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.

Beyond Knowledge

M.E/M.Tech Regulations 2023

M.E. – VLSI Design

Curriculum and Syllabi

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

CHAIRPERSON
Board of Studies
Faculty of Electronics & Communication Engg
Knowledge Institute of Technology
KIOT Campus, Kakapalayam,
Salem-637 504

Version:1 .0	**Date:**06.07.2024

	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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Board of Studies
Faculty of Electronics & Communication Engg
Knowledge Institute of Technology
KIOT Campus, Kakapalayam,
Salem-637 504

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 research
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

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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

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KNOWLEDGE INSTITUTE OF TECHNOLOGY (AUTONOMOUS), SALEM – 637504											
M.E. VLSI DESIGN											Version:1.0
Courses of Study and Scheme of Assessment (Regulations 2023)											Date:06.07.2024
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

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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 ElectivesI & 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

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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

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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

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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	நற்றமிழ்இலக்கியம்/ CLASSICAL TAMIL LITERATURE	AC	2	2	0	0	0	100	-	100

SPECIAL ELECTIVES (For Ph.D. Scholars)											
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks		
			CAT	CP	L	T	P	C	IA	ESE	Total
THEORY											
1	ME23VL421	Medical Image Analysis	SE	3	3	0	0	3	40	60	100
2	ME23VL422	Applied Optimization for Wireless and Bigdata	SE	3	3	0	0	3	40	60	100
3	ME23VL423	Medical Image Processing	SE	3	3	0	0	3	40	60	100

Special electives for Ph.D. scholars are determined by the recommendations of the Doctoral Committee for each individual scholar. The syllabus for these electives is also provided by the Doctoral Committee members, subject to approval by the Internal Board of Studies (BOS), and subsequently ratified in the next BOS meeting.

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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		

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ME23VL311	VLSI SIGNAL PROCESSING	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To introduce the concepts of DSP algorithms for parallel processing
2	To study algorithmic strength reduction techniques
3	To apply fast convolution algorithms in VLSI architectures
4	To apply arithmetic algorithms for optimization
5	To study synchronous and asynchronous pipelining methods

UNIT–I	INTRODUCTION TO DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING OF FIR FILTERS	9

Introduction to DSP systems (L2) – typical DSP algorithms, data flow and dependence graphs (L2) – critical path, loop bound, iteration bound, longest path matrix algorithm (L3), pipelining and parallel processing of FIR filters (L3), pipelining and parallel processing for low power (L2)

UNIT–II	RETIMING, ALGORITHMIC STRENGTH REDUCTION	9

Retiming – definitions and properties (L2), unfolding – an algorithm for unfolding (L3), properties of unfolding (L2), sample period reduction and parallel processing application (L2), algorithmic strength reduction in filters and transforms (L3)– 2-parallel FIR filter (L3), 2-parallel fast FIR filter (L3), DCT architecture (L2), rank-order filters (L2), Odd-Even, Merge-Sort architecture (L2), parallel rank-order filters (L2)

UNIT– III	FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS	9

Fast convolution (L2) – Cook-Toom algorithm (L3), modified Cook-Toom algorithm (L3), Pipelined and parallel recursive filters (L3)– Look-Ahead pipelining in first-order IIR filters (L3), Look-Ahead pipelining with powerof-2 decomposition (L3), Clustered look-ahead pipelining (L2), Parallel processing of IIR filters (L2), combined pipelining and parallel Processing of IIR filters (L2)

UNIT – IV	BIT-LEVEL ARITHMETIC ARCHITECTURES	9

Bit-level arithmetic architectures (L2)– parallel multipliers with sign extension (L3), parallel carry-ripple and carry-save multipliers (L3), design of lyon's bit-serial multipliers using Horner's rule (L3), bit-serial FIR filter (L3), CSD representation (L2), CSD multiplication using Horner's rule for precision improvement (L3), Distributed Arithmetic fundamentals and FIR filters (L2)

UNIT–V	NUMERICAL STRENGTH REDUCTION, SYNCHRONOUS AND ASYNCHRONOUS PIPELINING	9

Numerical strength reduction (L2)– sub-expression elimination (L3), multiple constant multiplication (L3), iterative matching (L3), synchronous pipelining and clocking styles (L2), clock skew in edge triggered single phase clocking (L3), Two-phase clocking (L2), wave pipelining (L2). Asynchronous pipelining (L2) - Bundled Data versus Dual-Rail protocol (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	Apply pipelining and parallel processing techniques to alter FIR structures for efficiency	L3 – Apply

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CO2	Analyse and modify the design equations leading to efficient DSP architectures for transforms apply low power techniques for low power dissipation	L3 – Apply
CO3	Develop fast and area efficient IIR structures	L3 – Apply
CO4	Develop fast and area efficient multiplier architectures	L3 – Apply
CO5	Explain multiplications and build fast hardware for synchronous digital systems	L2 – Understand

REFERENCE BOOKS:

1.	Keshab K. Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation", Wiley, 1st Edition, 2007.
2.	U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 4th Edition, 2014

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=UA0hmZU4G0M&list=PLkLMfaSJoziaRdKZB-4qOHT1ujJgtVSJu
2.	https://www.youtube.com/watch?v=7239zCwfmFU&list=PLkL MfaSJoziaRdKZB4qOHT1ujJ gtVSJu&index=4

WEB REFERENCES:

1.	NPTEL:: Electronics & Communication Engineering - VLSI Signal processing

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc20_ee44/preview

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High

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ME23VL601	PROJECT WORK – I	CP	L	T	P	C
		12	0	0	12	6
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To identify relevant research problems by searching academic databases and literature
2	To design and conduct preliminary studies to explore identified problems
3	To conduct, compile and present research findings effectively

COURSE CONTENT:

The student will identify and select a problem based on comprehensive literature survey

The student should submit a proposal and get it approved by the Head of the department

Three reviews will be conducted by Project review committee

Students will be evaluated by the committee during the review and suggestions will be offered by members

The report for PHASE -I should be submitted by the students at the end of course

Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Identify the research problem	L3 – Apply
CO2	Collect, analyze the relevant literature and finalize the research problem	L4 - Analyze
CO3	Design the experiment, conduct preliminary experiment, analyze the data and conclude	L4 - Analyze
CO4	Prepare project report and present	L5 - Evaluate

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1		
CO2	3	3	3	2	2	
CO3	3	3	3	3	2	
CO4		3				1
Average	2.6	3	3	2	2	1
1–Low, 2 –Medium, 3–High						

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ME23VL602	PROJECT WORK – II	CP	L	T	P	C
		24	0	0	24	12
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To develop the skill of students for analysing VLSI systems
2	To expose the students to identify optimization methods and evaluate trade off in VLSI systems
3	To expose the students to assess the impact of optimization in VLSI systems

COURSE CONTENT:

It is the continuation of Phase I project. Three reviews will be conducted by project review committee Students will be evaluated by the committee during the review and suggestions will be offered by members

At least one paper should be published by the student in international / national conference

The report should be submitted by the students at the end of course

Course Out comes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Conduct investigation on sources of delay and power consumption in VLSI systems	L2 - Understand
CO2	Analyze the research problem and propose a solution by comprehensive analysis of literature	L4 – Analyze
CO3	Design experiment perform optimization of the VLSI system	L4 - Analyze
CO4	Evaluate the proposed solution with respect to existing literature	L5 – Evaluate
CO5	Prepare project report and present the findings	L3 - Apply

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3		
CO2	3	3	3	2		
CO3	3	3	3	3	2	
CO4		3			2	1
Average	2.6	3	3	2.6	2	1
1–Low, 2 –Medium, 3–High						

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ME23VL411	MEMS and NEMS	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To introduce the concepts of Micro Electromechanical devices
2	To know the fabrication process of microsystems
3	To know the design concepts of micro sensors and micro actuators
4	To familiarize concepts of Nano systems
5	To introduce the concepts of Quantum Mechanics

UNIT–I	OVERVIEW	9

New trends in Engineering and Science: Micro and Nanoscale systems (L2), introduction to design of MEMS and NEMS, MEMS and NEMS – applications (L2), devices and structures (L2). Materials for MEMS: Silicon, Silicon compounds (L2), polymers, metals (L2)

UNIT–II	MEMS FABRICATION TECHNOLOGIES	9

Microsystem Fabrication Processes: Photolithography (L2), Ion Implantation (L2), Diffusion, Oxidation (L2). Thin Film Depositions: LPCVD, Sputtering, Evaporation, Electroplating (L2); Etching Techniques: Dry and Wet Etching, Electrochemical Etching (L2); Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-Like) Technology (L2); Packaging: Microsystems Packaging, Essential Packaging Technologies, Selection of Packaging Materials (L2)

UNIT– III	MICRO SENSORS	9

MEMS Sensors: Design of Acoustic Wave Sensors (L2), Resonant Sensor, Vibratory Gyroscope, Capacitive and Piezo Resistive Pressure Sensors (L2)- Engineering Mechanics Behind These Microsensors (L2). Case Study: Piezo-Resistive Pressure Sensor (L2)

UNIT – IV	MICRO ACTUATORS	9

Design of Actuators: Actuation Using Thermal Forces (L3), Actuation Using Shape Memory Alloys, Actuation Using Piezoelectric Crystals (L3), Actuation using Electrostatic Forces (Parallel Plate, Torsion Bar, Comb Drive Actuators) (L3), Micromechanical Motors and Pumps (L2). Case Study: Comb Drive Actuators (L2)

UNIT–V	NANOSYSTEMS AND QUANTUM MECHANICS	9

Atomic Structures and Quantum Mechanics (L2), Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave Function Theory (L3), Density Functional Theory (L3), Nanostructures and Molecular Dynamics (L3), Electromagnetic Fields and their Quantization (L2), Molecular Wires and Molecular Circuits (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	Discuss micro sensors and its applications	L2 - Understand
CO2	Differentiate various MEMS fabrication techniques	L2 - Understand
CO3	Explain micro actuators with case study	L2 - Understand

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CO4	Describe function of micro actuators for different applications	L3 - APPLY
CO5	Apply wave functions to derive quantum parameters	L3 - APPLY

REFERENCE BOOKS:

1.	Chang Liu, "Foundations of MEMS", Pearson Education India Limited, 2nd Edition, 2006
2.	Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1st Edition, 1997
3.	Stephen D. Senturia, "Micro System Design", Kluwer Academic Publishers, 2nd Edition, 2001
4.	Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2nd Edition, 2002

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=w261_0ki6FQ
2.	https://www.youtube.com/watch?v=jQF4_hO_2qw

WEB REFERENCES:

1.	https://link.springer.com/book/10.1007/b136111
2.	https://cse.usf.edu/~haozheng/teach/soc/

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc24_ee09/preview
2.	https://online.stanford.edu/courses/engr240-introduction-micro-and-nano-electromechanical-systems

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High

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ME23VL412	NETWORK ON CHIP	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To understand the concept of Network - on - Chip
2	To learn router architecture designs
3	To study fault tolerance Network - on - Chip
4	To familiarize concepts of faults in NOC
5	To introduce the concepts of 3D architectures

UNIT–I	INTRODUCTION TO NOC	9

Introduction to NOC (L2)– OSI Layer Rules in NOC (L2) - Interconnection Networks in Network-On-Chip (L2) Network Topologies (L2)- Switching Techniques (L2)- Routing Strategies (L2)- Flow Control Protocol Quality-of-Service Support (L2)

UNIT–II	ARCHITECTURE DESIGN	9

Switching Techniques and Packet Format (L2)- Asynchronous FIFO Design (L3)- GALS Style of Communication (L2) - Wormhole Router Architecture Design (L3) - VC Router Architecture Design (L3) - Adaptive Router Architecture Design (L3)

UNIT–III	ROUTING ALGORITHM	9

Packet Routing-QOS (L2), Congestion Control and Flow Control (L2) – Router Design (L2) – Network Link Design (L2)– Efficient and Deadlock-Free Tree-Based Multicast Routing Methods (L2) - Path-Based Multicast Routing For 2D and 3D Mesh Networks (L3) - Fault-Tolerant Routing Algorithms (L3)- Reliable and Adaptive Routing Algorithms (L2)

UNIT–IV	TEST AND FAULT TOLERANCE OF NOC	9

Design-Security in Networks (L2) - On-Chips - Formal Verification of Communications in Networks (L3) - On Chips-Test and Fault Tolerance for Networks-On-Chip Infrastructures (L3)- Monitoring Services for Networks-On-Chips (L3)

UNIT–V	THREE-DIMENSIONAL INTEGRATION OF NETWORK-ON-CHIP	9

Three-Dimensional Networks-On-Chips Architectures (L3)– A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures (L3)- Resource Allocation for QOS On-Chip Communication (L3)– Networks-On-Chip Protocols (L2) - On-Chip Processor Traffic Modeling for Networks- On-Chip (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	Compare different architecture design	L2 - Understand
CO2	Discuss different routing algorithms	L3 - Apply
CO3	Explain three dimensional Networks on Chip architectures	L2 - Understand
CO4	Test and design fault tolerant NOC	L3 - Apply

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CO5	Design three dimensional architectures of NOC	L3 - Apply

REFERENCE BOOKS:

1.	Chrysosto MO, Snicopoulos, Vijaykrishnan Narayanan, Chita R.Das "Networks-On-Chip Architectures Holistic Design Exploration", Springer, 2nd Edition, 2012
2.	Fayez gebali, Haytham Elmiligi, Mohamed watheq El-Kharashi "Networks-On-Chips Theory and Practice", CRC Press, 1st Edition, 2009
3.	Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-On-Chip Architectures", Springer, 1st Edition, 2013
4.	Palesi, Maurizio, Daneshtalab, Masoud "Routing Algorithms in Networks-On-Chip", Springer, 1st Edition, 2014

VIDEO REFERENCES:

1.	NPTEL:: Electronics & Communication Engineering - Network on Chip
2.	https://www.youtube.com/watch?v=OArCsk3Dsxc

WEB REFERENCES:

1.	What is Network on Chip? | Synopsys
2.	Education | Network on Chip

ONLINE COURSES:

1.	Network on Chip- Course (nptel.ac.in)
2.	Network on Chip| Udemy

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High

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ME23VL413	EVOLVABLE HARDWARE	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To study about the evolvable systems algorithms, multi-objective utility functions
2	To understand the concepts of reliability, design-in redundancy, fault tolerance and defect tolerance
3	To design of evolvable systems using Programmable Logic Devices (like FPGAs)
4	To familiarize concepts of modular subsystems with identical components and generalized controller algorithms
5	To introduce the concepts of fault-tolerant systems

UNIT–I	INTRODUCTION	9

Traditional Hardware Systems and its Limitations (L2), Evolvable Hardware, Characteristics of Evolvable Circuits and Systems (L2), Technology-Extrinsic and Intrinsic Evolution (L3), offline and Online Evolution (L3), Applications and Scope of EHW (L2)

UNIT–II	EVOLUTIONARY COMPUTATION	9

Fundamentals of evolutionary algorithms (L2), components of EA (L2), variants of EA (L2), Genetic Algorithms (L3), genetic programming (L3), evolutionary strategies (L3), evolutionary programming (L3), implementations – evolutionary design and optimizations (L3), EHW – current problems and potential solutions (L2)

UNIT– III	RECONFIGURABLE DIGITAL DEVICES	9

Basic architectures (L2)– Programmable Logic Devices (L4), Field Programmable Gate Arrays (FPGAS) (L3), using reconfigurable hardware – design phase, execution phase (L4), evolution of digital circuits (L2)

UNIT – IV	RECONFIGURABLE ANALOG DEVICES	9

Basic architectures (L2) – Field Programmable Transistor Arrays (FPTAS) (L2), analog arrays (L2), MWMS (L2), using reconfigurable hardware – design phase (L2), execution phase (L2), evolution of analog circuits (L2)

UNIT–V	APPLICATIONS OF EHW	9

Synthesis vs. Adaptation (L2), designing self-adaptive systems (L3), fault-tolerant systems (L3), real-time systems (L2), intrinsic reconfiguration for online systems (L3), EHW based fault recovery and future work (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	Explain the fundamentals of computational models and evolvable hardware	L3 – Apply
CO2	Differentiate the various principles of bio-inspired and unconventional computational systems	L3 – Apply
CO3	Analyse the different reconfigurable digital architectures and its computational intelligence techniques.	L4 – Analyse
CO4	Analyse the different reconfigurable analog architectures and its computational intelligence techniques.	L2 – Understand

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CO5	Summarise the typical applications of bio-inspired and other EHW systems	L3 – Apply

REFERENCE BOOKS:

1.	Garrison W. Greenwood and Andrew M. Tyhrrell, "Introduction to Evolvable Hardware: a Practical Guide for Designing Self- Adaptive Systems", Wiley-Blackwell Press, 1st Edition, 2006
2.	Tetsuya Higuchi, Xin Yao and Yong Liu, "Evolvable Hardware", Springer-Verlag, 1st Edition, 2004
3.	Lukas Sekanina, "Evolvable Components: From Theory to Hardware Implementations", Springer Verlag, 1st Edition, 2004

VIDEO REFERENCES:

1.	Evolvable Hardware - YouTube
2.	https://www.youtube.com/watch?v=dpszamfrSrU

WEB REFERENCES:

1.	Evolvable Hardware (cadence.com)
2.	Evolvable Hardware /main/lectures (utexas.edu)

ONLINE COURSES:

1.	Evolvable Hardware - Course (nptel.ac.in)
2.	Evolvable Hardware /lectures (msu.edu)

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		3	1		
CO2	1		3	1		
CO3	1		3	2		
CO4	1		1	1		
CO5	1		1	1		
Average	1		2.2	1.2		

1–Low, 2 –Medium, 3–High.

6/7/24

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ME23VL414	SOFT COMPUTING AND OPTIMIZATION TECHNIQUES	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To classify various soft computing frame works
2	To be familiar with the design of neural networks, fuzzy logic, and fuzzy systems
3	To learn mathematical background for optimized genetic programming
4	To be exposed to neuro-fuzzy hybrid systems and its applications
5	To introduce the concepts of optimization techniques

UNIT–I	FUZZY LOGIC:	9

Introduction to Fuzzy logic (L2)- Fuzzy sets and membership functions (L2)- Operations on Fuzzy sets (L3)- Fuzzy relations, rules, propositions, implications and inferences (L3)- Defuzzification techniques (L3)- Fuzzy logic controller design (L3)- Some applications of Fuzzy logic (L2)

UNIT–II	ARTIFICIAL NEURAL NETWORKS	9

Supervised Learning: Introduction and how brain works (L2), Neuron as a simple computing element (L2), The perceptron (L3), Backpropagation networks: architecture, multilayer perceptron, backpropagation learning (L4)- input layer, accelerated learning in multilayer perceptron (L3), The Hopfield network (L4), Bidirectional associative memories (BAM) (L3), RBF Neural Network (L3). Unsupervised Learning: Hebbian Learning (L4), Generalized Hebbian learning algorithm (L4), Competitive learning (L3), Self- Organizing Computational Maps: Kohonen Network (L4)

UNIT– III	GENETIC ALGORITHM:	9

Genetic algorithm- Introduction (L2) - biological background (L2) - traditional optimization and search techniques (L3)- Genetic basic concepts (L2) - operators (L3) – Encoding scheme (L3) – Fitness evaluation (L3) – crossover - mutation (L2) - Travelling Salesman Problem (L3), Particle swam optimization (L3), Ant colony optimization (L3)

UNIT – IV	NEURO-FUZZY MODELING	9

Adaptive Neuro - Fuzzy Inference Systems (ANFIS) (L2) – architecture (L2) - Coactive Neuro - Fuzzy Modeling (L2), framework, neuron functions for adaptive networks (L2) – Data Clustering Algorithms (L3) – Rule base Structure Identification (L2) – Neuro-Fuzzy Control (L2) – the inverted pendulum system (L2)

UNIT–V	CONVENTIONAL OPTIMIZATION TECHNIQUES	9

Introduction to optimization techniques (L2), Statement of an optimization problem (L3), classification (L2), Unconstrained optimization - gradient search method -Gradient of a function, steepest gradient – conjugate gradient (L3), Newton's Method (L3), Marquardt Method (L3), Constrained optimization – sequential linear programming (L3), Interior penalty function method, external penalty function method (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	Apply different soft computing techniques like Fuzzy, GA and Neural network	L3 - Apply

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CO2	Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.	L4 - Analyze
CO3	Apply machine learning algorithms through Neural networks.	L3 – Apply
CO4	Explain Neuro Fuzzy system for clustering and classification.	L2–Understand
CO5	Apply the optimization techniques to solve the real-world problems	L3 - Apply

REFERENCE BOOKS:

1.	J.S.R.Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI / Pearson Education, 2nd Edition, 2004
2.	David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley, 1st Edition, 2009
3.	George J. Klir and Bo Yuan, "Fuzzy Sets, Fuzzy Logic-Theory and Applications", Prentice Hall, 1st Edition, 2015

VIDEO REFERENCES:

1.	Soft Computing– YouTube
2.	Optimization Techniques – YouTube

WEB REFERENCES:

1.	Resources–Soft Computing and Optimization Techniques – udemy course ware

ONLINE COURSES:

1.	Soft Computing and Optimization Techniques – Course (nptel.ac.in)

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1	2	1
CO2	1		2	1	2	1
CO3	1		2	1	2	1
CO4	1		2	1	2	1
CO5	1		2	1		1
Average	1		2	1	1.8	1

1–Low, 2 –Medium, 3–High.

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ME23VL415	CAD FOR VLSI DESIGN	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To introduce the VLSI design methodologies and design methods.
2	To introduce data structures and algorithms required for VLSI design.
3	To study algorithms for partitioning and placement.
4	To study algorithms for floor planning and routing.
5	To study algorithms for modelling, simulation and synthesis.

UNIT–I	INTRODUCTION	9

Introduction to VLSI Design Methodologies (L2)– VLSI Design Cycle (L2) – New Trends in VLSI Design Cycle (L2) – Physical Design Cycle (L2) – New Trends in Physical Design Cycle (L2) – Design Styles (L2) – Review of VLSI Design Automation Tools (L2)

UNIT–II	DATA STRUCTURES AND BASIC ALGORITHMS	9

Introduction to Data Structures and Algorithms (L3)– Algorithmic Graph Theory and Computational Complexity (L3) – Tractable and Intractable Problems (L3) – General Purpose Methods for Combinatorial Optimization (L3)

UNIT– III	ALGORITHMS FOR PARTITIONING AND PLACEMENT	9

Layout Compaction (L3) – Problem Formulation (L2) – Algorithms for Constraint Graph Compaction (L3) – Partitioning (L3) – Placement (L2) – Placement Algorithms (L3)

UNIT – IV	ALGORITHMS FOR FLOORPLANNING AND ROUTING	9

Floorplanning (L2)– Problem Formulation (L2) – Floorplanning Algorithms (L3) – Routing (L2) – Area Routing (L3) – Global Routing (L2) – Detailed Routing (L2)

UNIT–V	MODELLING, SIMULATION AND SYNTHESIS	9

Simulation (L2)– Gate Level Modeling and Simulation (L3) – Logic Synthesis and Verification (L3) – Binary Decision Diagrams (L3) – High Level Synthesis (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	Use various VLSI design methodologies	L2 - Understand
CO2	Understand different data structures and algorithms required for VLSI design	L3 – Apply
CO3	Analyse partitioning and placement efficiency using algorithms	L3 – Apply
CO4	Develop algorithms for floor planning and routing	L3 - Apply
CO5	Construct algorithms for modelling, simulation and synthesis	L3 - Apply

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REFERENCE BOOKS:	
1.	Sabih H. Gerez, "Algorithms for VLSI Design Automation", Wiley-India, 2nd Edition, 2017
2.	Naveed a. Sherwani, "Algorithms for VLSI Physical Design Automation", Springer, 3rd Edition, 2017
3.	Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, "Handbook of Algorithms for Physical Design Automation", CRC Press, 1st Edition, 2008
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=bNGxSmgo_ic&list=PLrEFqtWVv0o56q3dY2kX14E6_NxKwgWOg
2.	https://www.youtube.com/watch?v=hJTK5nj1iq8
WEB REFERENCES:	
1.	NPTEL:: Electronics & Communication Engineering – CAD for VLSI Design
ONLINE COURSES:	
1.	https://archive.nptel.ac.in/courses/106/106/106106088/

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

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ME23VL416	VLSI Architectures for Image Processing	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To introduce the VLSI architectures for image processing
2	To introduce concepts of 3D image processing
3	To study algorithms for binary image processing
4	To study VLSI pipeline architectures for image processing
5	To study VLSI subsystems for image analysis

UNIT–I	IMAGE PROCESSING ALGORITHMS AND ARCHITECTURES	9

Image Processing Tasks (L2) - Low Level Image Processing Operations (L3) - Intermediate Level Operations (L3), Image Processor Architecture: Requirements and Classification (L2)- Uni and Multi Processors (L2)- MIMD Systems (L2)- SIMD Systems (L2)- Pipelines (L2)- Design Aspects of Real-Time Low-Level Image Processors (L2)- Design Method for Special Architectures (L2)

UNIT–II	3D IMAGE PROCESSING	9

Overview of 3D Image (L2) - Types and Characteristics of 3D Image Processing (L2) - Examples of 3D Image Processing (L2), Continuous and Digitized Images (L2), Models of Image Operations (L3), Algorithm of Image Operations (L3) - Smoothing Filter (L3) - Difference Filter (L3) - Differential Features of a Curved Surface (L3) - Region Growing (L2)

UNIT– III	3D BINARY IMAGE PROCESSING	9

Introduction (L2)- Labeling of a Connected Shrinking Surface (L3), Thinning and Axis Thinning (L3)- Distance Transformation and Skeleton (L2) -Border Surface Following (L2) -Knot and Link (L2) - Voronoi Division of a Digitized Image (L3) - Algorithms for Processing Connected Components with Gray Values (L3)

UNIT – IV	PIPELINED, 2D AND 3D IMAGE PROCESSING ARCHITECTURES	9

Architecture of a Cellular Logic Processing Element (L2) - Second Decomposition in Data Path and Control (L3) - Real Time Pipeline for Low Level Image Processing (L3) - Design Aspects of Image Processing Architectures (L3) - Implementation of Low Level 2D and 3D and Intermediate Level Algorithms (L3)

UNIT–V	VLSI SYSTEMS FOR IMAGE PROCESSING	9

Concurrent Systems for Image Analysis (L2) - VLSI Wavefront Arrays for Image Processing (L3) - Curve Detection in VLSI (L3) - Design of VLSI Based Multicomputer Architecture for Dynamic Scene Analysis (L3), VLSI-Based Image Resampling for Electronic Publish (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	Apply Various Architectures to Realize Image Processing Algorithms in 3D Image Processing Algorithms	L2 - UNDERSTAND

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CO2	Apply Various Processing Techniques of Image and Design Different Architectures for Image Processing	L3 - APPLY
CO3	Construct various pipelined hardware architecture for 2D and 3D Image processing	L3 - APPLY
CO4	Realize binary image processing algorithm in VLSI systems	L3 - APPLY
CO5	Implement filter techniques in 2D and 3D image	L3 - APPLY

REFERENCE BOOKS:

1.	Pieter Jonker, "Morphological Image Processing: Architecture and VLSI Design", Springer, 1st Edition, 1992
2.	Junichiro Toriwaki, Hiroyuki Yoshida, "Fundamentals of Three-Dimensional Digital Image Processing", Springer, 1st Edition, 2010
3.	King-Sun Fu, "VLSI for Pattern Recognition and Image Processing", Springer-Verlag, 1st Edition 2012

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=X0eBZUt9NRs&list=PLfMCiCIRnpUnFgNSy0QuOuqIIrG0fe5eD
2.	https://www.youtube.com/watch?v=iG5jqJde5EM

WEB REFERENCES:

1.	https://www.hindawi.com/journals/vlsi/2014/872501/
2.	https://www.sciencedirect.com/science/article/abs/pii/0141933183905367

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc24_ee63/preview
2.	https://onlinecourses.nptel.ac.in/noc19_ee55/preview

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	1	
CO5	1		1	1	1	
Average	1		1	1	1	

1–Low, 2 –Medium, 3–High.

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ME23VL417	SYSTEM VERILOG	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To give insight on System Verilog Concepts - Synthesis, Analysis and Architecture Design
2	To study System Verilog and SVA for improvements in Verification Efficiency
3	To introduce advanced verification features, such as the practical use of classes, randomization, checking, and coverage
4	To study interprocess communication and test coverage
5	To give insight on top level design of system verilog

UNIT–I	VERIFICATION METHODOLOGY	9

Verification Guidelines: Introduction (L2), Verification Process (L2), Verification Plan (L2), Verification Methodology Manual (L2), Basic Testbench Functionality (L2), Directed Testing (L2), Methodology Basics (L2), Constrained-Random Stimulus (L2), Functional Coverage (L2), Test bench Components (L2), Layered Testbench (L2)

UNIT–II	SYSTEM VERILOG BASICS AND CONCEPTS	9

Data Types: Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues (L2), Creating New Types with Typedef (L3), Creating User-Defined Structures (L3), Enumerated Types (L3), Constants, Strings (L2). Procedural Statements and Routines: Procedural Statements (L3), Tasks, Functions, and Void Functions (L3)

UNIT–III	OOPS	9

Introduction (L2)- Where to Define a Class (L2)- OOPS Terminology - Creating New Objects (L3)- Object De allocation (L3) - Using Objects - Static Variables Vs. Global Variables (L3) -Class Routines (L2) - Defining Routines Outside of The Class (L3) - Scoping Rules (L2)- Using One Class Inside Another (L3)- Understanding Dynamic Objects (L2) - Copying Objects (L2) - Public Vs. Private (L2) - Straying Off Course (L2) - Building a Test bench (L3)

UNIT–IV	THREADS AND INTER-PROCESS COMMUNICATION AND FUNCTIONAL COVERAGE	9

Working With Threads (L3), Inter-Process Communication (L3), Events, Semaphores, Mailboxes (L3), Building a Testbench with Threads and IPC (L3). Coverage Types (L2), Functional Coverage Strategies (L2), Simple Functional Coverage Example (L3), Coverage Options (L3), Parameterized Cover Groups (L3), Analysing Coverage Data (L2), Measuring Coverage Statistics (L2)

UNIT–V	COMPLETE DESIGN MODEL USING SYSTEM VERILOG-CASE STUDY	9

System Verilog ATM Example (L3), Data Abstraction (L2), Interface Encapsulation (L3), Design Top Level Squat, Receivers and Transmitters (L3), Test Bench for ATM (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

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Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Explain the system verilog verification models for digital designs	L2 - Understand
CO2	Apply system verilog to create testbenches for digital designs	L3 - Apply
CO3	Build new constructs in System Verilog for verification	L3 - Apply
CO4	Describe the communication between system verilog modules	L3 - Apply
CO5	Design a complete system model using Verilog	L3 - Apply

REFERENCE BOOKS:	
1.	Chris Spear, "System Verilog for Verification: a Guide to Learning the Testbench Language Features", Springer, 1st Edition, 2006
2.	Janick Bergeron, "Writing Testbenches: Functional Verification of HDL Models", 2nd Edition, Kluwer Academic Publishers, 2003
3.	Stuart Sutherland, Simon Davidman and Peter Flake, "System Verilog for Design: a Guide to Using System Verilog for Hardware Design and Modeling", 2nd Edition, Springer
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=zLZRwOkGLNA&list=PLDAnhhk0KczzWXNfA7S58FjlnCP71IzF
2.	https://www.youtube.com/watch?v=0oMTDaEy5o&list=PLDAnhhk0KczzWXNfA7S58FjlnCP71IzF o&index=5
WEB REFERENCES:	
1.	https://www.chipverify.com/tutorials/systemverilog
2.	https://www.systemverilog.in/p/systemverilog-tutorial.html
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc21_ee97/preview
2.	https://onlinecourses.nptel.ac.in/noc24_cs61/preview

Mapping of COs with POs

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

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ME23VL418	ADAPTIVE SIGNAL PROCESSING	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To study the basic principles of discrete random signal processing
2	To introduce the principles of spectral estimation
3	To learn about the weiner and adaptive filters
4	To understand the different signal detection and estimation methods
5	To acquire skills to design synchronization methods for proper functioning of the system

UNIT–I	DISCRETE RANDOM SIGNAL PROCESSING	9

Discrete Random Processes (L2), Random Variables (L2), Parseval's Theorem (L2), Wiener-Khintchine Relation (L3), Power Spectral Density (L3), Spectral Factorization (L3), Filtering Random Processes (L3), Special Types of Random Processes (L2)

UNIT–II	SPECTRAL ESTIMATION	9

Introduction (L2), Nonparametric Methods – Periodogram (L3), Modified Periodogram (L3), Bartlett, Welch and Blackman-Tukey Methods (L3), Parametric Methods – ARMA, AR and MA Model Based Spectral Estimation (L3), Solution Using Levinson-Durbin Algorithm (L3)

UNIT– III	WEINER AND ADAPTIVE FILTERS	9

Weiner Filter: FIR Wiener Filter (L4), IIR Wiener Filter (L4), Adaptive Filter: FIR Adaptive Filters (L4)– Steepest Descent Method (L3)- LMS Algorithm (L3), RLS Adaptive Algorithm (L4), Applications (L2)

UNIT – IV	ARITHMETIC BUILDING BLOCKS	9

Bayes Detection Techniques (L2), Map, Ml – Detection of M-Ary Signals (L2), Neyman pearson, Minimax Decision Criteria (L2), Kalman Filter- Discrete Kalman Filter (L3), The Extended Kalman Filter (L3), Application (L2)

UNIT–V	SYNCHRONIZATION	9

Signal Parameter Estimation (L3), Carrier Phase Estimation (L3), Symbol Timing Estimator (L3), Joint Estimation of Carrier Phase and Symbol Timing (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	Apply the basic principles of discrete random signal processing	L3 – Apply
CO2	Construct the principles of spectral estimation	L3 – Apply
CO3	Analyze the Weiner and Adaptive filters	L4 – Analyse
CO4	Explain the different signal detection and estimation methods.	L2 – Understand
CO5	Apply the synchronization methods for proper functioning of the system	L3 - Apply

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REFERENCE BOOKS:	
1.	Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, 2nd Edition, 2009
2.	John G. Proakis, "Digital Communication", McGraw Hill Publications, 4th Edition, 2001
3.	Simon Haykin, "Adaptive Filter Theory", 4th Edition, Pearson Education, 2003
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=nkGPnTzPqrk&list=PLCVaVjGeO3uFc4uEy3oFddcEc_8FO_0Sx
2.	https://www.youtube.com/watch?v=ya0-S1apej8
WEB REFERENCES:	
1.	https://www.sciencedirect.com/topics/engineering/adaptive-signal-processing
2.	https://abrarhashmi.wordpress.com/wp-content/uploads/2016/02/bernard-widrow-peter-n-stearns-adaptive-signal-processing-prentice-hall-1985.pdf
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc23_ee138/preview
2.	https://www.nptelvideos.com/electronics_and_communications/adaptive_signal_processing/

Mapping of COs with POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	1	1	1
CO2	1	1	2	1	1	1
CO3	2		2	1	1	1
CO4	2		1	1	1	1
CO5	2	1	2	2	1	1
Average	1.6	1	1.6	1.2	1	1

1–Low, 2 –Medium, 3–High.

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ME23VL419	MACHINE LEARNING	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To understand the concepts and mathematical foundations of machine learning
2	To explore the different supervised learning techniques including ensemble methods
3	To learn different aspects of unsupervised learning and reinforcement learning
4	To learn the role of probabilistic methods for machine learning
5	To understand the basic concepts of neural networks and deep learning

UNIT–I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS	9

What is Machine Learning? Need –History – Definitions (L2)– Applications – Advantages, Disadvantages & Challenges (L2) –Types of Machine Learning Problems (L2) – Mathematical Foundations (L2) – Linear Algebra & Analytical Geometry (L23) – Probability and Statistics (L3) - Bayesian Conditional Probability (L3) - Vector Calculus & Optimization (L3) – Decision Theory (L2) – Information theory (L2)

UNIT–II	SUPERVISED LEARNING	9

Introduction - Discriminative and Generative Models (L2) –Linear Regression - Least Squares – Under fitting / Over fitting –Cross Validation – Lasso Regression (L2) - Classification - Logistic Regression (L2) - Gradient Linear Models – Support Vector Machines (L2) – Kernel Methods (L2) – Instance based Methods (L2) – K-Nearest Neighbours (L2) – Tree based Methods (L2) – Decision Trees (L2) – ID3 – CART (L2) – Ensemble Methods – (L2) Random Forest (L2) – Evaluation of Classification Algorithms (L2)

UNIT– III	UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING	9

Introduction – Clustering Algorithms (L3) – K Means – Hierarchical Clustering (L3) – Cluster Validity – Dimensionality Reduction (L3) – Principal Component Analysis – Recommendation Systems (L3) - EM algorithm (L3), Reinforcement Learning (L2) – Elements – Model based Learning (L2) – Temporal Difference Learning (L3)

UNIT – IV	PROBABILISTIC METHODS FOR LEARNING	9

Introduction (L2)– Naïve Bayes Algorithm (L3) – Maximum Likelihood –Maximum Apriori (L2) – Bayesian Belief Networks (L3) – Probabilistic Modelling of Problems (L3) – Inference in Bayesian Belief Networks (L3) – Probability Density Estimation (L2)– Sequence Models (L2) – Markov Models – Hidden Markov Models (L3)

UNIT–V	NEURAL NETWORKS AND DEEP LEARNING	9

Neural Networks (L2) – Biological Motivation (L2) - Perceptron (L3) – Multi-layer Perceptron (L3) – Feed Forward Network (L3) – Back Propagation-Activation and Loss Functions (L4) - Limitations of Machine Learning (L2) – Deep Learning (L2) – Convolution Neural Networks (L4) – Recurrent Neural Networks (L3) – Use cases (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

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Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Outline the mathematical concepts of each type of machine learning	L3 - Apply
CO2	Describe the algorithms of supervised learning	L2 - Understand
CO3	Implement reinforcement learning algorithms for an application and analyze the results	L3 – Apply
CO4	Implement typical Clustering algorithms for different types of applications	L3 - Apply
CO5	Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification	L4 - Analyse

REFERENCE BOOKS:

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", CRC Press, 2nd Edition, 2014
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 1st Edition, 2012
3. Ethem Alpaydin, "Introduction to Machine Learning - Adaptive Computation and Machine Learning Series", MIT Press, 3rd Edition, 2014

VIDEO REFERENCES:

1. https://www.youtube.com/watch?v=ukzFI9rgwfU
2. https://www.youtube.com/watch?v=PeMlggyqz0Y

WEB REFERENCES:

1. https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-ml/
2. https://www.ibm.com/topics/machine-learning

ONLINE COURSES:

1. https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2. https://onlinecourses.nptel.ac.in/noc23_ee87/preview

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High.

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ME23VL420	ADVANCED DIGITAL IMAGE PROCESSING	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

Instructions if any

Course Objectives:

1	To provide the student with basic understanding of image fundamentals and transforms
2	To provide exposure to the students about image enhancement and restoration
3	To impart a thorough understanding about segmentation and Recognition
4	To know the Video Processing and motion estimation
5	To study the concepts will enable students to design and develop an image processing application

UNIT–I	FUNDAMENTALS OF IMAGE PROCESSING AND TRANSFORMS	9

Introduction (L2), Image sampling, Quantization, Resolution (L2), Image file formats (L2), Elements of image processing system (L2), Need for transform, image transforms (L2), Fourier transform, 2 D Discrete Fourier transform (L2), Walsh transform, Hadamard transform, Haar transform, KL transform (L2), singular value decomposition (L2), Radon transform (L2), comparison of different image transforms (L2), Digital Camera working principle (L2)

UNIT–II	ENHANCEMENT AND RESTORATION	9

Spatial domain methods: Histogram processing (L2), Fundamentals of Spatial filtering (L2), Smoothing spatial filters, Sharpening spatial filters (L3). Frequency domain methods: Basics of filtering in frequency domain (L3), image smoothing, image sharpening (L3), Introduction to Image restoration, Image degradation, Image restoration model (L3), Linear and Nonlinear image restoration techniques (L3), Blind deconvolution (L3), Color image enhancement (L2)

UNIT– III	SEGMENTATION AND RECOGNITION	9

Edge detection (L2), Edge linking via Hough transform (L3) – Thresholding (L3) – Region based segmentation (L4) – Region growing (L4) – Region splitting and merging (L3)– Morphological processing- erosion and dilation (L4), Boundary representation (L2), Boundary description (L2), Fourier Descriptor (L2), Regional Descriptors – Topological feature (L4), Texture – Patterns and Pattern classes (L4) – Recognition based on matching (L2)

UNIT – IV	BASIC STEPS OF VIDEO PROCESSING	9

Analog Video, Digital Video (L3), Time-Varying Image Formation models: Three-Dimensional Motion Models (L4), Geometric Image Formation, Photometric Image Formation (L4), Sampling of Video signals (L2), Filtering operations (L2)

UNIT–V	2-D MOTION ESTIMATION	9

Optical flow, optical flow constraints (L2), General Methodologies, Pixel Based Motion Estimation (L2), Block Matching Algorithm (L2), Mesh based Motion Estimation (L2), Global Motion Estimation (L2), Region based Motion Estimation (L2), Multi resolution motion estimation (L2), Waveform based coding, Block based transform coding, Predictive coding (L2), Application of motion estimation in Video coding (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

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Course Out comes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Explain the digital image, representation of digital image and digital images in transform Domain	L2 - Understand
CO2	Apply the detection of point, line and edges in images in various image compression techniques	L3 – Apply
CO3	Analyze the video technology from analog color TV systems to digital video systems, how video signal is sampled and filtering operations in video processing	L4 – Analyse
CO4	Apply the general coding methodologies for 2D motion estimation in video processing	L3 - Apply
CO5	Describe image and video processing systems	L2 - Understand

REFERENCE BOOKS:

1.	Gonzalez and Woods, "Digital Image Processing" Pearson, 3rd Edition, 2016
2.	Alan.C.Bovik, "Handbook of Image and Video processing", Academic press, 2nd Edition, 2010
3.	K.R.Castelman, "Digital Image processing", Prentice Hall, 1st Edition 2007

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=xUCsfKA8bi0&list=PLm_MSClsnwm9I2iviE0YKt6PZTyQCYc8j
2.	https://www.youtube.com/watch?v=DSGHkvQBMbs&list=PLuv3GM6gsE08DuaC6pFUvFaDZ7EnWGX

WEB REFERENCES:

1.	https://catalog.olemiss.edu/engineering/engs-673
2.	https://www.geeksforgeeks.org/digital-image-processing-basics/

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc23_cs218/preview

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High.

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ME23VL421	MEDICAL IMAGE ANALYSIS	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

(Special Elective)

Course Objectives:

1	To apply image enhancement and restoration techniques in medical images
2	To apply the image registration techniques for given medical image modalities
3	To segment and analysis the given medical image modalities
4	To apply computer- aided diagnosis methods for medical image processing and analysis
5	To apply deep learning techniques for given medical imaging modalities

UNIT–I	INTRODUCTION TO IMAGE PROCESSING	9

Overview of medical imaging modalities (X-ray, CT, MRI, Ultrasound, PET) (L2), Fundamentals of image formation and acquisition (L2), Image enhancement (filtering, contrast adjustment, histogram equalization) (L3), Image restoration (denoising, deblurring) (L3), Feature extraction and representation (L3)

UNIT–II	IMAGE REGISTRATION	9

Image registration (L2), Rigid transformation models (translation, rotation, scaling) (L3), non-rigid transformation models (elastic, spline-based, deformable) (L3), Practical applications of image registration in medical imaging (L2)

UNIT– III	IMAGE SEGMENTATION	9

Introduction to statistical shape models (L2), Principal component analysis (PCA) for shape modeling (L4), Applications in organ segmentation (L4), Partial differential equations (PDE) in image segmentation (L3), Level set methods and active contour models (L4), Applications in segmenting complex anatomical structures (L3), Practical applications of segmentation techniques (L2)

UNIT – IV	COMPUTER AIDED DIAGNOSIS	9

Introduction to computer-aided diagnosis (CAD) (L2), Case study on CAD for cancer detection (L4), Evaluation metrics (sensitivity, specificity, ROC analysis) (L4), Advanced CAD applications (L2), Integration of CAD systems in clinical workflow (L4), Ethical and regulatory considerations (L2)

UNIT–V	DEEP LEARNING FOR MEDICAL IMAGE ANALYSIS	9

Basics of deep learning in medical imaging (L2), 3D convolutional neural networks (CNNs) and architectures (L4), Applications in volumetric image analysis (L4)
Introduction to generative models (GANs, VAEs) (L4), Synthetic data generation for training deep learning models (L4), Applications in data augmentation and anomaly detection (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	Apply image enhancement and restoration techniques for given medical images	L3 – Apply
CO2	Apply image registration techniques for given medical images	L3 – Apply
CO3	Segment and analysis the given medical images	L4 – Analysis

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CO4	Analysis the given medical images by using computer-aided diagnosis	L4 - Analysis
CO5	Utilize the deep learning techniques to analysis the given medical images	L4 - Analysis

REFERENCE BOOKS:

1.	Atam P. Dhawan, "Medical Image Analysis", John Wiley & Sons, 1st Edition, 2010
2.	S. Kevin Zhou, Hayit Greenspan and Dinggang Shen, "Deep Learning for Medical Image Analysis", Elsevier, 1st Edition, 2017
3.	Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis and Machine Vision", Springer, 4th Edition, 2017
4.	Jerry L. Prince, Jonathan M. Links, "Medical Imaging Signals and Systems", Pearson Education, 1st Edition, 2014
5.	I.N. Bankman, "Handbook of Medical Image Processing and Analysis", Academic Press, 3rd Edition, 2008

VIDEO REFERENCES:

1.	https://onlinecourses.nptel.ac.in/noc22_bt34/preview
2.	https://onlinecourses.nptel.ac.in/noc24_ee57/preview

WEB REFERENCES:

1.	https://www.iitk.ac.in/cce/courses/23-24/BioMed/

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc23_cs218/preview

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High.

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ME23VL422	APPLIED OPTIMIZATION FOR WIRELESS AND BIGDATA	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

(Special Elective)

Course Objectives:

1	To understand the different techniques in wireless data transmission
2	To understand the basics of big data analytics
3	To introduce statistic and analytic tools in bigdata
4	To learn database frameworks in bigdata
5	To gain knowledge of bigdata optimization techniques

UNIT–I	WIRELESS DATA TRANSMISSION	9

Distributed data Streams (L2)- Dynamic data transmission in Wireless Sensor Networks (L2)- optimization techniques for wireless sensor networks (L2)- secure and efficient data transmission (L2)- Optimized Leach Protocol (L2)- MIMO Antenna design for Wireless Applications (L2)- Optimal Precoding in Hybrid MIMO systems (L3)- Wireless Underground networks (L2)- Radio propagation models (L2)

UNIT–II	INTRODUCTION TO BIGDATA	9

Introduction to Big Data Platform (L2) - Challenges of Conventional Systems (L2) - Intelligent data analysis (L2) - Nature of Data (L2) - Analytic Processes and Tools (L2) - Analysis Vs Reporting (L3) - Modern Data Analytic Tools (L2) - Statistical Concepts: Sampling Distributions (L2) - Re-Sampling - Statistical Inference - Prediction Error (L2)

UNIT– III	BIGDATA AND ALGORITHMS	9

Challenges of handling big data (L2) - data chain of Big Data application (L2) - Linear Regression (L3)- Decision Trees (L3)- Support Vector Machines (L3)- K-Nearest Neighbors (L3)– Clustering (L2)- Adaptive QOS (L2)- Aware scheduling algorithm (L3)- Big data in agriculture case studies (L2)

UNIT – IV	BIGDATA FRAMEWORKS	9

Map Reduce – Hadoop, Hive, MapR– Sharding (L2)– NoSQL Databases (L2)- Hadoop Distributed File Systems (L2)– Case Study (L2)- Preventing Private Information Inference Attacks on Social Networks (L2)

UNIT–V	OPTIMIZATION TECHNIQUES IN BIGDATA	9

Classification of optimization techniques (L2)– bigdata optimization techniques (L3)- Evaluation of Technique Effectiveness (L3) - Optimizing Intelligent Reduction Techniques for Big Data (L3) - query optimization process (L2) - ant colony optimization (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	Explain the different techniques in wireless data transmission	L2 - Understand
CO2	Describe the basic concept of bigdata analytics	L2 - Understand
CO3	Apply algorithmic tools for prediction in bigdata analytics	L3 - Apply
CO4	Relate the database framework in bigdata analytics	L2 - Understand
CO5	Apply various optimization techniques in bigdata	L3 - Apply

REFERENCE BOOKS:

1. Georgios Skourletopoulos, George Mastorakis, "Mobile Big data", Springer, 1st Edition, 2018

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2.	Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2nd Edition, 2019
3.	Bill franks, "Taming the Big Data Tidal Wave", John Wiley & sons, 1st Edition, 2012
4.	Hannah Bast, Claudius Korzen, "Algorithms for Big Data" Springer, 1st Edition, 2022
5.	Ali Emrouznejad, "Big Data Optimization: Recent Developments and Challenges", Springer 1st Edition, 2018
VIDEO REFERENCES:	
1.	https://onlinecourses.nptel.ac.in/noc20_ee59/preview
2.	https://archive.nptel.ac.in/noc/courses/noc16/SEM2/noc16-cs12/
WEB REFERENCES:	
1.	https://www.simplilearn.com/tutorials/big-data-tutorial/big-data-applications
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee63/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.						

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ME23VL423	MEDICAL IMAGE PROCESSING	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. VLSI DESIGN	Version: 1.0				

(Special Elective)

Course Objectives:

1	To understand the medical image formation principles such as X-Ray and CT
2	To learn how to store and process medical images for analysis
3	To become familiar with the fundamentals of image visualization
4	To understand the process of segmentation and classification of the field of medical image processing
5	To understand the concepts of nuclear imaging technologies

UNIT–I	INTRODUCTION	9

Introduction to medical imaging technology (L2) - systems, and modalities (L2) - Brief history – importance – applications – trends – challenges (L2) - Medical Image Formation Principles (L2) - X-Ray physics - X-Ray generation – attenuation – scattering (L2) - Basic principles of CT - reconstruction methods – artifacts - CT hardware (L2)

UNIT–II	STORAGE AND PROCESSING	9

Medical Image Storage (L2)- Archiving and Communication Systems and Formats Picture archiving and communication system (PACS) (L2) - Formats: DICOM Radiology Information Systems (RIS) and Hospital Information Systems (HIS) (L2) - Medical Image Processing (L2)– Enhancement - Filtering Basic image processing algorithms (L2), Thresholding - contrast enhancement (L2) - SNR characteristics - filtering - histogram modeling (L2)

UNIT– III	VISUALIZATION	9

Medical Image Visualization Fundamentals of visualization (L2)- surface and volume rendering/visualization (L3) – animation – interaction (L2) - Magnetic Resonance Imaging (MRI) (L2)- Mathematics of MR (L3)- spin physics (L2)- NMR spectroscopy (L3) - imaging principles and hardware (L2) - image artifacts (L2)

UNIT – IV	SEGMENTATION AND CLASSIFICATION	9

Medical Image Segmentation (L2)- Histogram-based methods (L2)- Region growing and watersheds (L2)- Markov Random Field models (L2)- active contours - model-based segmentation (L2)- multi-scale segmentation (L2)- semi-automated methods (L2)- clustering-based methods (L2)- classification-based methods (L2)- atlas-guided approaches - multi-model segmentation (L2)- Medical Image Registration Intensity (L2) -based methods - cost functions - optimization techniques (L2)

UNIT–V	NUCLEAR IMAGING	9

PET and SPECT Ultrasound Imaging methods (L2)- mathematical principles (L3)– resolution - noise effect (L3) - 3D imaging - positron emission tomography (L2) - single photon emission tomography (L2)- ultrasound imaging (L2)– applications - Medical Image Search and Retrieval (L3), Current technology in medical image search (L2) - content-based image retrieval (L3) - new trends – ontologies – Applications (L2)- Other Applications of Medical Imaging Validation (L3)- Image Guided Surgery (L2)- Image Guided Therapy (L2)- Computer Aided Diagnosis/Diagnostic Support Systems (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	Represent the medical image formation principles	L2 - Understand
CO2	Compare and contrast the storage and classification techniques involved in	L2 - Understand

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	medical image processing	
CO3	Illustrate the fundamentals of medical image visualization techniques	L3 - Apply
CO4	Elaborate various methods of segmentation and classification in medical image processing	L2 - Understand
CO5	Illustrate the technologies involved in nuclear imaging	L3 - Apply

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", PHI learning, 2nd Edition, 2012
2.	Yoshua Bengio, Aaron Courville, Ian Good fellow, "Deep Learning", MIT Press, 1st Edition, 2016
3.	Trevor Hastie, Robert Tibshirani and Jerome Friedman, "The Elements of Statistical Learning", 2nd Edition, 2009
4.	Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 1st Edition, 2006
5.	Shai Shalev, Shwartz, Shai Ben David, "Understanding Machine Learning", Cambridge University Press, 1st Edition, 2017

VIDEO REFERENCES:

1.	https://onlinecourses.nptel.ac.in/noc20_ee59/preview
2.	https://archive.nptel.ac.in/noc/courses/noc16/SEM2/noc16-cs12/

WEB REFERENCES:

1.	https://www.simplilearn.com/tutorials/big-data-tutorial/big-data-applications

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc22_ee63/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
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