monitoring(L2), Protection and control, Distribution systems: DMS(L2), Volt/Var control, Fault Detection(L2), Isolation and service restoration(L2), Outage management(L2), High-Efficiency Distribution Transformers(L2), Phase Shifting Transformers(L2), Plug in Hybrid Electric Vehicles (PHEV(L2)) (L2) – Grid to Vehicle and Vehicle to Grid charging concepts(L2).

UNIT– III	SMART METERS AND ADVANCED METERING INFRASTRUCTURE	9

Introduction to Smart Meters(L1), Advanced Metering infrastructure (AMI) drivers and benefits(L2), AMI protocols, standards and initiatives(L2), AMI needs in the smart grid(L2), Phasor Measurement Unit(PMU) & their application for monitoring & protection(L2). Demand side management and demand response programs (L2), Demand pricing and Time of Use, Real Time Pricing(L2), Peak Time Pricing(L2).

UNIT – IV	POWER QUALITY MANAGEMENT IN SMART GRID	9

Power Quality & EMC in Smart Grid(L2), Power Quality issues of Grid connected Renewable Energy Sources(L2), Power Quality Conditioners for Smart Grid(L2), Web based Power Quality monitoring(L2), Power Quality Audit (L2).

UNIT–V	HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS	9

Architecture and Standards(L2) -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols(L2), Basics of Web Service and CLOUD Computing(L2), Cyber Security for Smart Grid(L2).

Total : 45 PERIODS

Course Outcomes: **Upon completion of this course the students will be able to:**	**BLOOM'S Taxonomy**

CO1	Relate with the smart resources, smart meters and other smart devices.	L2 – Understand
CO2	Explain the function of Smart Grid	L2 – Understand
CO3	Experiment the issues of Power Quality in Smart Grid.	L2 – Understand
CO4	Analyze the performance of Smart Grid	L2 – Understand
CO5	Recommend suitable communication networks for smart grid applications	L2 – Understand

REFERENCE BOOKS:	
1.	Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012
3.	Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4.	Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5.	SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication. 2018

WEB REFERENCES:	
1.	https://www.researchgate.net/publication/224078022_Power_Quality_and_EMC_in_Smart_Grid
2.	https://amity.edu/icactm/Proceeding/Paper%20Index%20Content/24%20T4%20P9%20ID%209.pdf
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc21_ee68
2.	https://onlinecourses.nptel.ac.in/noc23_ee124/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=KgVFJnmJvKk&list=PLSJzHGpGe6lP5biCvZrtQdHf80tnSXRBr
2.	https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee65/

Mapping of COs with POs						
COs	**POs**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2		2	2	2
CO2	3		2	2		2
CO3	2		1			2
CO4	1			3	3	1
CO5		2	2	2	2	3
Average	2.25	2	1.66	2.25	2.3	2
1–Low, 2 –Medium, 3–High.						

ME23VL501	BIG DATA ANALYTICS	Version: 1.0
EXCEPT FOR M.E. VLSI DESIGN		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To understand the basics of big data analytics
2	To understand the search methods and visualization
3	To learn mining data streams
4	To learn frameworks
5	To gain knowledge on R language

UNIT–I	INTRODUCTION TO BIG DATA	9

Introduction to Big Data Platform (L2)– Challenges of Conventional Systems (L2)- Intelligent data analysis –Nature of Data (L2)- Analytic Processes and Tools (L2)- Analysis Vs Reporting (L2)- Modern Data Analytic Tools (L2)- Statistical Concepts: Sampling Distributions (L2)- Re-Sampling (L2)– Statistical Inference - Prediction Error (L2).

UNIT–II	SEARCH METHODS AND VISUALIZATION	9

Search by simulated Annealing (L2)– Stochastic, Adaptive search by Evaluation (L2)– Evaluation Strategies (L3) – Genetic Algorithm – Genetic Programming (L2) – Visualization – Classification of Visual Data Analysis Techniques (L3) – Data Types – Visualization Techniques (L3) – Interaction techniques – Specific Visual data analysis Techniques (L3)

UNIT– III	MINING DATA STREAMS	9

Introduction To Streams Concepts (L2)– Stream Data Model and Architecture (L2)- Stream Computing - Sampling Data in a Stream (L2)– Filtering Streams – Counting Distinct Elements in a Stream (L3)– Estimating Moments – Counting Oneness in a Window (L3)– Decaying Window (L3) - Real time Analytics Platform(RTAP) Applications (L3) - Case Studies - Real Time Sentiment Analysis (L3), Stock Market Predictions (L3)

UNIT – IV	FRAMEWORKS	9

Map Reduce – Hadoop (L2) , Hive, MapR – Sharding – NoSQL Databases (L2) - S3 - Hadoop Distributed File Systems (L2) – Case Study- Preventing Private Information Inference Attacks on Social Networks (L2) - Grand Challenge: Applying Regulatory Science (L2) and Big Data to Improve Medical Device Innovation(L2)

UNIT–V	R LANGUAGE	9

Overview, Programming structures: Control statements (L3) - Operators – Functions (L3) – Environment and scope issues (L3)- Recursion - Replacement functions (L3), R data structures: Vectors -Matrices and arrays (L3)- Lists -Data frames -Classes, Input/output, String manipulations (L3)

45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Understand the basics of big data analytics	L2 – Understand
CO2	Ability to use Hadoop, Map Reduce Framework	L3 – Apply
CO3	Apply big data analytics for increasing the business outcome	L3 – Apply
CO4	Understand the concepts of R language	L2 – Understand
CO5	Use R language to integrate and analyse large amounts of information	L3 – Apply

REFERENCE BOOKS:

1.	Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007
2.	Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020
3.	Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4.	Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012
5.	Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007

VIDEO REFERENCES:

1.	https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2.	https://onlinecourses.swayam2.ac.in/arp19_ap60/preview

WEB REFERENCES:

1.	https://www.ibm.com/analytics/big-data-analytics
2.	https://www.tableau.com/learn/articles/big-data-analytics

ONLINE COURSES:

1.	https://www.edx.org/learn/big-data/university-of-adelaide-big-data-analytics
2.	http://moocs.anuonline.ac.in/advance-diploma-in-big-data-analytics.html

Mapping of COs with POs

COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		2	3	3	1
CO2	2		2	2	3	1
CO3	1		2	2	3	1
CO4	1		2	3	2	1
CO5	2		2	2	1	1
Average	1.6		2	2.4	2.4	1
1–Low, 2 –Medium, 3–High.						

ME23VL502	INTERNET OF THINGS AND CLOUD	Version: 1.0
EXCEPT FOR M.E. VLSI DESIGN		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To understand Smart Objects and IoT Architectures
2	To learn about various IOT-related protocols
3	To build simple IoT Systems using Arduino and Raspberry Pi.
4	To understand data analytics and cloud in the context of IoT
5	To develop IoT infrastructure for popular applications

UNIT–I	FUNDAMENTALS OF IoT	9

Introduction to IoT (L2)– IoT definition – Characteristics (L2)– IoT Complete Architectural Stack (L2)– IoT enabling Technologies – IoT Challenges (L2). Sensors and Hardware for IoT (L2)– Hardware Platforms – Arduino, Raspberry Pi, Node MCU (L2). A Case study with any one of the boards and data acquisition from sensors (L3).

UNIT–II	PROTOCOLS FOR IoT	9

Infrastructure protocol (IPV4/V6/RPL) (L2), Identification (URIs) (L2), Transport (Wifi, Lifi, BLE), Discovery (L3), Data Protocols, Device Management Protocols (L3). – A Case Study with MQTT/CoAP usage-IoT privacy (L3), security and vulnerability solutions (L3).

UNIT– III	CASE STUDIES/INDUSTRIAL APPLICATIONS	9

Case studies with architectural analysis (L2): IoT applications – Smart City – Smart Water (L3)– Smart Agriculture (L2)– Smart Energy – Smart Healthcare (L3)– Smart Transportation – Smart Retail (L3)– Smart waste management (L3).

UNIT – IV	CLOUD COMPUTING INTRODUCTION	9

Introduction to Cloud Computing (L2)- Service Model (L2)– Deployment Model (L2)- Virtualization Concepts – Cloud Platforms (L2)– Amazon AWS (L2)– Microsoft Azure – Google APIs (L2).

UNIT–V	IoT AND CLOUD	9

IoT and the Cloud (L2)- Role of Cloud Computing in IoT (L2)- AWS Components (L2)- S3 – Lambda – AWS IoT Core (L2)- Connecting a web application to AWS IoT using MQTT (L3)- AWS IoT Examples (L3). Security Concerns, Risk Issues (L2), and Legal Aspects of Cloud Computing (L2)- Cloud Data Security (L2)

Total:-45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Understand the various concept of the IoT and their technologies.	L2 – Understand
CO2	Develop IoT application using different hardware platforms.	L3 – Apply
CO3	Implement the various IoT Protocols.	L3 – Apply
CO4	Understand the basic principles of cloud computing.	L2 – Understand
CO5	Develop and deploy the IoT application into cloud environment.	L2 – Understand

REFERENCE BOOKS:

1.	"The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2.	Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3.	EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4.	Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5.	Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.

VIDEO REFERENCES:

1.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2.	https://www.oracle.com/in/internet-of-things/what-is-iot/

WEB REFERENCES:

1.	https://innovationatwork.ieee.org/internet-of-things/
2.	https://www.ibm.com/topics/internet-of-things

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc23_cs82/preview
2.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2	3	3	1
CO2	2		2	2	3	1
CO3	1			2	3	1
CO4			2	3	2	1
CO5	2		2	2	1	1
Average	1.7		2	2.4	2.4	1
1–Low, 2 –Medium, 3–High.						

ME23VL503	MEDICAL ROBOTICS	Version: 1.0
EXCEPT FOR M.E. VLSI DESIGN		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Instructions if any

Course Objectives:

1	To explain the basic concepts of robots and types of robots
2	To discuss the designing procedure of manipulators, actuators and grippers
3	To impart knowledge on various types of sensors and power sources
4	To explore various applications of Robots in Medicine
5	To impart knowledge on wearable robots

UNIT–I	INTRODUCTION TO ROBOTICS	9

Introduction to Robotics (L2), Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization (L2).

Sensors and Actuators: Sensors and controllers (L2), Internal and external sensors, position, velocity and acceleration sensors (L2), Proximity sensors, force sensors Pneumatic and hydraulic actuators (L2), Stepper motor control circuits (L2), End effectors (L2), Various types of Grippers (L2), PD and PID feedback actuator models (L2)

UNIT–II	MANIPULATORS & BASIC KINEMATICS	9

Construction of Manipulators (L2), Manipulator Dynamic and Force Control (L2), Electronic and pneumatic manipulator (L2), Forward Kinematic Problems, Inverse Kinematic Problems (L2), Solutions of Inverse Kinematic problems (L2)

Navigation and Treatment Planning: Variable speed arrangements (L2), Path determination – Machinery vision (L2), Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor (L2)

UNIT– III	SURGICAL ROBOTS	9

Da Vinci Surgical System (L2), Image guided robotic systems for focal ultrasound based surgical applications (L2), System concept for robotic Tele-surgical system for off-pump (L2), CABG surgery, Urologic applications (L2), Cardiac surgery, Neuro-surgery (L2), Pediatric and General Surgery, Gynecologic Surgery (L2), General Surgery and Nanorobotics. Case Study (L2)

UNIT – IV	REHABILITATION AND ASSISTIVE ROBOTS	9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking (L2), Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking (L2), Motion Prediction, Motion Replication (L2). Portable Robot for Tele rehabilitation (L2), Robotic Exoskeletons – Design considerations (L3), Hybrid assistive limb. Case Study (L3)

UNIT–V	WEARABLE ROBOTS	9
Augmented Reality (L2), Kinematics and Dynamics for Wearable Robots (L2), Wearable Robot technology, Sensors, Actuators, Portable Energy Storage (L2), Human–robot cognitive interaction (cHRI) (L2), Human–robot physical interaction (pHRI) (L2), Wearable Robotic Communication - Case Study (L3)		
		Total:-45 PERIODS

OPEN ENDED PROBLEMS / QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Out comes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Describe the configuration, applications of robots and the concept of grippers and actuators	L2 – Understand
CO2	Explain the functions of manipulators and basic kinematics	L2 – Understand
CO3	Describe the application of robots in various surgeries	L2 – Understand
CO4	Design and analyze the robotic systems for rehabilitation	L3 – Apply
CO5	Design the wearable robots	L3 – Apply

REFERENCE BOOKS:

1.	Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2.	Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008
4.	Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
5.	Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
6.	Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
7.	Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
8.	Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, UK, 2008
9.	Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005
10	Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
11	Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011
12	Jocelyn Troccaz, Medical Robotics, Wiley, 2012
13	Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VIDEO REFERENCES:	
1.	https://nptel.ac.in/courses/107106090
2.	https://onlinecourses.nptel.ac.in/noc22_me05/preview
WEB REFERENCES:	
1.	https://web.stanford.edu/class/me328/
2.	https://robotnik.eu/applications-of-robotics-in-medicine/
ONLINE COURSES:	
1.	https://web.stanford.edu/class/me328/#lectures
2.	https://nptel.ac.in/courses/112106298

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				1		
CO2				2		
CO3	2		2	2	2	2
CO4	2		2	2	3	2
CO5	2		2	2	3	3
Average	2		2	1.8	2.6	2.3
1–Low, 2 –Medium, 3–High.						

ME23VL504	EMBEDDED AUTOMATION	Version: 1.0
EXCEPT FOR M.E. VLSI DESIGN		

Programme & Branch	M.E. VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3

Course Objectives:

1	To learn about the process involved in the design and development of real-time embedded system
2	To develop the embedded C programming skills on 8-bit microcontroller
3	To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
4	To learn about the tools, firmware related to microcontroller programming
5	To build a home automation system

UNIT–I	INTRODUCTION TO EMBEDDED C PROGRAMMING	9

C Overview and Program Structure (L2) - C Types, Operators and Expressions (L2) - C Control Flow – C Functions and Program Structures (L3) - C Pointers And Arrays (L3) - FIFO and LIFO (L3) - C Structures (L3) - Development Tools (L2)

UNIT–II	AVR MICROCONTROLLER	9

ATMEGA 16 Architecture (L2) – Non-volatile and Data Memories (L2) - Port System (L2) - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation (L2), USART, SPI, Two Wire Serial Interface (L2) , ADC, Interrupts - Physical and Operating Parameters (L2)

UNIT– III	HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS	9

Lights and Switches (L3) - Stack Operation - Implementing Combinational Logic (L3) - Expanding I/O - Interfacing Analog To Digital Convertors (L3) - Interfacing Digital To Analog Convertors (L3) - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface (L3) - Serial EEPROM - Real Time Clock (L3) - Accessing Constants Table - Arbitrary Waveform Generation (L3) - Communication Links - System Development Tools (L3)

UNIT – IV	VISION SYSTEM	9

Fundamentals of Image Processing (L2) – Filtering (L2) - Morphological Operations (L3) - Feature Detection and Matching (L3) - Blurring and Sharpening (L3) - Segmentation - Thresholding (L3) - Contours - Advanced Contour Properties (L3) - Gradient - Canny Edge Detector (L3) - Object Detection (L3) - Background Subtraction (L3)

UNIT–V	HOME AUTOMATION	9
Home Automation (L2) - Requirements - Water Level Notifier (L2) - Electric Guard Dog (L2) - Tweeting Bird Feeder (L2) - Package Delivery Detector (L2) - Web Enabled Light Switch (L2) - Curtain Automation (L3) - Android Door Lock - Voice Controlled Home Automation (L3) - Smart Lighting - Smart Mailbox (L3) - Electricity Usage Monitor (L3) - Proximity Garage Door Opener (L3) - Vision Based Authentic Entry System (L3)		
		45 PERIODS
	OPEN ENDED PROBLEMS / QUESTIONS	
Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination		

Course Out comes: **Upon completion of this course the students will be able to:**		**BLOOM'S Taxonomy**
CO1	Write embedded C programs for embedded system application	L2 – Understand
CO2	Describe internal subsystems of AVR microcontrollers	L2 – Understand
CO3	Analyze the 8-bit series microcontroller architecture, features and pin details	L3 – Apply
CO4	Develop the systems based on vision mechanism	L3 – Apply
CO5	Develop a real time home automation system	L3 – Apply

REFERENCE BOOKS:

1.	Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001
2.	Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005
3.	Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4.	Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012
5.	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011
6.	Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012

VIDEO REFERENCES:

1.	https://archive.nptel.ac.in/courses/106/105/106105193/
2.	https://archive.nptel.ac.in/courses/106/105/106105159/

WEB REFERENCES:

1.	https://community.arm.com/arm-community-blogs/b/embedded-blog
2.	https://www.embeddedrelated.com/blogs.php

ONLINE COURSES:

1.	https://nptel.ac.in/courses/106103182
2.	https://nptel.ac.in/courses/117106112

Mapping of COs with POs						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1					
CO2	1	3	1			3
CO3	1	3	2	1	2	3
CO4	1	3	2	2	3	3
CO5	1	3	1	2	3	3
Average	1	3	1.5	1.6	2.6	3
1–Low, 2 –Medium, 3–High.						

ME23AC701	ENGLISH FOR RESEARCH PAPER WRITING	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E- VLSI DESIGN	CP	L	T	P	C
		2	2	0	0	0

Course Objectives:

1	To teach how to improve writing skills and level of readability
2	To tell about what to write in each section
3	To summarize the skills needed when writing a title
4	To infer the skills needed when writing the conclusion
5	To ensure the quality of paper at very first-time submission

UNIT–I	INTRODUCTION TO RESEARCH PAPER WRITING	6

Planning and Preparation (L2), Word Order (L1), Breaking up long sentences (L2), Structuring Paragraphs and Sentences (L1), Being Concise and Removing Redundancy (L1),Avoiding Ambiguity and Vagueness (L2).

UNIT–II	PRESENTATION SKILLS	6

Clarifying Who Did What (L2), Highlighting Your Findings (L1), Hedging and Criticizing (L1), Paraphrasing and Plagiarism (L1), Sections of a Paper (L1), Abstracts, Introduction (L1).

UNIT–III	TITLE WRITING SKILLS	6

Key skills are needed when writing a Title (L1), key skills are needed when writing an Abstract (L1), key skills are needed when writing an Introduction (L1), skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check (L1).

UNIT–IV	RESULT WRITING SKILLS	6

Skills are needed when writing the Methods (L1), skills needed when writing the Results (L2), skills are needed when writing the Discussion (L2), skills are needed when writing the Conclusions (L2).

UNIT–V	VERIFICATION SKILLS	6

Useful phrases (L1), checking Plagiarism (L1), how to ensure paper is as good as it could possibly be the first- time submission (L1).

TOTAL: 30 PERIODS

OPEN ENDED PROBLEMS /QUESTIONS		
Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination		
Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOMS Taxonomy**
CO1	Understand that how to improve your writing skills and level of readability	L2 – Understand
CO2	Learn about what to write in each section	L1 – Remember
CO3	Understand the skills needed when writing a Title	L2 – Understand
CO4	Understand the skills needed when writing the Conclusion	L2 – Understand
CO5	Ensure the good quality of paper at very first-time submission	L2 – Understand
TEXT BOOKS:		
1.	Adrian Wall work, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.	
2.	Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006.	
REFERENCE BOOKS:		
1.	Goldbort R Writing for Science, Yale University Press (available on Google Books)2006.	
2.	HighmanN, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.	

ME23AC702	DISASTER MANAGEMENT	Version: 1.0
	(COMMON TO ALL BRANCHES)	

Programme& Branch	M.E- VLSI DESIGN	CP	L	T	P	C
		2	2	0	0	0

Course Objectives:

1	Summarize basics of disaster
2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5	Develop the strengths and weaknesses of disaster management approaches

UNIT–I	INTRODUCTION	6

Disaster: Definition (L1), Factors and Significance(L1); Difference between Hazard And Disaster(L2); Natural and Manmade Disasters: Difference, Nature, Types and Magnitude(L1).

UNIT–II	REPERCUSSIONS OF DISASTERS AND HAZARDS	6

Economic Damage (L1), Loss of Human and Animal Life (L1), Destruction Of Ecosystem (L1). Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches (L1), Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts (L1).

UNIT–III	DISASTER PRONE AREAS IN INDIA	6

Study of Seismic Zones (L1); Areas Prone To Floods and Droughts (L1), Landslides And Avalanches (L1); Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami (L1); Post-Disaster Diseases and Epidemics (L1)

UNIT–IV	DISASTER PREPAREDNESS AND MANAGEMENT	6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard (L2); Evaluation of Risk: Application of Remote Sensing (L1), Data from Meteorological And Other Agencies (L1), Media Reports: Governmental and Community Preparedness (L1).

UNIT–V	RISK ASSESSMENT	6

Disaster Risk: Concept and Elements (L1), Disaster Risk Reduction (L1), Global and National Disaster Risk Situation (L1).Techniques of Risk Assessment (L1),Global Co-Operationin Risk Assessment andWarning (L1), People's Participation in Risk Assessment. Strategies for Survival (L1)

TOTAL: 30 PERIODS

OPEN ENDED PROBLEMS /QUESTIONS		
Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination		
Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOMS Taxonomy**
CO1	Summarize basics of disaster	L1 – Remember
CO2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.	L2 – Understand
CO3	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives	L2 – Understand
CO4	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.	L2 – Understand
CO5	Develop the strengths and weaknesses of disaster management approaches	L2 – Understand
TEXTBOOKS:		
1.	GoelS.L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.	
2.	Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company, 2007.	
REFERENCE BOOKS:		
1.	Sahni, Pradeep Et.Al.,"Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi,2001.	

ME23AC703	CONSTITUTION OF INDIA	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme& Branch	M.E- VLSI DESIGN	CP	L	T	P	C
		2	2	0	0	0

Course Objectives:

1	To understand the premises in forming the twin themes of liberty and freedom from a civil rights perspective.
2	To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
3	To role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
4	To address the role of socialism in India after the commencement of the Bolshevik Revolution 1917 And its impact on the initial drafting of the Indian Constitution

UNIT–I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	6

History(L1), Drafting Committee(L1), (Composition & Working)

UNIT–II	PHILOSOPHY OF THE INDIAN CONSTITUTION	6

Preamble (L1), Salient Features (L1).

UNIT–III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	6

Fundamental Rights (L1), Right to Equality (L1), Right to Freedom (L1), Right against Exploitation (L1), Right to Freedom of Religion (L1), Cultural and Educational Rights (L1), Right to Constitutional Remedies (L1), Directive Principles of State Policy (L1), Fundamental Duties (L1).

UNIT–IV	ORGANS OF GOVERNANCE	6

Parliament (L1), Composition (L1), Qualifications and Disqualifications (L1), Powers and Functions (L1), Executive (L1), President (L1), Governor (L1), Council of Ministers (L1), Judiciary, Appointment and Transfer of Judges (L1), Qualifications, Powers and Functions (L1).

UNIT–V	LOCAL ADMINISTRATION	6

District's Administration head: Role and Importance (L1), Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation (L1). Pachayati raj: Introduction (L1), PRI: Zila Panchayat (L1). Elected officials and their roles (L1), CEO Zila Pachayat: Position and role (L1). Block level: Organizational Hierarchy (Different departments) (L1), Village level:Role of Elected and Appointed officials (L1), Importance of grass root democracy (L1).

UNIT–VI	ELECTION COMMISSION	6

Election Commission: Role and Functioning (L1). Chief Election Commissioner and Election Commissioners (L1) - Institute and Bodies for the welfare of SC/ST/OBC and women (L1).

Total:- 30 PERIODS

OPEN ENDED PROBLEMS /QUESTIONS

Course specific open ended problems will be solved during the classroom teaching. Such problems can be given as assignments and evaluated as internal assessment only and not for the end semester examination

Course Outcomes: Upon completion of this course the students will be able to:		BLOOMS Taxonomy
CO1	Discuss the growth of the demand for civil rights in India for the bulk of	L2 – Understand

	Indians before the arrival of Gandhi in Indian politics.	
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	L2 – Understand
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.	L2 – Understand
CO4	Discuss the passage of the Hindu Code Bill of 1956.	L2 – Understand
TEXTBOOKS:		
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.	
REFERENCE BOOKS:		
1.	M.P.Jain, Indian Constitution Law,7th Edn.,LexisNexis,2014.	
2.	D.D.Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.	

ME23AC704	நற்றமிழ் இலக்கியம் (தமிழில்)	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		2	2	0	0	0

Course Objectives:

1	சங்க இலக்கியம் பற்றி மாணவர்களுக்கு எடுத்துரைத்தல்
2	நீதி நூல்கள் வாயிலாக அறக்கருத்துகளை எடுத்து கூறுதல்.
3	சிலப்பதிகாரம், மணிமேகலை காப்பியங்களை எடுத்துரைத்தல்.
4	இலக்கியங்களில் காணப்படும் அருள்நெறிக் கதைகளைப் பற்றி விளக்குதல்.
5	தற்காலத் தமிழ் இலக்கியங்களை மாணவர்களுக்கு தெரியப்படுத்துதல்.

UNIT–I	சங்க இலக்கியம்	6

1. தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள் (L1)
2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம் (L1)
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி (L1)
4. புறநானூறு (95, 195) – போரை நிறுத்திய ஔவையார் (L1)

UNIT–II	அறநெறித்தமிழ்	6

1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ் (L2)
2. பிற அறநூல்கள் – இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்) (L2)

UNIT–III	இரட்டைக்காப்பியங்கள்	6

1. கண்ணகியின் புரட்சி- சிலப்பதிகார வழக்குரை காதை (L1)
2. சமூக சேலை இலக்கியம் மணிமேகலை – சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை (L1)

UNIT–IV	அருள்நெறித்தமிழ்	6

1. சிறுபாணாற்றுப்படை – பாரி முல்லைக்கு தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள். (L2)
2. நற்றிணை – அன்னைக்குரிய புன்னை சிறப்பு (L2)
3. திருமந்திரம் (617,618) இயமம் நியமம் விதிகள் (L2)
4. தர்மசாலையை நிறுவிய வள்ளலார் (L2)
5. புறநானூறு – சிறுவனே வள்ளலானான் (L2)
6. அகநானூறு (4) – வண்டு (L2)
7. நற்றிணை (11) – நண்டு (L2)
8. கலித்தொகை (11) – யானை, புறா (L2)
9. ஐந்திணை ஐம்பது (27) – மான் (L2)
    a. ஆகியவை பற்றிய செய்திகள் (L2)

UNIT–V	நவீன தமிழ் இலக்கியம்	6

1. உரைநடைத்தமிழ் (L1)
   – தமிழின் முதல் புதினம் (L1)
   – தமிழின் முதல் சிறுகதை (L1)
   – கட்டுரை இலக்கியம் (L1) –
   பயண இலக்கியம் (L1)
   – நாடகம் (L1)
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும் (L1)
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும் (L1)
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும் (L1)
5. அறிவியல் தமிழ் (L1)
6. இணையத்தில் தமிழ் (L1)
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம் (L1)

Total: 30 PERIODS

Course Outcomes: **Upon completion of this course the students will be able to:**		**BLOOMS Taxonomy**
CO1	சங்க இலக்கியம் மாணவர்கள் முழுமையாக அறிந்து பயன்பெறுதல்.	L1 - நினைவில் கொள்ளுதல்
CO2	அறநெறி இலக்கியம் வாயிலாக வாழ்வியலுக்குத் தேவையான தூய்மைப் பணிகளை மேற்கொள்ளுதல்.	L2 - புரிந்து கொள்ளுதல்
CO3	சிலப்பதிகாரம், மணிமேகலை காப்பியங்களில் உள்ள நீதிக்கருத்துகளை மாணவர்கள் தெரிந்துகொள்ளுதல்.	L1 - நினைவில் கொள்ளுதல்
CO4	இலக்கியங்களில் காணப்படும் அருள்நெறிக் கதைகளைப் பற்றி விளக்குதல்.	L2 – புரிந்து கொள்ளுதல்
CO5	தற்காலத் தமிழ் இலக்கியங்களை மாணவர்கள் தெரிந்து அவற்றின் வாயிலாக பயன் அடைதல்.	L1 – நினைவில் கொள்ளுதல்

TEXTBOOKS: தமிழ் இலக்கிய வெளியீடுகள் புத்தகங்கள்

1.	தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org.
2.	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org.
3.	தர்மபுர ஆதீன வெளியீடு.

4.	வாழ்வியல் களஞ்சியம் – தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்.
5.	தமிழ்க்கலைக்களஞ்சியம் - தமிழ் வளர்ச்சித்துறை (thamilvalarchithurai.com).
6.	அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்.

ME23AC704	CLASSICAL TAMIL LITERATURE (ENGLISH VERSION)	Version: 1.0
(COMMON TO ALL BRANCHES)		

Programme & Branch	M.E INDUSTRIAL SAFETY ENGINEERING	CP	L	T	P	C
		2	2	0	0	0

Course Objectives:

1	Providing guidance to students about Sangam literature.
2	Analyzing legal texts to articulate opinions on justice literature.
3	Discussing Silappathikaram, Manimekalai, and Kappiyankal.
4	Shedding light on narratives of grace found in literature.
5	Familiarizing students with contemporary Tamil literature.

UNIT–I	SANGAM LITERATURE	6

1. Tolkappiyam - The Fundamental Text of Tamil - Writing, language, and meaning (L1)
2. Akananuru (82) - Natural Melodious Garden (L1)
3. Kurinchipattu's Flower Landscape (L1)
4. Puranānuru (95, 195) - Avvaiyar Who Stopped the War (L1)

UNIT–II	JUSTICE & RIGHTEOUSNESS IN TAMIL	6

1. Thiruvalluvar who Expounded Virtue - Understanding justice, embracing love, avoiding falsehood, gratitude, and fame. (L2)
2. Other Legal Texts - Literary Medicine - Eladhi, Sirupanchamulam, Trigatukam, and Acharakkovai (A book emphasizing cleanliness). (L2)

UNIT–III	BINARY EPICS	6

1. Kannagi's Protest - Introduction to the Silappathikaram Legal Story (L1)
2. Social Structure Literature Manimekalai - Story of Siraikkottam turned into Arakkottam (L1)

UNIT–IV	SACRED TAMIL LITERATURE	6

1. Siruppanattrupadai - Pari Presented the chariot to Jasmine Creeper, Pegan Presented a blanket to Peacock, Gooseberry given to Avvai by Adhiyamaan, Royal honors. (L2)
2. Nattrinai - Special gift for Mother (L2)
3. Thirumandiram (617,618) - Rules of Conduct (L2)
4. Vallalar who founded Dharmasala (L2)
5. Puranānuru - The young man becomes a warrior (L2)
6. Akananuru (4) - The Chariot (L2)
7. Nattrinai (11) - Bull (L2)
8. Kalittokai (11) - Elephant, Tiger (L2)
9. Aindiṉai Aimpatu (27) - Deer (L2)

a. News about the above (L2)

UNIT–V	MODERN TAMIL LITERATURE	6

1. Literary Tamil (L1):
   - First Novel in Tamil (L1)
   - First Short Story in Tamil (L1)
   - Essay Literature (L1)
   - Travel Literature (L1)
   - Drama (L1)
2. National Liberation Struggle and Tamil Literature (L1)
3. Community Liberation and Tamil Literature (L1)
4. Women's Liberation and Tamil Literature in the Perspective of Feminist Criticism (L1)
5. Scientific Tamil (L1)
6. Tamil on the Internet (L1)
7. Tamil Literature in Environmental Conservation (L1)

Total: 30 PERIODS

Course Outcomes: Upon completion of this course the students will be able to:		**BLOOMS Taxonomy**
CO1	Students comprehensively understand and benefit from Sangam literature.	L1 – Remember
CO2	Emphasize cleanliness tasks needed for the vitality of literary life.	L2 – Understand
CO3	Familiarize students with ethical principles found in Silappathikaram and Manimekalai.	L1 – Remember
CO4	Illuminate stories of grace in literature.	L2 – Understand
CO5	Students acquire knowledge of contemporary Tamil literature and apply its insights.	L1 – Remember

TEXTBOOKS:

1.	Tamil Virtual University - www.tamilvu.org.
2.	Tamil Wikipedia - https://ta.wikipedia.org.
3.	Release of Dharmapuri Adheenam.
4.	Biotechnology Symposium - Tamil Nadu Agricultural University, Thanjavur.
5.	Tamil Arts Symposium - Department of Tamil Development (thamilvalarchithurai.com).
6.	Science Symposium - Tamil Nadu Agricultural University, Thanjavur.

Note:

Syllabus for the courses offered from 3rd Semester to 4th Semester, will be added after the approval of the Board of Studies (BoS) & Academic Council (AC) in due course.